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Review of fisheries management issues and regimes in the Pacific Islands Region

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Contents

Abbreviations and Acronyms

CITES	Washington Convention on International Trade in Endangered Species of Wild Flora and Fauna
CMT	Customary Marine Tenure
CNMI	Commonwealth of the Northern Mariana Islands
CZM	Coastal Zone Managemment
DWFNs	Distant water fishing nations
EEZ	Exclusive Economic Zone
FFA	South Pacific Forum Fisheries Agency
FFVs	Foreign fishing vessels
FS	`Forum Secretariat
FSM	Federated States of Micronesia
GEF	Global Environment Facility
IA	Agreement for the Implementation of the Provisions of the United Nations Convention of the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
IW	International Waters
LME	Large marine ecosystem
MARPOL	International Convention for the Prevention of Pollution from Ships
MBSY	Maximum Biologically Sustainable Yield
MEY	Maximum Economic Yield
MHLC	Multilateral High-Level Consultation on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific
mmt	million metric tonne
PIC	Pacific Island Country
PICTs	Pacific Island Countries and Territories
PIMRIS	Pacific Island Marine Resource Information Service
PNG	Papua New Guinea
ROs	Regional Organisations
SAP	Strategic Action Programme
SIDS	Small island developing state
SOPAC	South Pacific Bureau for Applied Geoscience
SPC	South Pacific Commission
SPOCC	South Pacific Organisations Coordinating Committee
SPREP	South Pacific Regional Environment Programme
SSA	SPC Statistical Area
ToR	Terms of Reference
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
USA	United States of America
USP	University of the South Pacific
WCPO	Western Central Pacific Ocean
WPWP	Warm Pacific Warm Pool

Executive Summary

The Pacific Island region's coastal fisheries produce a little over 100,000 tonnes of fish and seafood products per year. They are very significant in providing food, income and jobs for Pacific Islanders, and further contribute to Pacific Island economies through import substitution and generation of export earnings. However their sustainability is uncertain due to two main threats: overfishing and habitat degradation. In many of the most accessible localities fisheries production from coastal areas is thought to be at or beyond maximum sustainable yield and higher production cannot be expected. Population growth in the region will lead to increased fishing and decreased yields, especially near urban areas. Additional coastal fishing pressure will result from growing international demand for seafood caused by expanding markets and trade liberalization. The situation in regard to habitat degradation is worsening and the ability of coastal ecosystems to absorb further deleterious changes may be diminishing.

Although these issues are becoming more widely known among Pacific Island fisheries and planning officials, corrective or mitigating action to date has been limited. This is attributable to limited fisheries management capacity in Pacific Island countries, inadequate knowledge about the production potential and exploitation status of particular resources, and prioritization of other issues over fisheries and coastal zone management. In some countries there is complacency and a lack of political will or ability to institute fisheries or coastal zone management. Major efforts need to be made at a regional level to: carry out research that will increase understanding of coastal fishery resources and their response to exploitation; develop broad management guidelines or 'rules of thumb' for key species; raise awareness of the need for coastal fishery management among resource users and administrators; put in place suitable coastal fishery management regimes, especially those based on co-management; and promote the uptake of coastal zone management principles and practices in Pacific Island countries.

The tuna fishery of the wider Pacific region presently produces about 1 million tonnes of tuna, plus an unknown amount of by-catch each year, most of which is harvested by foreign fishing vessels. The tuna stocks on which the fishery is based are not believed to be biologically overexploited at this time, although the market-led growth of the fishery during the last few years may be a cause for concern. The fishery provides income to Governments of the region and employment for Pacific Islanders, and has the potential to provide much more, as well as to contribute more directly to the region's food supply. Less than 0.25% of the catch from the regional tuna fishery enters the domestic food supply of Pacific Island countries, even though a substantial portion is discarded at sea due to being lower-value or undesirable species or the tuna being too small. There is a need for regional-level action to promote the development of domestic tuna fisheries as a means of increasing the contribution of offshore resources to regional economic and food security, and of diverting fishing pressure away from over-exploited coastal resources.

Various studies have found significant gaps in international efforts to conserve tunas and other large ocean fishes in the Pacific Ocean. The gaps may be divided into two classes: geographical and functional. Geographical gaps result from incomplete geographical coverage by fisheries management regimes. Functional gaps result from the lack of authority or capability in such a regime to carry out some key element in conservation, such as enforcement or data collection and analysis. At present the management of the international tuna fishery in the region may be said to be deficient in both these areas. There is a need to support and strengthen the institutional arrangements for management of the region's international tuna fishery.

Although a great deal of progress has been achieved to date in researching and managing the regional tuna fishery, there is a pressing need for additional research programmes to address the stock status of the four main target tuna species (especially bigeye, which may be most in danger of over-exploitation) as well as of many poorly-known by-catch species, including billfishes and sharks. These need to be carried out in parallel with the development of a broader-based management regime which covers the entire geographical and biological range of the fishery and which meets recently agreed international requirements in regard to sustainable exploitation and conservation. There is also a need for further large-scale study of the Western Pacific Warm Pool (WPWP) large marine ecosystem, tailored to the development of an ecosystem approach to the management of the area.

Many of these issues are identified as trans-boundary problems, or problems with trans-boundary dimensions, which require or would benefit from the development of solutions at a regional or international level. Specific recommendations on possible regional actions, to be implemented through existing Pacific regional organizations, are presented in section 5.

1 Introduction

1.1 Background to the present study

In December 1996 the Global Environment Facility (GEF) committed financial support from its Project Development Fund to facilitate the preparation of a Strategic Action Programme (SAP) for International Waters (IW) in the Pacific Islands region[1]. The proposal was submitted on behalf of countries of the region by the South Pacific Regional Environment Programme (SPREP), and is being implemented by SPREP with the assistance of, *inter alia*, the South Pacific Commission (SPC), the South Pacific Forum Fisheries Agency (FFA) and the South Pacific Bureau for Applied Geoscience (SOPAC). The SAP will be prepared by a Regional Task Force which will consider information on the current status of International waters in the region, and options for their future management. The SAP is intended to address not only management issues that have a clear international dimension, but also national level problems that have international implications due to their being widespread among, or repeated in, many countries.

To assist the Task Force in its work, reviews of key issues relating to the use and management of international waters have been commissioned, covering three broad areas:

- Critical Habitats and Species;
- Threats to International Waters; and
- Living Marine Resource Management Regimes. The present report comprises review of living marine resource management regime and is intended to be considered in conjunction with the other two studies.

The terms of reference (ToR) for the present review are to:

- describe fishery and other living marine resource management regimes currently in place in the region;
- identify trans-boundary problems relating thereto;
- analyze the root causes of these problems;
- identify current attempts to address them;
- describe any knowledge gaps that impede the development of such solutions;
- suggest actions that should be taken to eliminate the knowledge gaps;
- propose other solutions to the problems identified; and

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1 The Pacific Islands region is defined as the 22 Pacific Island countries and territories that are members of the South Pacific Commission (see table 1). For the purpose of this definition, the Pacific Islands region does not specifically include Australia, New Zealand, Hawaii, Pitcairn Island, Easter Island, the minor US possessions (Wake, Howland, Baker, Johnson and Jarvis islands, and Palmyra or Kingman Reef) or the Japanese Pacific possession of Minami Tori Shima. However, where the review identifies trans-boundary issues that involve these entities, they are covered to the extent required.

- suggest priorities for action in response to the above issues, including sectoral interventions, capacity building, and the national and regional institutional mechanisms needed for them to take place.

The definition of fisheries used in the present report is the same as that used in most pieces of fishery legislation in the region. Fisheries involve the harvesting or other extractive use of naturally-occurring living marine resources irrespective of their phylogenetic classification and including, *inter alia*, adults, juveniles, eggs and miscellaneous parts of fish, invertebrates, plants and other organisms that rely on the marine environment for some part of their life cycle. In the present report "fisheries" are not considered to include aquaculture or non-extractive resource uses such as tourism, although these issues are also discussed.

Fisheries management in the Pacific Islands region encompasses a wide range of situations and issues, from customary systems of marine tenure practiced by coastal communities, through national fishery development and governance, to the international management of the world's largest tuna fishery which crosses the national jurisdictions of at least 21 resource-owning states, as well as extensive areas of high seas, and which involves harvesting by the fishing vessels of 26 different nations. Managing the use of these widely differing resources is implicitly linked to aspects of marine resource biology, economic conditions in the region and elsewhere, pre-existing patterns of fishery exploitation, and the requirements imposed by customary practices and other socio-cultural factors.

Reviewing such a wide range of to PICTs in a supposedly concise document means that, by necessity, a good deal of fine detail has had to be omitted. Given the focus of the ToR on trans-boundary issues, these have been emphasized in the review, in some cases perhaps at the expense of specific national-level concerns.

In the present report expressions in the masculine gender are intended also to include the feminine gender, and vice versa, unless the context clearly implies otherwise. The views expressed are those of the author, who takes responsibility for them, and for any errors of fact or interpretation that the report may be found to contain.

1.2 Global context

World fisheries production, including marine and inland fisheries and aquaculture, currently averages about 100 million metric tonnes (mmt) per year. Fish is now the largest single source of animal protein in the world and the fastest-growing food commodity in international trade, providing direct and indirect employment to over 100 million people globally. Over one billion people rely on fish and shellfish as their main protein source. Of the top forty countries ranked by the share of animal protein derived from fish, 39 are developing countries. Most of the 50 mmt of wild-caught marine fish used for human consumption is produced by artisanal fishermen (FAO, 1995a).

The widespread introduction in the late 1970s of exclusive economic zones (EEZs) and the adoption in 1982, after long deliberations, of the United Nations Convention on the Law of the Sea (UNCLOS) provided a new framework for the management of marine resources. The new legal regime of the ocean gave recognition to coastal States rights and responsibilities for the use and management of fishery resources within their EEZs, which collectively cover only about 10% of the ocean's surface but embrace some 90% of the world's marine fisheries (Weber, 1994). However, although it constituted a necessary first step towards better fisheries management, extended national jurisdiction on its own was insufficient to assure fisheries development on a sustainable basis. The first priority of many coastal states was simply to extract greater benefits from fisheries within their EEZs (FAO, 1995b). In many countries this was achieved by investing in modern fishing fleets and processing factories in response to growing international demand for fish and fishery products. In the Pacific Islands region a more common approach was to maximize revenues from fishing activities by distant-water fishing nations (DWFNs).

World fisheries are currently suffering from global-scale over-fishing such that total marine fish catches, which grew from about 20 mmt in the 1930s to a high of 82.2 mmt in 1989, have now fallen

back to about 78 mmt. These statistics mask the fact that many fisheries have undergone more serious declines. All but two of the world's fifteen major fishing areas have shown decreasing productivity and, in the most extreme cases, entire fisheries have disappeared. World marine capture fishery production is being maintained by the increased exploitation of those resources that are not yet overfished, and by the harvesting of newly discovered or previously unexploited stocks. Both these processes are subject to finite limits that will be reached in the near future, if they have not already.

Underlying the rapid growth in fisheries production since the 1930s has been a large increase in global fishing effort, both in numbers of vessels and in technological capacity, such that the total world gross registered tonnage of fishing vessels more than doubled between 1970 and 1989 (World Bank, 1995b). The global fishing fleet is excessively large and is heavily subsidized, with its total operating cost estimated to exceed its revenues by about US$ 54 billion each year (Garcia, 1994).

The absence of property rights in fisheries, coupled with continued heavy government subsidies to fishing operators, is considered to be the major contributors to over-investment and over-exploitation. In the context of marine capture fisheries, FAO (1995a) notes that "the policy measures most likely to bring about effective resource management are those which embrace removal of free and open access to resources and introduce, wherever appropriate, measures to allocate resources and establish use rights. Where it is possible to introduce such measures they will, *inter alia*, provide greater incentives to reduce excess fishing capacity which has been one of the factors most responsible for overfishing". Excess fishing capacity and other forms of overcapitalization are often perpetuated in cases where fleets or processing facilities continue to benefit from Government subsidies.

The tuna fishery of the Western Central Pacific Ocean (WCPO) is one of only two remaining major fisheries in the world still considered to be in healthy condition and amenable to increased exploitation. This fishery, and the large marine ecosystem on which it is based, is a global asset which requires the concerted attention and support of the international community if it is to be managed on a sustainable basis for the benefit of the present and future generations.

In addition to large international fisheries, many local or coastal fisheries of vital significance to domestic economies and food security are being threatened worldwide, not only directly by overexploitation or other aspects of poorly regulated harvesting, but also indirectly through the deleterious effects of pollution, habitat destruction through coastal development and poor watershed management. The Pacific Islands are no strangers to these phenomena, and the declining, sometimes overfished and frequently degraded coastal fisheries of the region are as much in need of protection and management as their counterparts in other regions of the world.

1.3 Definition and aims of fisheries management

There appears to be no broadly accepted definition of the term "fisheries management". Interpretations of the meaning of this phrase range from a fairly narrow definition relating to the limitation of fishing catch and/ or effort through regulation, surveillance and enforcement, to a much broader sense in which economic and market manipulations and development-oriented interventions are viewed as part of the management process. The term 'governance' has also recently entered the fisheries parlance and is frequently used to designate higher-level functions which aim to exert a directed influence over fisheries but which are carried out through institutions or mechanisms that are multi-sectoral (rather than focused only on the fisheries sector) and socio-political (rather than technical or economic) in nature.

Some party that has authority over the fishery resources being exploited usually undertakes fisheries management. These ranges from local resource-owning or exploiting communities, through provincial or national governments, to specialized bodies established specifically for the purpose. Depending on the nature of the managing authority, management may involve direct controls as well as incentives and disincentives of various types. Direct controls may affect inputs (e.g. restrictions on vessel numbers, other forms of effort limitation, or regulations on gear efficiency) or outputs (e.g. total or species-by-species catch quotas or size limits) and often involve a mixture of both. Incentives and disincentives are frequently financial or economic in nature, and may involve grants, operating subsidies, concessionary financing and tax relief or, conversely, import and export duties, fees, and

punitive taxation schemes. Measures such as quotas or quarantine/ public health requirements applied to imported products often function as non-tariff barriers to trade and may be used specifically to manage a fishery by protecting it from competition.

The goal of management is often to achieve a level of output which optimizes either biological or economic production, or a combination of the two, on a long-term basis. These goals may, however, take second place to shorter-term priorities when management actions would be to the immediate detriment of fishing operators or other sectors of the community. A frequently stated goal of fisheries management is to avoid overexploitation and permit sustainable resource use. However these two terms are not necessarily mutually exclusive because fisheries may be sustainable at various levels of production, including, in some cases, when being overfished (sometimes called "sustainable overfishing"). In making a case for the "precautionary approach" to fisheries management, Garcia (1994) suggests that it may be more appropriate to define sustainability in terms of level of risk, rather than level of production, of a fishery.

1.3.1 Overfishing

Overfishing is a frequently cited but widely misunderstood notion that may manifest itself in different ways. **Growth overfishing** is a situation in which an excessive level of harvesting prevents the exploited stock from maximizing its biological production. This may occur in more or less extreme forms and is itself a "sustainable" condition, in that it may be perpetuated indefinitely. A more complex version of this situation arises when a fishery exploits numerous different species. In this case, overall production from the fishery may be sustained but at the expense of a major change in species composition, often such that high-value apex predators are replaced by lower-value species occupying similar ecological niches. This situation is particularly relevant to coastal fisheries in Pacific Island countries and territories (PICTs). At higher levels of effort growth overfishing may be accompanied by **recruitment overfishing**, which occurs when the spawning stock is so reduced that it is unable to produce enough recruits to maintain the population. This most extreme form of overfishing is what generally leads to the dramatic collapse of fish stocks.

In most commercial fisheries, provided that they are not subsidized, maximum economic yield (MEY) occurs at a lower level of biological production than the maximum biologically sustainable yield (MBY). Exceptions may be where the costs of inputs to fishing are low and the value of the product is high (as in many Pacific Island invertebrate fisheries), in which case overfishing is likely. Many fisheries are subsidized in one way or another, thus artificially lowering the costs of inputs, and increasing the probability of overfishing. Subsistence fisheries can also lead to exploitation levels higher than MBY, and thus overfishing, since the economic and opportunity costs of harvesting are usually small. In both these cases the growth in overfishing may take place on a sustainable basis so that the fishery is permanently in less-than-optimal condition in terms of its biological or economic yield.

Occasionally fisheries management may be tuned to the biological condition not of the target species but of ecologically related species. This is particularly the case in regard to threatened or sensitive organisms such as marine mammals, reptiles and seabirds. Some fisheries, such as the Eastern Pacific tuna purse-seine fishery, have been heavily regulated or prohibited because of the perceived deleterious impacts on sensitive species taken incidentally by the fishing gear. Regulation of this type is becoming more frequent and may be accelerated as a result of media campaigns organized by environmental agencies. Negative public attitudes, often influenced by such campaigns, have resulted in the closure or economic failure of fisheries perceived as being environmentally damaging, even in the absence of fishery management regulations. As a result, environmental issues are becoming increasingly important factors in fisheries management.

According to World Bank (1995b) "establishing a fisheries management regime is an exercise in social engineering involving not just technical, biological and economic aspects but a range of social and political considerations which include public attitudes, regional conditions, power relations, interest groups, and traditional social values and methods of production. Some of these aspects may justify important modifications to the components of the fisheries management regime. Others, if not attended to in time, may develop into serious obstacles to the implementation and eventual success of the fisheries management regime".

1.4 International agreements and conventions relating to fishery management

A number of international agreements and conventions govern the way that PICTs approach the management of their fisheries. Principal among these is the UNCLOS, adopted in December 1982, which provides the international legal basis for pursuing the protection and sustainable development of the marine and coastal environment and its resources. UNCLOS confers rights and responsibilities onto coastal states to exploit and manage both living and non-living resources within their EEZs.

UNCLOS had received a total of 159 signatures when the period for signature closed on 9 December 1984, and entered into force in November 1995 after the required 60 instruments of ratification or accession had been deposited. Most of the ratification's that have been received are from developing nations: many developed or industrialized nations have yet to adopt the provisions of the Convention. One of the main problem areas delaying acceptance by industrialized nations is in relation to the regime for deep seabed mining.

The living marine resource responsibilities of coastal States were further reinforced by chapter 17 of *Agenda 21*, which was adopted by the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992. Chapter 17 deals with "protection of the oceans, all kinds of seas, including enclosed and semi-enclosed areas, and coastal areas and the protection, rational use and development of their living resources". This component of Agenda 21 has promoted widespread recognition of the fact that critical environmental problems are shared globally and that oceans and coastal areas are key components of most of those global problems. A key difference between UNCLOS and UNCED is that the former focuses on the resources of EEZs, usually meaning the zone between 12 miles and 200 miles from the coast, while the latter gives more attention to coastal and inshore waters. In this sense UNCLOS and Agenda 21 are complementary.

Chapter 17 of Agenda 21 devotes a separate programme area to Small Island Developing States (SIDS), in recognition of their special circumstances and dependency on the marine environment and its resources. Their special interests are also addressed in two more recent conventions, the *Framework Convention on Climate Change* and the *Convention on Biological Diversity*. Both these conventions may be regarded as important complements to UNCLOS in certain specific areas. The Climate Change Convention calls for financial and technological commitment to the promotion of sustainable management, and cooperation in the conservation and enhancement of coastal marine ecosystems. The Convention on Biodiversity provides that it shall be implemented with respect to the marine environment consistent with "the rights and obligations of states under the Law of the Sea". Both Conventions give prominence to the promotion of appropriate coastal area management practices.

The results of UNCED are intended to give much-needed impetus to the development, at all levels, of more comprehensive and multi-disciplinary approaches to the many inter-related aspects of sustainable marine and coastal development, especially the conservation and management of marine living resources, conservation of biodiversity, and scientific cooperation for these purposes. Agenda 21 gives particular attention to the development and implementation of concepts of integrated management of marine and coastal areas, and ecosystem-based management. Programme area A of chapter 17 of Agenda 21 deals with integrated marine and coastal area planning and management, and represents the first time that this topic has been elevated to the level of a global issue. The relationship of integrated marine and coastal area planning and management to the control of land-based sources of marine pollution, the conservation of biodiversity and adaptation to global climate change is recognized, as is the potential benefit of adopting ecosystem-based approaches to marine management.

Just prior to UNCED, FAO organized an International Conference on Responsible Fishing that was held in Cancún, Mexico, in early 1992. The *Declaration of Cancún* endorsed at that Conference gave impetus to development of the concept of responsible fishing and was an important contribution to UNCED, which subsequently supported the development by FAO of a *Code of Conduct for Responsible Fisheries*. The FAO Technical Consultation on High Seas Fishing, held in September 1992, further recommended the elaboration of a Code of Conduct to address issues regarding high seas fisheries. This consultation also ultimately led to the adoption by the 27th Session of the FAO

Conference, in November 1993, of the *Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas.*

Programme area C of Chapter 17 of Agenda 21 makes specific reference to the fact that "management of high seas fisheries is inadequate in many areas and some resources are over-utilized". This situation was attributed to a range of causes, including unregulated fishing, over-capitalization, and excessive fleet size, vessel re-flagging to escape controls, insufficiently selective gear, unreliable databases and lack of sufficient cooperation between states. Acknowledgment of these problems led to the convening of the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, which ran from 1993 to 1995. At its 6th and final session in August 1995 the Conference approved the *Agreement for the Implementation of the Provisions of the United Nations Convention of the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.* Commonly referred to as the Implementing Agreement, or IA, this instrument 'gives teeth' to the provisions of UNCLOS in regard to management of fisheries that straddle several EEZs and/ or high seas areas. Countries may accede to the provisions of the IA even though they have not ratified UNCLOS, thus de-linking the development of living marine resource management regimes from the protracted deadlock over other issues (such as deep seabed mining). In addition, the IA defines more clearly a number of issues relating to living marine resources that are addressed in UNCLOS in more general terms (Van Dyke, Nakano and Gardner, 1996). Table 1 shows which independent PICTs have acceded to UNCLOS and which to the IA.

Table 1. ***Status of independent Pacific Island countries in regard to UNCLOS and the IA (FFA, 1997).***

State	UNCLOS		Implementing
	Signed	Ratified	Agreement
Cook Islands	x	x	
Federated States of Micronesia	x	x	
Fiji	x	x	x
Kiribati			
Marshall Islands	x	x	
Nauru	x	x	x
Niue	x		
Palau	x	x	
Papua New Guinea	x	x	
Solomon Islands	x		x
Tokelau			
Tonga	x	x	x
Tuvalu	x		
Vanuatu	x		
Western Samoa	x	x	x

The IA is an important step forward in the development of international fisheries management regimes because, for those countries that accede to it, participation in management arrangements is mandatory, not optional or discretionary. Further, management is to be based on the "precautionary approach" under which the absence of scientific certainty may not be used as a reason for failing to take conservation and management measures. In addition, under the precautionary approach the burden of proving whether or not a fishery is capable of withstanding increased exploitation may be shifted from those responsible for regulating the fishery to those wishing to benefit from increased exploitation (Garcia, 1994). This is particularly significant for those states which have limited means to gather or interpret the scientific data necessary for meaningful fishery stock assessment or monitoring in their EEZ (as opposed to coastal) areas.

The capabilities of developing nations to implement the IA are also addressed in another of its important provisions. Article 24 of the IA requires that "States shall give full recognition to the special requirements of developing States in relation to conservation and management of straddling fish stocks and highly migratory fish stocks. To this end, States shall, either directly or through the UNDP, the FAO of the United Nations and other specialized agencies, the GEF, the Commission on Sustainable Development and other appropriate international and regional organizations and bodies, provide assistance to developing states".

The last important instrument relating to international fisheries management is the Code of Conduct for Responsible Fisheries which, after considerable debate and many revisions in various FAO meetings and conferences related to fisheries, was adopted in October 1995 by the 28th Session of the FAO Conference. It provides principles and standards for the conservation, management and development of all fisheries, and covers the capture, processing and trade of fish and fishery products, as well as fishing operations, aquaculture, fisheries research and the integration of fisheries into coastal area management. Although voluntary, the Code is largely based on relevant rules of international law, including UNCLOS, and its widespread formal adoption is anticipated.

As can be seen, many of the current instruments governing international cooperation and obligations in regard to fisheries management have been developed during the course of the past five years, and the most important - the Implementing Agreement and the Code of Conduct - within the past 18 months. As a result the fisheries management situation in the region - and in the world - is presently very dynamic, with some important new developments currently taking place in regard to oceanic fisheries in particular. Management of these fisheries to ensure sustainable utilization at a high level of production and to maximize economic returns to PICTs, either through licensing or through domestic fleet development is high on the agenda of countries of the region. The Forum Heads of Government meeting in Madang, PNG in September 1995 "considered that comprehensive regional fisheries management arrangements, and a structure consistent with the UN Conference outcome to administer them, should be developed as a matter of urgency".

Several other recent agreements also have indirect relevance to living marine resource management. The Kyoto Declaration on the Contribution of Fisheries to Sustainable Food Security recognises the need for responsible management if fisheries are to maintain or increase their contribution to world food security. Several conventions and agreements relating to pollution, environmental management and biodiversity conservation have fisheries or living marine resource provisions. These include the International Convention for the Prevention of Pollution from Ships (MARPOL) , the Programme of Action for Small Island Developing States, the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities, the Apia Convention, the SPREP Convention, the Action Strategy for Nature Conservation in the South Pacific Region, and the Pacific Regional Strategy of the International Coral Reef Initiative (ICRI). These conventions are discussed in more detail in the companion paper on Critical Habitats and Species, and are thus not described here.

The management regimes and issues that concern coastal resources are somewhat different than those of the open ocean. Coastal fisheries are discussed in more detail in section 3, and oceanic fisheries in section 4.

2 The Pacific Islands Region

2.1 Constituency

For the purposes of the present study the Pacific Islands region is considered to be a distinct geographical area which includes the 22 countries and territories of the central and western Pacific ocean.

Table 2 indicates the political status or affiliation of the region's constituent states, and shows which are defined as SIDS and which are members of the GEF (and thereby in the preparation of the Strategic Action Plan for International Waters). It also shows their membership of the various regional organizations described in section 2.2.

Table 2. ***States of the Pacific Islands region and their affiliations.***

State	Political status/ affiliation	SIDS	GEF	SPC	FFA	SPREP
American Samoa	US territory			x		x
Cook Islands	New Zealand-affiliated developing country	x	x	x	x	x
Federated States of Micronesia	US-affiliated developing country	x	x	x	x	x
Fiji	Independent developing country	x	x	x	x	x
French Polynesia	French territory			x		x
Guam	US territory			x		x
Kiribati	Independent developing country	x	x	x	x	x
Marshall Islands	US-affiliated developing country	x	x	x	x	x
Nauru	Independent developing country	x	x	x	x	x
New Caledonia	French territory			x		x
Niue	New Zealand-affiliated developing country	x	x	x	x	x
Northern Marianas	US territory			x		x
Palau	US-affiliated developing country	x		x	x	x
Papua New Guinea	Independent developing country		x	x	x	x
Pitcairn Islands	UK territory			x		x
Solomon Islands	Independent developing country		x	x	x	x
Tokelau	New Zealand territory	x		x		x
Tonga	Independent developing country	x	x	x	x	x
Tuvalu	Independent developing country	x	x	x	x	x
Vanuatu	Independent developing country		x	x	x	x
Wallis and Futuna	French territory			x		x
Western Samoa	Independent developing country	x	x	x	x	x

Ethnically, the region is usually broken into three major components: **Micronesia**, comprising the north-western countries of Palau, Federated States of Micronesia (FSM), Guam, Northern Mariana Islands, Marshall Islands and Kiribati; **Polynesia**, which includes the south-eastern countries of Tuvalu, Tokelau, Wallis and Futuna, the Samoas, Tonga, Niue, Cook Islands, and French Polynesia; and **Melanesia**, which comprises Papua New Guinea (PNG), Solomon Islands, Vanuatu, New Caledonia and Fiji (which latter is a transition point between Melanesia and Polynesia).

The region contains less than 0.6 million square kilometres (sq. km.) of land that is distributed as about 200 high islands and 2,500 low islands and atolls. Apart from the Pitcairn group and the southern part of French Polynesia, in the east of the region, all the islands lie in the tropical zone and experience sea surface temperatures which rarely fall below 20°C. In general, the islands increase in size from east to west, such that over 83% of the region's land is situated in PNG, and most of the rest is in the other Melanesian countries and territories.

In contrast to its tiny land area, the region's EEZs cover an estimated ocean area of 30.6 million sq. km., equivalent to about 30% of the world EEZ area. In most PICTs the area of maritime jurisdiction is thousands of times greater than the available land area. The region also includes about 8 million sq. km. of high seas areas (international waters) which are not under national jurisdiction.

Given the geographic isolation of most PICTs and the limited alternative resources available to many of them, the fish stocks contained in this vast ocean area represent the principal hope for economic development and self-reliance in many of these nations.

2.2 Regionalism and regional organizations

Historically, extensive migration has taken place throughout the region, and this continues today in the form of labour movement and economic migration. All but one of the countries of the region (Tonga) was colonized by European nations during the 18th century. Some have since become independent states, while others continue to be formally associated in some way with the original colonizing nations, or with other nations.

The region's ethnic origins, combined with modern-day political affiliations, and the various indigenous and introduced languages now shared among some groups of states, influence the composition of the various political and economic groupings that exist in the region. Principal among these is the South Pacific Forum, a political alliance which brings together the independent countries and self-determining states of the region (the latter being the US- and NZ-affiliated developing countries of table 2), as well as Australia and New Zealand. Outside the Forum, the various US, French and NZ-affiliated states and territories also have formal political and economic links with their respective 'mother' countries.

This historical background predisposes PICTs to a high degree of 'regionalism' which nowadays is further justified by:

- the fact that many countries share problems which justify a collaborative search for common solutions and;
- the small size and limited human and financial resources of most countries, which constrains their ability to address the wide range of development problems they face.

Cooperation among PICTs in fisheries management is an especially striking feature of the region, to the point where it has been the subject of study by other geographical and economic groupings of countries (e.g. CARICOM, and the island states of the Indian Ocean) hoping to put in place improved regional arrangements of their own.

The high level of cooperation among PICTs is fostered largely through various regional organizations (ROs) which have been established as a means of obtaining technical information, advice and support on a collective, cost-sharing basis. The three ROs with major involvement in living marine resource management matters are:

- The **South Pacific Commission** (SPC) headquartered in Nouméa, New Caledonia. SPC is a multi-disciplinary technical assistance agency serving 22 Pacific Island countries and territories and which has a fisheries section with two major components. The Oceanic Fisheries Programme (OFP) is primarily concerned with scientific research on the region's tuna fisheries, while the Coastal Fisheries Programme (CFP) is involved in research, development and management of coastal fisheries ;

- The **Forum Fisheries Agency** (FFA) headquartered in Honiara, Solomon Islands, is concerned primarily with economic and policy aspects of the offshore tuna fisheries in its 14 independent member PICTs, as well as Australia and New Zealand. The FFA has achieved a high degree of success in the development of regional fishery management arrangements, to the point where the organization has several times been held up as a model that could be adopted in other regions of the world;
- The **South Pacific Regional Environment Programme** (SPREP) headquartered in Apia, Western Samoa. SPREP takes a lead role in coordinating regional approaches to environmental conservation and management, and has been active in promoting the concept of integrated coastal zone management in PICTs. SPREP also provides technical assistance and support at the national level, particularly in regard to pollution and waste management issues.

There are also regional programmes which are relevant to the management of living marine resources at the University of the South Pacific (USP) and the South Pacific Applied Geoscience Commission (SOPAC), both located in Suva, Fiji. The former undertakes research and higher education in regard to living marine resources, while the latter carries out bathymetric, geological and hydrological studies that provide valuable information on habitats and habitat change.

Another form of regional cooperation relevant to marine resources is in relation to trading arrangements. Under the South Pacific Area Regional Trade and Economic Cooperation Agreement (SPARTECA) PICTs may export goods to Australia and New Zealand at reduced or, in the case of seafood, zero tariff rates. Other regional trade agreements, such as between France and the French territories, between the USA and US territories, and between certain independent PICTs, also exist.

2.3 Economic characteristics of the region

The region's 6.5 million people are at various stages of development, and socio-economic conditions vary widely between and within countries. In general, those people living in the dependent territories of metropolitan countries have better access to goods and services than inhabitants of the independent or freely associated states. Throughout the region, urban residents live a more consumerist lifestyle than those in small isolated islands, remote coastal areas, and the interiors of large islands. These latter follow more of a subsistence way of life, have a relatively low income and, based on usual evaluation methods, have a low standard of living.

Information from SPC (1995a), UNDP (1994), and Booth and Muthiah (1993) were used by GPA (1996) to compile the socio-economic data given in Table 3.

Table 3. ***Socio-economic data for Pacific Island countries (GPA, 1996.***

Country	US$ per capita GDP	Aid (1990)	Govt. Exp. (1992)	Agriculture production (% of GDP)	Estimated population Total (1995)	Density (1994)	Growth rate (%)
American Samoa	5,328	1,693	-	-	57,000	273	3.7
Cook Islands	4,156	729	2,286	18	18,100	81	1.1
FSM	2,720	-	-	25	125,100	151	3.0
Fiji	2,172	51	580	18	768,700	43	2.0
French Polynesia	15,697		4,116	-	221,300	62	2.5
Guam	9,884	702	-	-	150,000	271	2.3
Kiribati	480	336	554	8	80,400	97	2.3
Marshall Islands	1,596	1,108	-	14	56,500	299	4.0
Nauru	17,934	22	-	-	10,400	505	2.9
New Caledonia	14,346		3,741	-	186,800	10	2.0
Niue	3,156	3,227	-	16	2,200	8	-2.4
N. Marianas	10,352	-	3,002	-	71,800	120	9.5
Palau	3,330	725	-	-	16,900	34	2.2
PNG	1,505	102	384	28	3,951,500	9	2.3
Pitcairn Islands	-	-	-	-	100	-	-
Solomon Islands	757	139	-	27	375,000	13	3.4
Tokelau	382	3,000	-	-	1,600	150	-1.3
Tonga	1,452	311	287	34	98,900	132	0.5
Tuvalu	1,004	555	-	24	9,900	365	1.7
Vanuatu	1,342	269	403	20	168,300	13	2.8
Wallis & Futuna	-	75	-	-	14,700	56	1.3
Western Samoa	1,044	106	587	34	163,900	56	0.5

The economies of most PICTs are largely based on agriculture (which for statistical purposes often includes fishing). Fiji, FSM, Tonga, Samoa, Kiribati, Vanuatu, and the Solomon Islands all have agricultural sectors which employ more than 40% of the labour force (Booth and Muthiah, 1993). However, the amount of arable land per person in the region is relatively small. Kofe (1990) gives estimates of this statistic in Fiji (2.1 ha per person), Solomon Islands (1.4), Tonga (1.8), Vanuatu (1.4), and Samoa (3.5). Atoll countries have the smallest per-capita arable land areas and also the poorest soil, factors that are connected to a higher level of dependence on marine resources in these countries. In those PICTs with higher agricultural potential there is nevertheless a tendency for increasing diversification into the industry and services sectors.

For the Pacific Islands region as a whole economic growth during the past decade has been almost nil (World Bank, 1995a). Between 1970 and 1990 the population of the region grew by 2,222,000 people, equal to an annual growth rate of 2.3% which is high relative to the world average of 1.8% (NCDS 1994). The combination of high population growth and poor economic performance is arguably the Pacific Islands' greatest long-term problem. UNDP (1994) states that "the combination of low economic growth and high population growth poses a serious threat to the future performance in human development of many Pacific Island countries".

The socio-economic conditions of 13 independent PICTs were reviewed by UNDP (1994) which concludes that PNG, Solomon Islands, and Vanuatu would fall into the category of 'low human development'. Globally, of the 173 countries listed in the report, 55 fall into this category. The other ten countries reviewed are classified as being of 'medium human development', amongst 65 countries in this category. None of the PICTs covered by the report is amongst the 53 countries categorized as 'high human development'.

A characteristic of Pacific Island countries is the large number of people who derive most of their basic needs from non-monetary subsistence production. Anon (1992) estimated the proportions of the subsistence economy in the Solomon Islands (80% of the population), Tuvalu (80%), Kiribati (80%), Western Samoa (60%) and FSM (at least 50%).

The term 'subsistence affluence' is sometimes used to describe the relatively high quality of life on some of the Pacific Islands. The term refers to a condition of well-being outside the cash economy. Factors contributing to this situation vary from place to place and may include some or all of the following: low population densities, fertile soil, a benevolent climate, effective traditional resource management, and social systems which provide a safety net for disadvantaged members of society. In recent times, however, high birth rates, unsustainable commercial practices in regard to natural resource use, increasing dependency on the cash economy, labour migration, and the deterioration of traditional authority and social systems are all having a negative impact on the quality of subsistence life on many islands. Nevertheless, the fact that widespread poverty has not emerged in response to the gradually deteriorating economic conditions in most PICTs gives some indication as to the strength of traditional social support systems.

Population movement from outer islands or rural areas into towns and cities is a prominent and growing feature in most PICTs. According to the World Bank (1995a), the average urbanisation rate across the region (i.e. proportion of population living in conditions defined as urban) was 17% in 1970 but had increased to 24% in 1990.

The problems of low per capita GDP become much more acute as populations become more urbanized. Urban migrants are often unable to find employment and have no access to land or fishing rights, both of which are usually governed by traditional systems that effectively exclude 'outsiders'. Migration into towns and cities generates urban poverty which contrasts starkly with the 'subsistence affluence' of many rural areas, and which is the source of many social problems, including rising urban crime rates.

The high amount of development assistance received by the region, and remittance income, are two external factors which will tend to mitigate against the appearance of poverty, at least in the short term. Overall the region receives a relatively large US$204 of aid per capita (Fairbairn, 1994), although this is unevenly distributed between countries (table 3). In addition, the economies of many PICTs benefit from cash remittances by relatives living overseas. These can be substantial and in some PICTs exceed the value of national exports. However both aid and remittances face an uncertain future as the countries which provide aid and those which accept Pacific Island immigrants show signs of changing their policies in regard to these issues. There may be potential for growth in the employment of Pacific Islanders aboard foreign fishing and merchant vessels.

Tourism is a sector that is growing in importance in some, but not all, countries of the region. Many PICTs have ambitious tourism development plans, although in some cases high travel costs, poorly developed services and inadequate infrastructure render these somewhat pessimistic. Nevertheless tourism will probably increase in the region, even if only gradually in some cases. One of the factors that many countries expect to attract tourists is easy access to a pristine marine environment, an expectation which requires that the marine environment be effectively managed so as to retain (or in some cases, re-attain) this quality.

2.4 Economic value of living marine resources

The EEZs of PICTs cover 30.5 million sq. km, compared with meager land resources of about 550,000 sq. km., equivalent to about 1.8% of their maritime jurisdiction. PICTs thus look toward fisheries as an important means to advance their economic development through the creation of jobs and the generation of exports and income. Although living marine resources support non-consumptive uses such as tourism to a certain extent, their most significant economic role by far is in providing the basis for commercial and subsistence fisheries.

Fisheries in the Pacific Islands region fall into two main categories:

- **coastal fisheries**, which involve localized harvesting of an estimated 108,000 tonnes of a very diverse range of finfish, invertebrates and algae by thousands of subsistence, artisanal and commercial fishers throughout the region. Virtually all the coastal catch is taken by PICTs themselves, with very little access by foreign fishing vessels (FFVs);
- **oceanic fisheries**, essentially meaning the international tuna fishery which straddles the Western Central Pacific Ocean (WCPO) and which currently involves the industrial harvesting of about 1 million tonnes of tuna per year, plus an unknown amount of by-catch, by more than 1,300 fishing vessels from 21 different countries. About 7% of this catch is thought to be taken by PICTs.

There is some degree of overlap between the two, such that the tuna resources exploited by the industrial fishery may also support small-scale coastal fishing activities. There is also overlap between the definitions of industrial, commercial, artisanal and subsistence fishing. Although the terms represent a generally decreasing level of sophistication and cash-orientation, many fishing activities do not fall clearly into one category or the other.

Fisheries contribute to Pacific Island economies in a number of important ways:

- **Food supply**. Fisheries produce a substantial amount of food, largely through subsistence fishing, thus enhancing food security. Coastal fisheries are estimated to produce some 108,000 t/ year, of which up to 84,000 t, or 78%, may be from subsistence fishing (Dalzell and Adams, 1994). Only about 5,000 t of this production is exported, with the remainder being consumed domestically in PICTs (Gillett, 1995). The catch includes a wide range of finfish, invertebrates and marine algae.

  Little of the industrial tuna catch enters the region's food supply. About three-quarters of the annual catch of 1 million t is 'exported' to canneries or other markets outside the region while the remaining quarter is processed in the region's canneries in American Samoa, Fiji and Solomon Islands. About 1% of this regionally-processed product, equivalent to 2,500 t of fresh-caught fish, is consumed locally, with the highest rates of consumption being in those three countries that have locally-based canneries[2]. Some "leakage" from tuna transshipment or export operations also occurs in some locations, and results in an unknown amount of frozen tuna or by-catch entering domestic markets (Gillett, 1995).

  After accounting for imports and exports, apparent per capita fish consumption region-wide is estimated at 27.8 kg/ year, about double the world average (GPA, 1996). If PNG's large inland population is excluded from the calculation, the regional average is 45 kg/year. In some individual atolls per capita fish consumption is almost 200 kg/ year, probably the highest in the world (Gillett, 1995).

  These high levels of fish consumption are very positive for household food security, especially in rural areas where alternative sources of protein may be limited or much lower in nutritional quality. Observations in the Pacific so far suggest that much imported food is nutritionally inferior to a diet based on subsistence products, being low in complex carbohydrates and high in salt, sugar and fat. Many lifestyle-related diseases and nutritional disorders, including obesity, diabetes, vitamin A deficiency and, among children, low birth weights, slow growth rates, and anemia, are directly attributed to a growing dependence on imported, poor-quality foodstuffs that, because of their low cost, are progressively replacing local products. Domestic fishing activities in general and subsistence fisheries in particular act directly to counter this chronic undermining of household food security (GPA, 1996).

- **Employment and income**. UNDP (1994) estimated that there were about 370,000 wage earning job opportunities in the 14 independent PICTs, for an economically active population of 1.8 million. Gillett (1994) estimates that nearly 5,000 people are employed in the two tuna canneries in American Samoa, while Gillett and McCoy (1997) estimate that 1,200 Pacific Islanders work on US, Japanese, Korean and Taiwanese fishing vessels. Adding employment in other tuna canneries, on FFVs and in the locally based commercial fishing fleets in the

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2 Solomon Islands, Fiji and American Samoa. The development of a new tuna cannery is also under way in Papua New Guinea, but is not yet operative.

region, GPA (1996) estimates that the regional tuna industry may employ up to 15,000 people.

Hamnett (1990) estimated that there were about 82,000 people involved in small-scale commercial fishing in the region at that time. McCoy (1991) states that there were about 25,000 non-motorized and 17,000 motorized fishing vessels operating in the Pacific Islands, although it is not known how many people are involved in their use, or what proportion of their activity relates to subsistence as opposed to commercial fishing. Much fishing, especially for subsistence purposes, does not involve the use of a boat. The numbers of people involved in subsistence fishing across the whole region is unknown, but in some countries comprises a large proportion of the population (see for example Rawlinson et al., 1994).

FAO (1996) estimates that fisheries provide income to almost 100,000 Pacific Islanders. The general conclusion is therefore that fisheries-related employment is important to the economies of the region.

- **Foreign exchange** earnings for PICTs are generated both by fishery exports, and by the fees that FFVs pay for access to fishing grounds within Pacific Island EEZs.

  There is no reliable estimate of the total quantity or value of fishery product exports from the region, and national statistics on this subject are often not comparable with each other. Almost all the tuna caught in the region is exported, either fresh or after canning. Since 1993 any transshipping that FFVs wish to carry out must take place in Pacific Island ports or other designated locations. This, plus the development of shore-base facilities for tuna fishing vessels in some countries has had the effect of bringing into national export statistics tuna catches that were previously 'exported' directly from the country by the catcher vessel, or transshipped at sea. As a result apparent exports of fishery products from some countries have increased enormously in recent years. World Bank (1995b) notes that, for FSM, the share of fish in national exports nearly doubled to 86% of the total between 1988 and 1993, while in Marshall Islands it increased five-fold, to over 80% of total exports, during the same period.

  A few countries have domestic fisheries exporting small quantities of bottom fish, reef fish and crustaceans. Gillett (1995) estimates that the quantity of non-tuna exports from the region's capture fisheries (i.e. excluding aquaculture) is less than 5,000 t/ yr, or less than 5% of coastal fishery production. The principal exports by value from coastal fisheries in the region are bêche-de-mer and shell products derived from trochus and green snail shells. Overall the region's imports of fish exceed its exports in volume terms (GPA, 1996), and probably also in terms of value (although in many countries domestic consumption of locally produced fish far exceeds both).

  FFA (1996b) estimates that in 1995 access fees for the Pacific Islands region totaled about US$ 60 million. Although very important for some countries (e.g. Kiribati, where fishery license fee revenue covers more than half the Government's recurrent budget (IMM, 1993)) this nevertheless represents only a small proportion (about 3.7%) of the total value of the regional tuna catch, estimated in 1995 at about US$ 1.7 billion. Issues relating to access fees are discussed in more detail in section 4.4.2.

- **Non-economic values**. Fisheries and coastal areas have cultural, religious and recreational significance among many coastal and island communities whose daily lives and cultures are closely connected to the marine environment. Spurgeon (1992) defines the following non-economic values of coral reef resources and fisheries:

  - Social value;
  - Biological value;
  - Cultural value;
  - Existence value;
  - Option value;
  - Rarity value; and
  - Heirloom value.

Further values may also exist, depending on the local situation. These are discussed in more detail by Preston et al (in press) in the context of coastal degradation through coral reef damage in PICTs.

Although estimates vary widely, formal assessments indicate that the fisheries sector accounts for only a modest share of gross domestic product (GDP) in most countries of the region. However these estimates significantly underestimate the economic importance of the sector because they fail to account adequately for artisanal and subsistence production (World Bank, 1995b). Failure to appreciate the importance or extent of subsistence fisheries is paralleled by the fisheries development and management policies of many PICT Governments, which continue to focus on the more visible but sometimes less economically or socially significant commercial fisheries.

2.5 Coastal zone development

The coastal zone is referred to regularly in discussions and documents relating to marine resource management in PICTs, often in the context of 'coastal planning', 'coastal zone management' or 'integrated coastal zone management', collectively referred to here as CZM. These expressions refer to the concept of multi-disciplinary, multi-sector management arrangements that take into account the full range of often-conflicting uses of the coastal zone.

Uses of the coastal zone, or activities that take place within it, may be aquatic or terrestrial and typically include the following:

- fishing;
- coastal shipping;
- port and harbour development;
- water-based recreation, including diving, especially commercial tourism-related activities;
- coastal construction - building of houses, hotels, commercial and industrial premises, etc;
- infrastructure development - building of roads, installation of power and water supply, etc;
- sewage treatment and disposal;
- rubbish dumping, disposal of factory effluent and other forms of waste disposal;
- shoreline protection - construction of sea walls or other forms of shoreline stabilization;
- agriculture;
- logging;
- mining of various types, including petrochemical extraction; and
- modification of watercourses (dams, etc).

The focus of the present study is on living marine resources, so, although they are important, development and management issues relating specifically to the terrestrial elements of the coastal zone, or to non-fishery uses of marine spaces, are not described in detail here, except in as far as they relate directly to living marine resource management. It is sufficient to point out that these and other activities take place at variable distances from the coast, but affect the coastal zone in one way or another to varying degrees. CZM aims to ensure that development of the coastal zone takes place in a sustainable manner which allows for multiple uses of the zone, and attempts to prevent the activities of one user group having negative consequences for those of another (or for itself).

Unfortunately a definition of what exactly constitutes the coastal zone, both in the Pacific Islands region and in other regions of the world, remains elusive. Clark (1992) states that "By virtually any set of criteria the coastal zone is a linear band of land and water that straddles the coast - a 'corridor' in planning parlance" but then goes on to add that "there is no single description of the coastal area or coastal zone: boundaries are delineated on the basis of the particular problems that CZM attempts to solve. The zone may extend inland and seaward to a variable extent - the boundaries of the coastal zone depend on political, administrative, legal, ecological and pragmatic considerations because there is a broad array of possible coastal issues and because the zone can be affected by remote activities. A

narrow coastal zone could be appropriate if the purpose were to manage only the shoreline and intertidal areas. If watershed issues are of concern, then an inland extension is necessary. Likewise, if the issues extend far seaward then the EEZ might be included. The boundaries must be adaptive to the goals and objectives".

Sorensen and McCreary (1990) agree that "boundaries for integrated coastal zone management programmes should be tailored to capture and enable resolution of all the major coastal issues. Because there is a broad array of possible coastal issues there is also a broad array of possible management boundaries". Some boundaries are quite narrow, and are best suited to deal with use conflicts occurring at the immediate shoreline. But if watershed-generated impacts were serious then a coastal management boundary extending far inland would be justified. The ICZM zone of jurisdiction may be based on political and administrative considerations as well as economic and biogeographic ones.

Although the coastal zone may be drawn broadly or narrowly, it always includes the water's edge - the boundary line between land and sea that includes the subtidal, intertidal and supratidal zones. This is where authority changes abruptly, where storms hit, where waterfront development locates, where boats make their landfalls, and where some of the richest aquatic habitat is found. It is also where typical terrestrial type planning and resource management programmes are at their weakest. The edge zone includes coastal flood plains, mangroves, marshes and tidal flats, beaches and dunes and fringing corals. It is a place of great dynamism and energy. The water's edge is also the place where the greatest competition and conflict between users is found (Clark, 1992).

In the case of small island countries, including most PICTs, the above considerations would lead to the entire country being defined as falling within the coastal zone. Even in the larger PICTs the inland areas are sufficiently close to the coast, and intimately-enough connected to it through watersheds and ground water resources, that almost all inland development activities would have direct impacts on the coastal zone. In the case of PICTs and other small island states, therefore, the concept of ICZM becomes modified, such that it essentially comprises the expansion and enhancement of general development planning to adequately cater for the needs and sensitivities of the coastal zone. Evidence is that PICTs have made only limited progress in this form of planning. Only two of the countries participating in the current SAP exercise (Marshall Islands, and Kosrae and Yap states in FSM) have formally established national or state-level coastal zone management plans. This arises by virtue of the affiliation of these PICTs with the USA[3]. Various planning and CZM development exercises have taken place in other countries (for example the development of National Environmental Management Strategies, or NEMS, promoted by SPREP), and some countries, such as Fiji, have put in place Government inter-departmental committees to coordinate or facilitate multi-disciplinary approaches to coastal zone development. However no other PICTs have formally adopted CZM plans, or have national-level development plans which adequately account for CZM issues, and approaches to CZM thus remain informal and ad hoc.

In any case, incorporation of CZM issues into the national development planning cycle would only be a first step. Even in those countries that have national development plans, the actual implementation of the plan tends to be incomplete, with development activities often responding to the needs of short-term political or economic expediency rather than to long-term strategies for sustainable resource use. The reasons vary from country to country, but are generally related to the widespread difficulties encountered in all PICTs in establishing mechanisms whereby Government Departments communicate and interact effectively with each other, with political decision-makers, and with institutions, organizations, communities and individuals outside the public sector.

It should perhaps be emphasized that PICTs are far from being alone in this regard. According to UN (1992) "experience shows integrated marine and coastal area planning and management to be a highly complex process, entailing the use of various policy and economic instruments, and the introduction of special institutional arrangements. Most countries have encountered difficulties in implementing this form of management and attribute these to a general failure to effectively incorporate the marine and coastal dimension into national development planning processes and thereby command adequate

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3 US concerns and legislation have required the establishment of coastal zone management plans in many US coastal states and in several US-affiliated PICTs, including American Samoa, Guam and CNMI.

political and financial support. That impediment is also experienced at the sectoral level, even with respect to such valuable economic assets as fisheries".

Despite these failures, it is becoming increasingly important that the principles of CZM be adopted in PICTs, both to conserve fisheries and for many other reasons related to the sustainable use of coastal resources. As noted in section 3.3.2, the threats to fisheries from coastal zone development are real, and growing. Fisheries management efforts alone, whether carried out in regard to specific resources or to the ecosystem as a whole, may be insufficient to protect coastal fisheries in the absence of actions to mitigate the deleterious effects of increased sedimentation, eutrophication, toxic pollution, habitat destruction and other negative impacts of indiscriminate coastal zone use.

There is thus a need for concerted action to promote the understanding and application of CZM by PICTs. This would best be done through regional and national programmes of education, technical advice, training and institution building. Truly integrated CZM involves all coastal resource users in the planning and management process. Mechanisms whereby this can occur need to be developed and implemented in PICTs. Failure to act in this way will undoubtedly result in further coastal degradation, additional pressure on coastal fishery resources that may already be stressed, economic loss, and deterioration in the quality of life.

3 Coastal Fisheries

3.1 Principal characteristics of coastal fisheries

3.1.1 Production

Although dwarfed in volume by the offshore tuna fisheries, exploitation of nearshore resources in the region is well developed and embraces a wide range of activities that vary between countries. Fishing may be for subsistence and/ or commercial purposes and may range in sophistication from hand-collection to the use of complex traditional techniques or modern vessels and equipment. Many types of finfish are taken with a range of modern and traditional gears that includes gill nets, spears, hook-and-line, traps and fish weirs, and fish drives. Numerous crustaceans, gastropods, bivalves, and other invertebrates, as well as some algae are harvested, often by women. These fisheries typically involve a large variety of species. For instance, Zann (1992) reports that the Samoan subsistence fishery makes use of 500 species.

Table 4 shows estimated levels of annual production from coastal fisheries in the region.

Table 4. ***Estimated annual coastal fisheries production in Pacific Island countries (Dalzell and Adams, 1994) .***

	Fisheries production (t)		
Country	Subsistence	Commercial	Total
American Samoa	215	52	267
Cook Islands	858	124	982
Federated States of Micronesia	6,243	637	6,880
Fiji	16,600	6,653	23,253
French Polynesia	3,691	2,352	6,043
Guam	472	118	591
Kiribati	9,084	3,240	12,324
Niue	2,000	369	2,369
Nauru	98	279	376
New Caledonia	2,500	981	3,481
Niue	103	12	115
Northern Marianas	2,825	141	2,966
Palau	750	736	1,485
Papua New Guinea	20,588	4,966	25,554
Pitcairn Islands	8	0	8
Solomon Islands	10,000	1,150	11,150
Tokelau	191	0	191
Tonga	933	1,429	2,362
Tuvalu	807	120	927
Vanuatu	2,045	467	2,512
Wallis & Futuna	621	296	917
Western Samoa	3,281	208	3,489
Total	**83,913**	**24,330**	**108,242**

Of the approximately 108,000 t of fish thought to be supplied annually by the region's coastal fisheries, 84,000 t, or 78%, is from subsistence fishing. Subsistence fisheries are important in all PICTs and make extremely important, often unrecognized contributions to household food security, dietary health and import substitution.

Subsistence fisheries are nevertheless gradually being transformed into commercial or semi-commercial fisheries in some areas, and may have been almost completely supplanted in places where cash economies are well developed, such as in urban zones. Commercial fisheries operate at a variety of scales, ranging from occasional sale of some of the subsistence catch, through to targeted exploitation of tuna and deep-water demersal fish using specialized vessels and gear.

From the available data it is clear that coastal fisheries are significant in terms of output value. They have a crucial role in food security and provide almost all the non-imported fish supplies to the region, being far more important than the much larger oceanic fisheries in this regard. Coastal fisheries are also important for local employment, both formal and non-formal, as well as, to a lesser extent, export earnings (World Bank, 1995b).

3.1.2 Subsistence fisheries

Virtually every coastal village in the Pacific Islands is involved in subsistence fishing activities. Throughout the region subsistence fishery harvests exceed domestic commercial harvests. Dalzell and Adams (1994) present data to show that subsistence fisheries land greater volumes of seafood than coastal commercial fisheries (i.e. excluding industrial fisheries) in all PICTs, sometimes by a factor as

high as 10:1. The apparent per capita consumption of fish in the region is very high, at about 45 kg/ person/ yr (excluding PNG's inland population), and most of this derives from subsistence fisheries.

The importance of subsistence fisheries is underlined by data presented in World Bank (1995b) which indicates that 83% of coastal households of the Solomon Islands, 35% of rural households in Vanuatu, 50% of rural households in Samoa, 87% of all households in the Marshall Islands and 99% of all households in Kiribati carry out fishing, primarily for home consumption.

Although much of the subsistence catch is consumed at home, a growing amount is sold, traded, bartered or forms the subject of customary exchange. In Papua New Guinea, GPNG (1995) estimates that the traded proportion is only about 15% of the total, but anecdotal information suggests that the true proportion could be higher, and increasing (Preston, 1996). Subsistence fisheries are undergoing a gradual transformation to semi-commercial or commercial activity and this sometimes blurs the distinction between what is truly subsistence and what should be classed as commercial. In the Solomon Islands about 17% of all households integrated into the cash economy sell nearshore fisheries products. In contrast the industrial and commercial sector provided less than 4% of the formal employment of the Solomons and about 10% in Kiribati (World Bank, 1995b).

In many cases the main alternative to locally caught fish is imported food. Using the "substitute value method" (valuing subsistence fisheries at the market price of their closest marketed substitute) World Bank (1995b) estimated the value of subsistence fisheries to consumers in selected PICTs as: Fiji US$ 6.3 million, Vanuatu US$ 2.2 million, Solomon Islands US$ 7.8 million, and Western Samoa US$ 0.5 million. ANZDEC (1995) assigned a value of 26 million Kina (MK), now equivalent to about US$ 20 million, to PNG's marine subsistence fishery, based on a nominal value of K 1.00/ kg for the 26,000 t estimated to be taken annually. In fact a fairer estimate might place the value of subsistence fishery products at K 2.00-K2.50/ kg, giving the fishery a nominal worth of some 52-65 MK, or about 3-4 times the production value of 16.4 MK currently being generated by the domestic commercial fishery.

Apart from their importance in terms of dietary health and household food security, therefore, subsistence fisheries appear to support national economies by fulfilling a valuable import substitution function. Management of these fisheries to maximize sustainable production could have significant benefits to Pacific Island economies. For instance, David and Cillaureen (1992) consider that better management of "small-scale unstructured village fishing" in Vanuatu could lead to a 25% increase in subsistence fish production, which would save about 400 million Vatu (about US$ 3.5 million) annually in food imports. They argue that this would be a more valid form of fishery development than the promotion of commercial fisheries in rural areas.

Unfortunately, from the management viewpoint, subsistence fisheries have a disadvantage because of their unsophisticated nature and the low cost of inputs into fishing. In such fisheries, provided that there is a need (or market) for the product, harvesting can still be carried out intensively even when the resources are heavily exploited. In a true (i.e. non-subsidized) commercial fishery, there comes a point of economic failure where the cost of fishing is higher than the returns, so fishing operations slow down or ceases and the resource gets some relief. In a subsistence-type situation, however, there is little capital, recurrent or opportunity cost in fishing and, by necessity, fishers will still continue harvesting even when catch rates have been severely reduced by resource depletion.

This disadvantage, however, may be balanced in the Pacific Islands region by the fact that the stakeholders in the fishery may practice some form of customary marine tenure (see section 3.4.2) and may have few alternative sources of protein or income. Both these factors tend to act in support of the development of sustainable fishery management regimes.

There have been several development projects which have attempted to transform subsistence fishing operations into commercial ones, but these have usually met with limited success. In reviewing such a project in PNG, UNDP (1989) said: "The project aimed to develop a little-studied traditional, subsistence economic activity - fishing... in 5 years, a rapid transformation which has never been achieved by any other subsistence activity in PNG. Such projects are long-term developments, a process which occurs more slowly in remote areas because of constraints such as the isolated and scattered characteristics of the population".

Another major factor constraining the commercialization of subsistence fisheries is the considerable difficulty of transporting the catch from lightly exploited outer islands and remote areas to markets in

urban centres. Kofe (1990) states that “one of the greatest constraints to small-holder agriculture and fishing is the lack of transportation and market outlets for produce”. On the basis of studying the fish marketing situation in many PICTs Carleton (1983) concluded: “the basic structure of the subsistence sector is not conducive to the regular supply of fish to urban communities in sufficient quantities to satisfy demand.” Inadequate fishery product transport and distribution systems are widely recognized as a major constraint to coastal fishery development in most PICTs. Where such infrastructure problems are overcome, subsistence fishing may be transformed into commercial fishing almost overnight, often with negative effects from the viewpoint of local resource management, nutrition and food security.

The issue of gender in subsistence fishing deserves special mention. Typically women are heavily involved in various inshore fishing activities, such as reef gleaning and invertebrate collection, as well as in the preparation of food from the products of fishing activities. In most countries of the region a large proportion of the subsistence fishery harvest comprises invertebrates and is gathered almost entirely by women. Men are usually involved in fishing further offshore, fishing for large species of finfish and in diving activities (although there are important exceptions to this generalization). Many observers estimate that fishing activity by women results in a greater amount of family food production than does fishing activity by men.

As well as fish and invertebrates, subsistence fisheries also result in the harvesting of various traditionally used marine organisms such as turtles, dugongs, and certain seabirds. Many of these are now considered to be endangered or threatened and international trade is banned or regulated under the *Washington Convention on International Trade in Endangered Species of Wild Flora and Fauna* (CITES). In some PICTs domestic commerce in these animals is also banned or regulated, but in most countries harvesting for subsistence or traditional purposes is still permitted or, in any case, carried out. Management of the exploitation is discussed in more detail in the companion review of Critical Species and Habitats, and is thus not dealt with here.

It can be concluded that, despite increasing commercialization, subsistence fisheries remain a vital source of protein and cash income in the region. This is particularly true in isolated and small islands, among coastal communities, and in areas where sources of cash income are scarce. Subsistence fisheries also present particular management difficulties which in general are not being addressed, and are generally thought to be facing declines in production in the short-to-medium term, due principally to the growing intensity of exploitation..

Despite these facts, however subsistence fishing is rarely taken into account in Government development plans or quantified in national accounts. In many countries the importance or extent of subsistence fisheries are not fully appreciated and most fishery development and management attention throughout the region continues to focus on the commercial components of the catch. Fisheries generally feature in national plans mainly in terms of their economic development potential and not their contribution to the subsistence economy or small-island nutrition. Fisheries development policies tend not to recognize or acknowledge the importance of subsistence fisheries in general, of inshore invertebrate harvests, or of the role of women in these fisheries.

3.1.3 Artisanal and small-scale commercial fisheries

Unlike other parts of the developing world, communities in which small-scale commercial fishing is a dominant activity are not typical of the Pacific Islands area. Men or women engaged in fishing usually also have other occupations, such as various types of agriculture, so that fishing is practiced only on a part-time basis. This is especially the case in rural areas, to the continued frustration of fishery development activities which require that fishermen operate on a full-time basis in order to justify the costs of equipment and infrastructure.

The more usual situation is for rural residents to carry out fishing on a part-time basis, and to sell part of the catch, or for a small segment of the population in an urban or semi-urban area to supply fish to local markets in towns and cities, and in some cases for export. Examples include Papeete in French Polynesia (tuna), Tongatapu in Tonga (snapper), Pohnpei in Federated States of Micronesia (tuna), Suva in Fiji (inshore reef fish and, more recently, tuna), Apia in Samoa (snapper, tuna), and Rarotonga in the Cook Islands (flying fish).

Commercial fishing operations can be very small-scale, for example subsistence fishers (often women) in many countries who glean reefs for a few hours and then sell the majority of what they have obtained, or who sell catches in times of surplus or a particular need for cash. Alternatively, they may operate on a larger scale (e.g. bottom-fishermen in Tonga who do weeklong trips) and conform more closely to the classic definition of a commercial fisherman.

Commercial fishing for fresh/ frozen consumption, either domestic or export, is most intense around urban areas, while commercial harvesting of bêche-de-mer and shell products is widely dispersed among rural areas and outer islands. The commercial catch in the region is made up of the following components:

- reef and deep slope fish (43%);
- coastal pelagic species (18%);
- trochus, green snail and pearl shell (9%);
- crustaceans (8%); beche-de-mer (7%); and
- estuarine fish (6%) (Dalzell and Adams, 1994).

It should be noted, however, that although shell products and beche-de-mer make up only 16% of total landings by final product weight, this underestimates their importance, which would be shown to be higher if landings were measured by either commercial value or fresh landed weight.

Commercial fishing is the principal target of almost all government fishery development and management activities in the region, and is the area for which statistics and other forms of quantitative information are most readily available. Because it makes a direct, visible contribution to national economies, especially where the product is exported, the development of commercial fisheries is a priority for all PICTs, and in particular those atoll countries which have few alternative resources. Historically, therefore, there has been considerable effort to promote development of these fisheries, often in the absence of any good information on the limits of the resource to support increased production. Only in recent times as attention begun to swing to management of resources which, especially around urban areas, are now presumed - again with little concrete evidence to support or refute the presumption - to be over-exploited.

Although there have been few economic studies on small-scale commercial fishing in the Pacific Islands, it appears that commercial fishers are not greatly different in socio-economic status from the rest of the community. Their main difficulties in business are typical of other small businesses in the Pacific: insufficient planning, social obligations frequently over-riding business concerns, inadequate savings, and poor record keeping. Pacific Island Governments have dedicated substantial resources to economic work on the industrial fisheries, but there currently appear to be no regional efforts to study the economics of small-scale fisheries (GPA, 1996).

3.1.4 Industrial fisheries

Industrial fishing takes place from coastal bases in several PICTs. Three countries of the region (Solomon Islands, Fiji and Kiribati) have industrial pole-and-line fishing fleets which catch tuna at varying distances from the coast, including close inshore whenever the fish are present in this zone. Pole-and-line fishing relies on the capture of live bait, which is taken at night in coastal bays or in atolls using nets and underwater lights.

In addition about half of the countries of the region have either shore bases or transshipment points for (mainly foreign-owned) industrial tuna fishing vessels. Three countries of the region (Solomon Islands, Fiji and American Samoa) have tuna canneries, and a new cannery is being constructed in PNG. In some cases entire coastal communities are supported by these operations in whole or in part, either through the fishing itself or through subsequent processing of the catch. This is particularly true in regard to the tuna canneries, which exert a large influence on the socio-economic situation of the areas and even the countries in which they are located. The canneries in American Samoa employ nearly 5,000 workers (Gillett, 1994), a substantial work force considering that the entire population of

American Samoa is only about 57,000 people. The canneries in Fiji and Solomon Islands are distant from the main urban centres, and provide formal employment in areas which otherwise would have few jobs.

The economic activity generated by industrial fishing can be substantial. For example, in 1995 Fiji's relatively small tuna cannery exported 920,000 cartons of canned tuna worth about US$ 25 million (Anon, 1996). On the other hand, these industrial operations can have negative impacts. Several studies, including Doumenge (1966), point out that social problems, increased incidence of communicable diseases, increased urbanisation, and pollution are unwanted side effects.

The tuna canneries of the region mainly employ women. FFA (1995) states:

> "The region's canneries bring cash incomes to women who would otherwise not have had the opportunity to enter the money economy, and therefore they have had a favourable, if fairly small, effect on the gender distribution of both employment and income."

An alternative view on the employment of women in the Fiji tuna cannery has been put forward by Alexander (1995), who states:

> "Women leave home early in the morning and put in long tiring days. They have less time and more cash and so tend to buy processed fish rather than catching and processing it themselves. This not only makes women dependent on the market and the fishing industry for a product in which they could presumably be self sufficient, but will in the long run have deleterious effects on the health of those concerned."

3.2 Fisheries of special interest or concern

3.2.1 Bêche-de-mer and shell fisheries

Beche-de-mer is a dried comestible product used in Chinese cuisine and is produced from holothurians, or sea cucumbers of about 20 species, mainly of the genera *Holothuria* and *Actinopyga*. Shells of the gastropods trochus (*Trochus niloticus*) and, to a lesser extent, green snail (*Turbo marmoratus*), as well as the shells of pearl oysters (*Pinctada margaritifera* and *P. maxima*) are cleaned and processed into buttons for clothing, furniture inlay, or other decorative and curio items). These products form the basis of the region's most important small-scale commercial fisheries and deserve special mention because of their nature, and the special management problems they present.

Both fisheries produce export products whose ultimate destination is mainly SE Asia, and for which there is little or no domestic demand. In addition both fisheries, despite their commercial nature, are practiced in a low technology, low-cost manner by Pacific Island villagers in a fashion that is reminiscent of subsistence fishing. Collection is typically by hand or from small, often non-motorized boats, and is variously carried out by men, women and children. Processing is by boiling and, in the case of beche-de-mer, smoking and/ or drying, using drying racks and other equipment that is improvised by whatever materials are available. Product is typically sold to local buyers or middlemen and may pass through several hands (and, in the case of trochus, a local button-making or blanking factory) before being exported.

Beche-de-mer fisheries are described in detail by Preston (1989). The main areas of production are the countries of Melanesia, but beche-de-mer fisheries are also important to rural areas in the rest of the region. World events outside the region, such as the increasing liberalization of trade with mainland China (a major market) and the ongoing civil war in Sri Lanka (a major producer) have a great impact on the Pacific beche-de-mer trade, and in the last ten years have led to a steady increase in demand for Pacific Islands product, and consequent rises in price. The region has responded by greatly increasing its beche-de-mer production and exports, in some countries well beyond the capacity of the resource

to sustain. For example in Fiji beche-de-mer production rose from 32 t in 1984 to 650 t in 1988, a twenty-fold increases (Preston et al, 1988). When translated back to wet weight, 650 t of dried beche-de-mer is equivalent to about 6,500 t of fresh product - more than the combined total of about 5,000 t from all other fisheries production in Fiji (including the domestic industrial tuna fishery) in the same year.

Trochus fisheries of the region are described by Nash (1994). The natural distribution of the main commercial trochus species (*Trochus niloticus*) is from Madagascar in the western Indian Ocean to Fiji in the West-Central Pacific, and again Melanesian countries have historically been the major producers. However because of its potential economic value the natural range has been extended by deliberate translocation. Trochus has been introduced to at least 110 locations in the Pacific Islands region, from the Caroline Islands to French Polynesia (Gillett, 1988), and now forms the basis of locally important fisheries in many of these places.

Because of their non-perishable nature the products of these fisheries provide income-earning opportunities in remote coastal areas where the storage and transport infrastructure needed for more perishable products does not exist. In many Pacific Island countries beche-de-mer and shell fisheries are extremely important in maintaining rural stability, and for some countries (e.g. Wallis and Futuna) they provide the principal export commodity. Collectively they make up about 16% (trochus, green snail and pearl shell 9%, beche-de-mer 7%) by weight of the commercial catch from coastal fisheries in the region. However, they would be responsible for a much greater share of production if measured in terms of either their fresh weight or their commercial value.

Beche-de-mer fisheries are less benign than trochus fisheries, and may have a number of undesirable environmental impacts. Much beche-de-mer is smoked, and it is estimated that 10 t of wood are required to produce 1 t of beche-de-mer. Smoking is often done using mangrove wood from areas close to the fishing grounds, and the beche-de-mer trade has been responsible for extensive mangrove deforestation in some areas. The wastewater from beche-de-mer boiling is toxic to marine animals, including corals, if disposed of directly into the sea, as is often the case. In addition, some sea cucumber species are responsible for turning over sea-bottom sediments and the wholesale removal of these animals may have negative (although so far undocumented) consequences for benthic ecosystems. Management of beche-de-mer fisheries thus needs to take into account not only the sea cucumber resource and the economics of the fishery, but also the environmental aspects of the trade.

Considerable effort has been spent on trochus research and management in the region in order to maximize benefit from the fisheries. Numerous population surveys and resource assessments have been carried out, and to some extent the survey methodology is now standardized so that results from different studies can be compared directly. A wide range of management approaches have been used, including size limits, total quotas, individual transferable quotas, closed seasons, permanent reserves, temporary reserves, and the enhancement of natural populations through the release of artificially propagated juveniles. In most cases the success or failure of these efforts has been documented. Although much of this exists in the ‘grey literature’ (internal reports, unpublished documents, files and other ephemera), the body of comparative information on trochus is probably better and more comprehensive than for any other Pacific Island coastal fishery resource.

Although they are equally widespread and perhaps more economically important, beche-de-mer fisheries are less well understood than trochus fisheries, and until recent times they have been essentially unmanaged. Numerous factors contribute to this situation. Beche-de-mer fisheries are multi-species (at least 28 tropical species are currently traded commercially) and thus present more complex management problems than does an essentially single-species fishery such as trochus. Fishery or export statistics may not allow distinction of sea cucumber species, or may be incorrect, due to difficulties of identification. Sea cucumbers are also notoriously difficult to study for these reasons: size-based data on populations is difficult to gather and use due to the changeable shape and weight of the animals (a factor which also complicates size-based fishery regulations):

- they quickly reject most kinds of external tags;
- they demonstrate negative growth when kept in captivity (thus confounding growth studies); and

- the fact that many species undergo both sexual and asexual reproduction invalidates standard fishery population modeling techniques such as cohort or virtual population analysis.

As a result, although there has been considerable research on beche-de-mer, the population dynamics and reproductive biology of most sea cucumber species remains poorly known, and this has impeded the widespread development of beche-de-mer fishery management regimes. While there is some published research and trade information on beche-de-mer, therefore, there is considerably less management experience on which to draw.

3.2.2 Aquarium life fisheries

The world trade in aquarium fish has been estimated at around 350 million animals annually. About 10 per cent of this trade is of marine origin, compared to only 1 per cent some twenty years ago (Matoto et al, in press). This rapid growth has resulted from improved aquarium-keeping knowledge and technology that now enable the average hobbyist to keep marine fish successfully by establishing aquaria that replicate the marine environment. In addition to fish, marine aquaria may also incorporate a wide range of invertebrates, including live corals, as well as two naturally occurring bio-active materials known as 'live rock' and 'live sand'. These are actually dead coral rubble and sand which have been collected sub-tidally after becoming coated or permeated with living organic material, much of which is microscopic, and which includes bryozoans, sponges, and bacteria. These materials are important in creating a natural and hospitable aquarium environment (Bassleer, 1994).

The marine aquarium trade is based primarily on tropical reef fish, although some desirable species are found in mangroves or other habitats. Enthusiasts, generally not more than 6 months old and 10 cm long, most often seek juvenile fish, after, although attractive fish which are small in size as adults are also favoured. The fish species considered desirable for marine aquaria are extremely numerous but few of them are juveniles of commercial food fishes (Lewis, 1985). Live coral pieces of a range of species, usually measuring no more than 20 cm overall, are also sought after by marine aquarists, both for their beauty and because they assist in recreating a 'natural' aquarium environment. Ornamental dead corals, which have usually been collected live and then dried, washed and bleached, are also sold in the aquarium trade.

Approximately 85% of marine aquarium fish offered on the world market are captured in the waters of the Philippines and Indonesia, while the remaining 15% come from the tropical waters of other regions of the world, including PICTs. Marine aquarium fish are or have been collected and exported from Palau, Cook Islands, FSM, Fiji, Guam, Kiribati, Marshall Islands, Tonga, Samoa and Vanuatu (Pyle- 1993). Similarly live corals are principally harvested outside the Pacific region, mainly in Indonesia, Haiti, the Philippines, Singapore, Sri Lanka, and Taiwan, but some PICTs, including Fiji, Tonga and Kiribati have exported quantities of live coral in recent years.

Although published information is scarce, Pyle (1993) suggests that between 200,000 and 250,000 fish with an approximate export value of US$1 million to US$1.5 million are exported annually from the independent countries of the Pacific. These figures suggest that the Pacific region (excluding Hawaii, Guam, and the Philippines) accounts for 4 to 10% of the world trade in marine aquarium fishes. The USA imports over 60% of the marine aquarium fish and invertebrates in this international trade, while European and East Asian countries and Australia account for the rest. The USA and European countries are also the major importers of live coral. US imports rose from 40,000 pieces in 1988 to 345,000 pieces in 1991, a nearly tenfold increase which parallels the growth of the aquarium fish trade (Wells et al, 1994).

The demand for aquarium species has expanded rapidly, leading to the emergence of new commercial aquarium fisheries worldwide. Destructive fishing, habitat damage and over-exploitation have characterized aquarium life fisheries in the Philippines and other locations, causing decreased production from some areas and leading overseas buyers to seek alternative sources of supply. As air services, infrastructure and technology develop in the Pacific Islands region, new opportunities have developed for PICTs to participate in this trade.

Concerns expressed about the sustainability of fisheries for aquarium fish, live rock and live sand in PICTs have largely been allayed by recent studies (e.g. Sharron, 1997; Matoto et al., in press; Preston 1995; and numerous others) which suggest that, provided that they are managed and monitored, these

fisheries can be carried out in a way that will have little impact on resources which are generally abundant and widespread. Since, in terms of dollars per unit weight, the value of aquarium products is high - live rock retails in the USA for US$14-40/ kg (L. Sharron, pers. comm.) - and since there appears to be little interaction between subsistence/ commercial food fisheries and those for aquarium, the promotion of aquarium fisheries would seem to be a logical development step for PICTs.

Somewhat different considerations apply to the collection and export of live corals. Although probably the most valuable of the aquarium life commodities - live coral specimens of a size suited to home aquaria sell in the USA for US$45-130/ piece (L. Sharron, pers. comm.) - the lower growth rates of corals and the general role they play in supporting the reef ecosystem means that any live coral harvesting needs to take place in a very conservative manner to avoid reef or ecosystem-level damage.

Thus, although aquarium fisheries appear to offer the potential for environmentally responsible economic growth in PICTs, there is a need to ensure that the negative experiences of other areas are not repeated. Aquarium fishery development needs to take place according to a basic code of practice which includes overall limits on harvesting, sensible rotation of collection effort to avoid localized over-exploitation, and strictly-enforced bans on the use of narcotics, toxins, coral breakage or other destructive harvesting techniques. There will be a need to put in place differential management systems for the live corals, fish and live rock/ sand components of the trade. Economically, it is desirable that local residents and resource owners be involved in the actual collection activities to the greatest extent possible, especially in rural or outer island areas where properly managed fisheries of this kind have the potential to contribute significantly to local economies.

3.2.3 Live food-fish collection

The past decade or so has seen the rapid development of fisheries based on the collection of certain types of high-value reef fish and their live transport to market destinations in SE Asia where they are used mainly in the restaurant trade. These fisheries focus particularly on groupers, napoleon wrasse, red snappers, and other visible or high trophic-level components of the ecosystem. In general they involve FFVs fitted with live wells operating under license or joint venture arrangements in Pacific Island countries. In some cases holding tanks or cages have been established to allow the progressive accumulation of fish for collection by a transport vessel.

In most cases these fishing operations at least make a pretence of purchasing fish from local fishermen, but usually at least part, and often most, of the fishing is done by foreign crew using diving gear and toxic chemicals to stun fish that are hiding in holes or crevices in the reef. Use of these toxins, which include sodium cyanide, is known to have long-term damaging effects on a wide range of reef organisms, including corals. Fishing operations typically involve intensive fishing and poisoning of an area, following which the vessel moves on to another area to repeat the process, leaving behind a fish community stripped of high-level predators and possibly seriously damaged due to poisoning (Johannes and Riepen, 1995).

Live fish fisheries have thus acquired a poor reputation for their destructive and non-sustainable characteristics. Some PICTs have become aware of their destructive nature and have banned this type of fishing operation, or have attempted to prevent the use of toxins while still permitting fishing to continue. In others, lack of awareness of the destructive aspects of the fisheries or the potential for rapid short-term economic gain mean that these fisheries continue to operate destructively in some areas.

3.2.4 Commercial sport fishing

Commercial sport fishing is a specialized form of small-scale commercial fishing that is growing in importance in the region. Sport fishing vessels operate mainly from urban or tourist centres and provide recreational opportunities to tourists or local sport-fishermen, who may be willing to spend considerable amounts of money for the opportunity to indulge in recreational fishing in areas where they believe the resources are rich or underexploited.

Numerous analyses, often sponsored by game fishing associations, have demonstrated that local economies benefit more from sport fishing activities than they do from commercial fisheries based on the same resources (e.g. Pooley, 1991). Sport-fishermen, especially tourists, spend far more money on vessel charter, accommodation, provisions and shoreside recreation than do commercial fishermen, and also make greater use of locally-produced (as opposed to imported) goods and services. Where there is a substantial commercial sport-fishing fleet the establishment of secondary industries providing gear, vessel and general tourist services may follow.

Sport fishing is thus seen by some PICTs as a logical and environmentally responsible form of development which is more akin to tourism than to commercial fishing and which will maximize the dollar returns to the national economy from fishery resources. As a result there have been a number of investigations into the sport fishing potential of countries of the region (e.g. Watt, in press; Bright, 1996). Some of these have been quite innovative, proposing the training of local subsistence or commercial fishermen in the etiquette of acting as tourist guides using their own boats, rather than the more classical approach of encouraging the establishment of standard western game fishermen, which rely more heavily on imported skills, technology and equipment in order to be successful.

It seems likely that commercial sport fishing will continue to develop in the region, and will be strongly influenced by the growth of the tourist industry. If sport fishery development activities are to be successful, there may be a need for management arrangements that restrict commercial fishing activities

3.3 Management issues

3.3.1 General

Commercial fisheries have been a development target of Pacific Island Governments for several decades. Most development efforts have focused on coastal resources, which are more easily accessed both physically and in financial/ investment terms than are offshore pelagic stocks. In many cases such development has been underpinned by the assumption, often unfounded, that resource availability would not be a principal limiting factor to development.

In fact Government efforts have only rarely resulted in real, sustainable fisheries development. Many Government-sponsored projects have led to the establishment of inefficient, heavily subsidized fish harvesting, processing and distribution operations which have not only been economically non-viable in themselves, but have also served to impede the development of the private sector by competing with it on unfair terms.

Nevertheless, the development of most of the current commercially operating fisheries in the region has been market-led, and has generally happened independently, or in spite, of Government initiatives. Many PICTs now realize this and are altering their policies so as to withdraw from direct involvement in commercial aspects of fisheries, as well as attempting to create an environment in which the private sector can fulfill its role as the engine of economic growth in regard to marine resources. However the transition has been slow, and is far from complete.

The focus by PIC Governments on economic development has in the past often acted contrary to the interests of resource conservation and sustainable management. Even when they have been economic failures, Government-sponsored fisheries development efforts have effectively provided subsidies to commercial fishing operations and in some cases have continued to allow harvesting when economic considerations might have suggested a reduction of effort. Examples include some of the various Government-funded fish buying and collection services that have been established in many PICTs over the past two decades, and which have led to localized resource depletion while at the same time losing money for the Government.

In general, whether Government-supported or market-driven, the region’s coastal fisheries are characterized by low-capital, labour intensive fishing methods targeting reef and lagoon species. The costs of inputs may often be low, a characteristic that may encourage overfishing. Increasing levels of fishing pressure, usually market-driven, combined with the technological improvements that have been made to even the most basic fishing equipment, has led to widespread overfishing of many high-

value resources. Commercial fisheries supplying domestic markets tend to be centered on urban areas. The extensive coastal zone development that usually characterizes these areas combines with high levels of commercial fishing effort to produce negative impacts on fishery resources. These may be further compounded by the use of destructive fishing methods, including various types of toxic compounds (traditional vegetable poisons and, increasingly frequently, household bleaches and weed killers), explosives (usually obtained from relict WW2 ordnance and mining projects), and the physical breakage of corals using hammers and crowbars.

As a result, degradation of inshore fisheries is a serious and growing problem throughout the region. In many cases such degradation is chronic and thus does not evoke the same emotive response among policy-makers and the population at large as would the sudden collapse of an important fish stock (or, for that matter, unsustainable fishing practices by FFVs).

It is only in the last decade or so that there has been a growing awareness of the finite and fragile nature of inshore resources on the part of policy-makers, fishermen and others. However the idea that coastal waters in PICTs are resource-abundant continues to persist in the minds of many investors, investment promotion agencies, and Government officers. According to Adams (1996) “Many development prospectuses still associate the adjective ‘teeming’ with marine resources”.

Nevertheless it is now generally recognized that improved management systems for many of the region’s inshore fisheries are urgently needed. Unfortunately, development of such systems is a complex and highly politicized issue in most PICTs. The lifestyles, employment and nutrition of a high proportion of the region’s population are largely dependent on the marine environment, which in many cases is the only potential source of such benefits. Few politicians are willing to risk the electoral wrath of their constituencies by supporting unpopular fishery management systems such as catch or effort limitations, even if these might be needed or might bring long-term benefits. In addition, systems requiring extensive centralized policing and research capacities are unrealistic in many PICTs due to the lack of any capability to maintain such functions, and because of the small size and complex nature of the fisheries themselves.

The emerging consensus, therefore, is that, if they are to be successful, coastal fishery management regimes must be adopted and supported, and in some cases implemented, by the fishing communities themselves, working in partnership with government or other resource management authorities. Developing systems that conform to this requirement while maximizing biological production and economic returns is now the major challenge for PIC coastal fisheries management.

3.3.2 Coastal zone degradation

Apart from direct exploitation, various forms of environmental degradation also threaten fishery resources, which arise from a number of human-induced causes as discussed in section 2.5. The damaging consequences of various coastal zone developments include:

- increased freshwater runoff and siltation due to logging, mining, land clearance, coastal constructions and other major disturbances to watersheds or the terrestrial ecosystem;
- organic pollution from human settlements (sewage), agricultural practices (fertilizers) or food processing activities (sugar mills, fish canneries and transshipment sites);
- chemical pollution from agriculture (pesticides), industrial sites, mining, petrochemical extraction and handling, ships running aground, use of poisons for fishing, etc;
- physical damage to habitat from coastal sand and gravel mining, dredging, coastal construction, blasting of reef passages, shipwrecks, and the use of destructive fishing methods (dynamite); and
- loss of fish nursery grounds and other critical habitats, especially mangroves and seagrass beds, due to deforestation, reclamation, or other coastal impacts.

These various impacts tend to have a negative effect on fisheries, leading to partial or total reduction in abundance of desired species, or ecosystem changes involving species ‘flips’, in which dominant species become irreversibly replaced by other, often less commercially desirable species. The changes tend to be gradual rather than sudden, making the relationship between cause and effect less obvious, and reducing the likelihood of remedial action being taken.

Another widespread consequence of coastal degradation is increased incidence of ciguatera, a type of human food poisoning caused by eating fish which have bio-accumulated toxins produced by a micro-organism which colonizes damaged or broken coral surfaces. Toxins enter the food chain through grazing by herbivorous fish, and then become increasingly concentrated at higher trophic levels. Chronic ciguatera incidence may be associated with ongoing coral breakage due to weather in exposed areas, or may be due to coral mortality from human-induced pollution or sedimentation. Acute ciguatera is characterized by local or temporal outbreaks that may follow cyclones, floods or other natural causes of coral breakage or mortality. Although few formal studies have been carried out to prove the linkage, circumstantial evidence strongly suggests that ciguatera outbreaks can also result from human activities such as reef blasting, ship grounding or coastal construction.

Because they are a direct consequence of human population growth, many of these impacts tend to be concentrated around urban areas, where fishing pressure is also highest due to the commercial opportunity to supply urban markets.

Improved management of coastal developments within the framework of an integrated coastal zone management plan could mitigate many of the impacts on fisheries. In particular reductions in the discharge of organic and inorganic pollutants into coastal systems and protection of coastal mangrove systems could have positive impacts - or might prevent further negative impacts - on fishery production.

The concept of integrated coastal zone management in PICTs has in the past been promoted by SPREP, but has not yet taken extensive hold, despite the fact that the coastal zone comprises 100% of many PIC land areas. It is possible that the linkage between terrestrial development and fishery degradation is not yet fully appreciated by many decision-makers. In addition, as mentioned earlier, the value of fisheries, and especially subsistence fisheries, to national economies appears to be underestimated in many PICTs. The need for management of coastal systems in general, and fisheries in particular, may thus not yet be widely realized[4].

3.3.3 Aquaculture

Aquaculture has been viewed in the region as a means of supplementing or replacing production from wild fisheries, and of producing new or unfamiliar and usually high-value products. Experimental aquaculture projects to these ends have taken place in PICTs for at least the last 3 decades. So far, however, results have been generally disappointing. The French territories have made progress in aquaculture, and these efforts have led to a substantial prawn farming industry in New Caledonia, the pearl industry in French Polynesia, which may be considered the region's two main aquaculture industries. In addition various aquaculture projects have been established in Guam. In each case these efforts have received the long-term, costly technical support of metropolitan research institutions, as well as various forms of indirect subsidization throughout their history.

Examples of working, commercial aquaculture activities in the independent PICTs, which have not benefited from the extensive research support that the territories have had access to, are far fewer. The pearl industry of the Cook Islands, a prawn farm in Solomon Islands, village-level tilapia farms in Fiji, and seaweed farming in Kiribati are the predominant exceptions to the general failure of aquaculture to take hold in the independent PICTs. Adams (pers. comm.) argues that this is because of a past tendency to concentrate on high-value export products rather than focusing on low-cost aquaculture to supply domestic markets.

Various experimental projects are continuing throughout the region and involve a diverse range of species, including giant clams, pearl oysters, wing oysters, edible oysters, prawns, various strains of tilapia, milkfish, mullet, rabbitfish, barramundi, seaweed, trochus and beche-de-mer. Although aquaculture efforts continue to receive the support of a number of aid donors, both bilateral (especially Japan) and multilateral (especially FAO), in general these support activities tend not to be

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4 Not all commentators agree with this viewpoint, however. For example Gillett (1995) argues that decision-makers know very well the needs for and benefits of both fishery and coastal zone management, and that lack of knowledge is generally not the main reason for lack of action.

sustained over the 20-30 year development period that has been required to establish the regions two major aquaculture industries in the French territories.

As well as production-oriented aquaculture, the concept of resource enhancement through the release of aquaculture-produced juveniles into wild populations has received considerable attention in the past 5-10 years. Several countries have established hatcheries for trochus and giant clams, both of which are easy to breed and both of which are prone to localized over-exploitation throughout the region. However, despite considerable effort, there is not yet any evidence to demonstrate that releasing juveniles into the wild has any discernible impact on fishable adult populations. In addition, Preston and Tanaka (1990) argue that experience in Japan and elsewhere clearly demonstrates that reef restocking of this kind will not lead to resource replenishment unless there is also effective control of resource harvesting through a fishery management regime. Unfortunately much of the interest in reef replenishment in the Pacific has been generated because of the false belief that restocking can replace management - in other words, the presence of a hatchery pumping out large numbers of juveniles into the wild means that control over harvesting of adults will no longer be needed. Trochus harvesters and exporters in particular have argued in Vanuatu that even the establishment of an experimental hatchery is adequate justification for the lifting of all trochus fishery regulations. Unfortunately, this is not the case. PICTs thus need to take care that, in experimenting with essentially unproven resource enhancement techniques, they do not inadvertently undermine the basis for management of the species concerned.

Aquaculture in PICTs tends to be viewed as a form of development that could lead to the reduction of fishing pressure on wild stocks, and thus inherently environmentally responsible. However aquaculture development experience in SE Asia has demonstrated that, far from being a clean, environmentally friendly activity, aquaculture can, if allowed to proceed without proper regulation and management, be highly damaging to and destructive of coastal environments. Mangroves are a particular area of concern in this regard. Their flat nature, firm soil, and closeness to the sea make mangrove areas very desirable as sites for aquaculture projects and mangrove destruction has been the result of aquaculture development throughout SE Asia. In Fiji and New Caledonia mangroves have been cleared to make way for aquaculture projects, which in some cases have failed, thus creating a net negative effect for the coastal environment.

In addition, many aquaculture activities rely on high stocking densities of the cultured animals, which increase their susceptibility to infectious diseases. Water treatment may be necessary to keep diseases in check, and these may variously involve the use of antibiotics and disinfectants that, ultimately, make their way into the ground water or the coastal environment or both. Aquaculture thus has the potential both to increase the likelihood of infectious pathogen outbreaks that could spread into wild fish stocks, and to act as an additional source of toxins or pollutants into the coastal zone.

Therefore, while aquaculture may have an important role to play in PICTs in the future, this role needs to be carefully evaluated in the context of broader national fishery development and management problems, so that scarce human and financial resources are deployed in support of those activities most likely to produce tangible benefits, and so that development avenues are not pursued that may worsen, rather than improve, PICTs abilities to manage their fisheries and coastal zones.

3.3.4 Domestic demand for coastal marine products

According to SPC (1993) the population of the Pacific Islands region will increase from 6,068,000 to 8,871,060, or 46%, between 1990 and 2010. If present levels of per capita fish consumption are maintained, this will result in a demand for fish of 166,776 tonnes in the year 2010, or 58,535 tonnes (49%) more than at present (Gillett, 1995).

This demand increase will be tempered to some degree by income and price, especially for that portion of the population living in the more magnetized economies of urban areas. World Bank/IMF data suggests that the annual growth of GDP per capita in the region during the period from 1990 to 2010 will be a modest 1.7%, which will vary considerably from country to country, with some PICTs expected to show negative growth. NCDS (1994) predicts that urbanisation will occur in the region at an increasingly rapid rate. For example, in Papua New Guinea the urban population is projected to increase from the present 16% to 48% by the year 2010. During the same period in the Solomon Islands the proportion of people living in cities and towns is expected to double to 32%.

Major increases in food supplies from medium and small-scale fisheries are unlikely due to the fully exploited nature of many of the readily accessible resources. The coastal resources of some inaccessible areas, including much of Papua New Guinea, are exceptional in this regard in that they appear substantially underexploited and could produce yields much higher than at present (UNDP, 1989; ANZDEC, 1995; Preston, 1996). However, under-exploitation is a direct result of inaccessibility and poor internal product distribution channels. As these become better developed, those remaining underexploited areas will be progressively brought into production. It is possible that, with lack of effective management, destructive fishing, and coastal zone degradation, the yields from coastal fisheries in many areas could actually decrease in real terms between now and 2010 (GPA, 1996).

Tuna fishing is the most promising means through which PICTs could increase domestic fish production, but due to the nature of tuna fishing its contribution to food supply in the region has not been great. This situation could change if, for example, developments occur allowing small scale fishermen access to tuna resources through fish aggregation devices (FADs) or small scale longlining. Alternatively, encouraging commercial or industrial tuna fishing vessels to land their by-catch could improve domestic fish supply and provide relief to inshore resources, although there may also be negative economic impacts for small-scale commercial fishermen who may find themselves unable to compete on price terms with industrial fishing operations.

There is the possibility that aquaculture could contribute more substantially to food supply in the region. Unfortunately past performance in aquaculture has been poor (see section 3.3.3) and does not provide an encouraging model for the future contribution of aquaculture to the region's food supply.

In view of the population increases expected and the limited coastal resources of most of the countries, it seems highly probable that the proportion of per capita fish supply contributed by the region's coastal resources will decline. The degree to which this happens will depend on the extent to which coastal fisheries are impacted by other coastal zone developments and the effectiveness of any fishery management regimes put in place.

If coastal fishery production per capita declines, the most likely responses are: greater consumption of non-coastal fish resources (such as tuna); greater consumption of imports; an overall decline in per capita fish consumption; or, most likely, some combination of the three.

Indications of PICTs' ability to pay for increased fish imports are not promising. The World Bank (1995a) states that "Past patterns of growth and development in the Pacific Island Member Countries do not appear to be sufficient to provide a progressive improvement in living standards in the future". NCDS (1994) concludes "rapid population growth is not a cause for concern if it is matched by similar levels of economic growth. But for most of the PICTs real per capita income declined in the 1980s and if low rates of economic growth continue, they could decline in the next two decades".

Gillett (1995) predicts that, between now and the year 2010, the most probable scenario is that the dependency of PICTs on imported or non-local foods will increase, resulting in decreasing diet quality, worsening dietary health and deteriorating food security at both household and national levels. This scenario could be mitigated by improved management of coastal fisheries, improved coastal zone management regimes, and by efforts to increase domestic supply and consumption of tuna or tuna by-catch.

3.3.5 Export demand for coastal marine products

FAO (1995a) predicts a decline in fish supply worldwide in the coming years, leading to a strengthening of international prices for seafood products. If this prediction proves correct, there is the possibility that exports of fish from coastal fisheries in the region could increase. In this context it is worth recalling that most fisheries development efforts in the region so far, whether Government or private-sector led, have targeted export markets. This trend is likely to increase in the face of higher international seafood prices and the increased trade liberalization currently occurring world-wide.

In terms of their value, the most important coastal fishery export products over the past decade or two have been beche-de-mer and shell (see section 3.2.1). Although the markets for these products are quite different they share a common characteristic in that, because the end products of these fisheries require no refrigeration, harvesting can take place even in remote areas lacking in infrastructure.

Where refrigeration infrastructure and distribution chains exist, commercial exporting of more perishable high-value products such as lobsters, crabs, octopus and selected finfish also takes place.

Several countries of SE Asia, including Hong Kong, Singapore and Taiwan, are the traditional markets for most PIC coastal fishery exports, due to the nature of the products, their relative proximity, and the existence of workable shipping connections. These are among the fastest growing economies in the world and their demand for seafood is increasing rapidly. In addition, huge new markets for seafood products are opening up in mainland China and Korea. Although past demand has focused mainly on non-perishable products like beche-de-mer, improved transport infrastructure is leading to a rise in fresh and frozen seafood exports to these markets. In addition, they are beginning to demand non-traditional products such as live groupers, wrasses and other reef fish whose very high value justifies the high cost of harvesting in, and transportation from, remote locations. These fisheries are developing all the more quickly because over-exploitation in areas closer to the markets, such as Indonesia and the Philippines, has led to resource depletion in those countries.

Such fisheries are typically organized or financed by Asian companies which extend operations over several countries. The comparatively high prices on offer provide the leverage to bypass traditional constraints on exploitation, particularly where the commodity being exploited is not an item of regular subsistence nutrition (Adams, 1996).

These fisheries are not in themselves a problem, and with proper management could be prosecuted indefinitely on a sustainable basis. They currently target a only small fraction of the range of organisms which are available for subsistence nutrition and local commerce and provide one of the few sources of direct income for rural communities. However, the intensity with which they may be carried out can be excessive in small island ecosystems and can lead to rapid resource depletion. In addition, this type of fishery often has undesirable side-effects, such as burning of large quantities of mangrove wood for beche-de-mer processing, use of sodium cyanide or other toxic compounds to achieve high catch rates of live fish, and decompression injuries resulting from diving with underwater breathing apparatus by Pacific Islanders untrained in its use.

Many Pacific Island communities and leaders recognize that these fisheries would be of far more long-term cash benefit if exploited on a smaller scale and over a longer term, but the mechanisms with which to regulate the fisheries are usually inadequate. The re-empowerment of community management is considered by many to be the only realistic way of controlling over-exploitation, but it requires a very strong community to withstand the temptations of short-term financial gain that these high-value fisheries offer.

There are, however, management opportunities for export fisheries other than at the level of local harvesting. Export products can be monitored relatively easily at departure ports or airports, which in PICTs are not very numerous, and can be restricted through various mechanisms, including inspection and quality control requirements and the imposition of export tariffs designed specifically to limit product types or volumes, or to reduce the profitability of fishing to the point where over-exploitation is discouraged.

Government regulatory approaches that restrict international trade run counter to the current process of trade liberalization taking place under the General Agreement on Tariffs and Trade, and through other regional and global trade agreements (including the establishment of the World Trade Organization). However, exceptions exist in the case of endangered or threatened species which are listed in CITES, and which include all species of marine turtles and giant clams. For these species trade restrictions are an acceptable and at least partly successful conservation tool which have had an important positive effect on people’s attitudes toward excessive resource exploitation (Adams, 1996).

Irrespective of international arrangements to liberalize trade in seafood products, any nation or collectivity of nations, including PICTs, has the authority to put in place export restrictions or bans on fishery products whose production may be thought to lead to domestic resource overexploitation. As exploitation of inshore fishery resources increases in PICTs, the development of international trade control instruments or the extension of CITES or other agreements to protect sensitive or fragile species or ecosystems may be a further possible management option. In addition, improved trade monitoring by both exporting and importing countries would assist in quantifying the exploitation levels of the resources in question.

3.3.6 Ecosystem management

All fisheries exploit resources that are themselves components of sometimes complex ecosystems, and many factors other than human activities play an important role in influencing fishery resource population dynamics. In some cases these ecological influences may be more extensive than previously realized, and more important than fishing or coastal zone development activities. There is a growing body of evidence to suggest that, unless they are obtained in an ecosystem context, the results of fishery research may be misleading and fishery management actions may be misguided and ineffectual, or even damaging.

Sherman (1994) reviews recent research on a number of large marine ecosystems (LMEs), most of which support commercial fisheries. In a number of cases fishery declines have been initially attributed to human overfishing, but ecosystem-level studies have subsequently suggested that the observed declines were actually due principally to extraneous factors. These include current shifts, the effects of inter-annual or secular fluctuations in temperature on primary and secondary productivity, as well as on reproductive success of the target resource, and changes in populations of predator and prey species in response to these factors.

In many cases these extraneous factors are themselves human-induced, but not as a result of fishing activity, and more often than not at a large scale. Current fluctuations and changes in the ocean weather system have major impacts on fisheries and may be connected to the process of global climate change associated with greenhouse gas emissions. Coastal developments may induce ecosystem-level changes that affect fishery performance in unexpected ways. For example the crown-of-thorns starfish, which predates on reef corals, occasionally undergoes population explosions or ‘plagues’ which, in the Pacific, have been causatively linked to coastal pollution and eutrophication (Zann and Eager, 1987). On the Great Barrier Reef in Australia, Bradbury and Mundy (1989) found that predation by crown-of-thorns starfish plagues resulted in a shift in the biomass and species composition of corals, a change in the community structure of the benthos, and a decoupling of energy transfer to several fish stocks.

In such cases fishery management responses to declines in fish stocks may have little or no effect since the decline is not occurring as a result of fishing but is a manifestation of an ecosystem-level change that may not otherwise be obvious. Ecosystem-level management and research is therefore needed as a means of supplementing fisheries information and interpreting fishery changes. This is particularly true in relation to coastal fisheries, where shoreline or inland developments may be having impacts on many aspects of the coastal marine ecosystem.

Inshore fisheries in coastal areas, and the ecosystems on which they depend, remain for the most part poorly studied and understood. In particular their physical extent and the degree to which they interact with the ocean ecosystem is not well known. However there is a growing body of evidence to suggest that the linkages between coastal and oceanic ecosystems, and between coastal ecosystems which are widely separated from each other, are more extensive than has traditionally been supposed. The following paragraphs provide examples of such linkages:

- many reef fish and invertebrate species, including those of commercial importance, spawn on spring tides, which results in eggs being drawn offshore. Egg and larval development then takes place in the offshore milieu, a reproductive strategy that avoids excessive juvenile mortality caused through predation by corals and other reef-based planktivores. The larvae metamorphose to pre-settlement juveniles just before the next spring tide, which brings them back to the reef environs. At this time mass settlement occurs, resulting in a recruitment pulse. Many reef species are thus dependent on the offshore or oceanic environment for part of their life cycle;

- certain tropical lobster species have extended pelagic larval phases - up to one year in some cases - during which they may be transported long distances by ocean currents before eventually settling. In such a case downstream recruitment may occur, such that fished adult stocks originate mainly from spawning populations in another, geographically distant, ecosystem;

- many pelagic fish species, including tunas, spend part of their lives in the oceanic environment but also periodically enter the coastal environment, thus transferring

production from one ecosystem to another. Many coastal fisheries for tuna and other pelagic species are probably harvesting the trophically-accumulated products of primary production which occurred in other, distant, geographical locations; and

- genetic analyses of widely separated populations of giant clams and pearl oysters from atoll countries have indicated that these resources, which tend to occur in discrete and isolated populations which were previously thought to be independent, demonstrate some degree of genetic interchange (Benzie and Ballment, 1994).

These few examples serve mainly to illustrate the paucity of available knowledge of coastal marine ecosystems and their relationships with each other and with the oceanic environment. There is a need for more study at the ecosystem level, not only to enhance effective conservation and management of fisheries, but also to increase understanding of the impacts of coastal developments and CZM practices on marine ecosystems as a whole. As Sherman (1994) concludes, "discipline-oriented studies can contribute more toward achievement of resource sustainability when they are conducted within a framework of science at the level of organisation that is multi-disciplinary and focused on populations, habitats and ecosystems on large spatial scales".

3.3.7 Research

The region's coastal fisheries involve hundreds of species in several different phylogenetic classes, exploited through many different techniques in the waters of thousands of sometimes-remote islands, atolls and inaccessible coastal areas.

Government fisheries officers in PICTs are not numerous, and have a variety of usually development-related works to accomplish. Institutional activities tend to be driven by crisis rather than plan, and, as discussed in section 3.3.1, have had a historical focus on short-term income generation from fisheries, rather than long-term management to achieve sustainability.

As a result, fishery research in PICTs has in general been scant, and has tended to have a development slant (e.g. experimental fishing or gear trials that aim to promote further exploitation) rather than a management orientation. The main exception to this generalization has been the history of management-related research carried out in PNG for almost 30 years, and some management-oriented research in Fiji from time to time. It is no coincidence that these are the two PICTs with the largest and most capable national fisheries agencies in the region.

Even these two countries, however, share in common with all other PICTs the characteristic that even such basic information as current or recent historical levels of coastal fishery production are not known with any reliability. Fishery statistics programmes have come and gone in most countries, with substantial time series of landings or other data being rare and of dubious quality. Some information has been gathered through occasional surveys or activity reports, often carried out under external assistance projects or for specific, one-off purposes. Surveys may be decades apart, local in scale, and use different methodologies or target different sectors so that they cannot be readily compared. Many of these issues have been reviewed in detail, country-by-country, by Adams et al (1995).

Information on the exploitation or status of fishery resources in PICTs, as well as on the biological characteristics of even the more important resources is thus thin and patchy in both time and space.

It is possible to manage fisheries without detailed knowledge of the exploitation history or ecology of the species involved. This can be done through the process of 'adaptive' or experimental management (Walters and Hilborn, 1990) in which catch potential is regularly adjusted in response to perceived changes in the abundance of the stock: or by the use of the 'precautionary approach to fisheries management' (Garcia, 1994), in which deliberately conservative management measures are put in place to minimise risk to a resource whose status and characteristics are poorly known.

Where customary marine tenure (CMT) (see section 3.4.2) exists it typically relies on a combination of the adaptive and precautionary mechanisms, coupled with restrictions on access and supplemented by traditional ecological knowledge, to achieve sustainable resource use. However, where CMT does not exist this form of management can only be applied if there is another authority, e.g. national or provincial government, which can monitor and respond to changes in the exploited stock.

PIC Fisheries Departments are, however, largely unable to monitor coastal fisheries, at least not at the relatively fine temporal and geographical scales that would be required for successful adaptive management. This is partly due to the scattered nature of subsistence and small-scale commercial fisheries, partly due to inadequate Government capacity and infrastructure for fishery monitoring, and partly due to inappropriate prioritisation (Adams, 1996). In addition, as discussed in section 3.3.1, even if they had better monitoring capabilities, PIC Fisheries Departments are not renowned for being highly responsive to management issues, and certainly have no history of consciously taking a precautionary approach to marine resource management. It would seem hopeful to expect a reversal of these characteristics in the short term.

The most desirable strategy would thus seem to be to improve the knowledge base on the region's coastal fisheries, and use this knowledge as the foundation for management. Unfortunately, national Fisheries agencies are at present poorly equipped for this task.

The various Pacific regional organisations have attempted to step into the gap by encouraging and supporting national research and management efforts, and by providing a vehicle for their coordination and comparison:

- SPC has a long history of assisting PICTs with national or local-level surveys of specific fishery resources, of providing technical input into national or local fishery management plans and, due to its multi-disciplinary nature, of promoting fisheries management issues within broader economic development plans and programmes. SPC has also carried out reviews of Fisheries Department research and human resource development plans, as well as a wide range of technical training programmes aimed at developing research capacity at the national level. This work has been complemented and supported by the Forum Fisheries Agency, with many projects being carried out as joint activities;

- SPREP has undertaken a wide range of activities to encourage the sustainable use and conservation of living resources, including those of the marine environment. SPREP has been instrumental in the establishment of marine protected areas in countries of the region, in developing national and regional responses to oil spills and other forms of pollution events, in planning for waste management, in promoting the concept of responsible, integrated coastal zone development, and in documenting traditional resource management practices, all of which impact activities on fisheries;

- USP maintains active fishery-related teaching and research programmes which have a management focus. USP provides technical support to other organisations, especially SPREP, which in turn channels many of its higher-level training activities through the University. USP also operates the Pacific Information Centre, a major regional document collection with a large marine resources component; and

- SOPAC carries out coastal bathymetry, hydrography and other geophysical studies in support of coastal development projects and plans in PICTs. This work has been valuable in providing assessments of the type and extent of fishery habitats in countries of the region, which has then been applied to resource assessments. The organisation has integrated its data holdings into a geographic information system (a computerized, geo-referenced database) on the regions coastal-hydrographic/ bathymetric and oceanographic characteristics. SOPAC has also been involved in national-level coastal zone planning in many PICTs, particularly in advising on the environmental impacts of physical modifications to the shoreline.

These varied and wide-ranging activities are carried out in a manner that is, by and large, well coordinated and integrated. Many areas of common interest among the agencies are addressed by:

- memoranda of agreement among the agencies, which define non-overlapping work areas in order to avoid duplication of effort; or

- joint projects which capitalise on the strengths of each agency. The most prominent is the Pacific Island Marine Resource Information Service (PIMRIS), which provides information to fisheries workers in the region and which involves all the above agencies.

Such inter-agency coordination is necessary because member or donor countries may themselves be unclear as to the precise roles of each agency, or may wish to seek the involvement of the wrong agency for non-technical reasons. Coordination has been considerably strengthened by the establishment of the South Pacific Organisations Coordinating Committee in 1992, which itself grew from the SPC/ FFA Colloquium, a two-agency coordinating mechanism established in 1990.

As well as the indigenous Pacific regional organisations, coastal fisheries research is supported by a number of international agencies, including the FAO of the United Nations and the International Centre for Living Aquatic Resource Management, which have a presence in the region, and which have carried out both national and regional fisheries development activities. Several metropolitan government research bodies and universities also have offices or branches in US or French territories in the region, and a number of private foundations have research stations in PICTs.

Despite this apparently extensive infrastructure and high degree of focus on coastal fishery research, the range and nature of the fisheries means that there is as yet no good idea of the level of production at which the region's coastal fisheries should be managed to be sustainable and maximally productive. In fact even the area of coral reef present in the region is not known with any certainty, so scaling factors cannot be used to extrapolate production potentials for areas or nations based on surveys of individual reefs. In addition, there is a lack of knowledge about how tropical reef species interact and respond to exploitation (Adams, 1996).

One important approach that has been taken in regard to certain fisheries or resources has been the development of 'rules of thumb' which can be applied in the absence of good management information. An example is the now widely used statistic relating to outer-reef slope fisheries, whereby management is now frequently based on the assumption that, once virgin biomass has been removed, these fisheries can be sustainably exploited at the rate of about 70-210 kg per kilometer of 100-fathom reef-slope isobath (Dalzell and Preston, 1992). Although such a figure is certain to be ill-adapted to many situations, it provides the fishery manager with a point of departure and a means of analysing whether current or projected rates of exploitation are within reasonable bounds or not. Similar management 'rules of thumb' could be developed for many fisheries in the region, based on data gathered or surveys made in various differing fishery situations, including known cases of overexploitation. An advantage of the Pacific Islands region in this regard is that its archipelagic nature provides many examples of such differing fishery situations, and thus good opportunities for the collection of comparative information on a regional basis.

According to Adams (1996), most PICTs would also benefit from a concerted long-term effort to perform a series of rapid quantitative fishery assessments on a sample of sites, using identical methodologies, to boost basic fishery knowledge. It is unlikely that this would lead to an accurate absolute assessment of the status of reef fishery resources with respect to sustainability, but it would enable reefs to be rigorously compared and priorities for further action to be identified.

The fact that many Pacific Island coastal fisheries can still support human subsistence nutrition is perhaps a matter more of good fortune than of effective management, either by Governments or communities. However, a knowledge of the limits of sustainable exploitation will become increasingly important as the population, the demand for fish, and the cash economy all grow and the need for more formalised, knowledge-based fisheries management becomes more pressing.

3.4 Management arrangements

3.4.1 General

The legislative bases of fishery management in PICTs are reviewed by Campbell and Lodge (1991). Most systems rely on one or more Acts of Parliament which define the regulatory provisions that apply to fisheries or marine spaces. Many legislative instruments provide for species minimum and maximum size limits, quotas, closed seasons, gear restrictions such as the mesh size of gill-nets, licensing of local and foreign vessels, and other essentially western management measures. Few give any formal recognition or authority to customary systems of marine tenure and resource management,

despite the fact that these are enshrined in the cultures of almost all the countries of the region and in the constitutions of many of them.

3.4.2 Customary marine tenure

Customary marine tenure (CMT) is the general term given to the various systems of ownership or control of marine spaces and the resources they contain by indigenous tribes, clans or communities. CMT has been traditionally practiced in most PICTs and continues to exist in various forms throughout the region. In some countries aspects of CMT have been codified into law or are recognised by fishery regulations or by practice. However in most places this is not the case, so CMT and the law may be at odds with each other, usually to the detriment of both systems. CMT represents the most "local" form of fishery management practiced in PICTs.

In the past traditional aquatic or marine tenure rights were strongly influenced by subsistence fishing practices. Where fishing was locally unimportant such rights may not have existed, while in places where fishing was an important activity traditional fishing grounds were subject to sometimes complex systems of rules defining ownership. Depending on the extent to which people exploited fishery resources, therefore, CMT may have been exercised over coastal or fringing reefs, over offshore reefs, over waters within a particular range (for instance, waters accessible to a local resident fishing from a canoe), as far as the visible horizon or, in some cases, even further (UNDP, 1989).

Within these areas, different family lines or individuals of a given customary status may have exercised specific rights over the capture of certain species, the use of particular techniques by certain groups, or the declaration of seasonal or area closures. The fisheries under tenure are essentially the property of the resource owners who may exploit or restrict access to them as they see fit. Resources such as trochus, green snail and beche-de-mer, which are found and exploited principally in shallow inshore waters, are particularly affected by CMT practices.

Although CMT is essentially a traditional assertion of control over known resources, exercised to a greater or lesser extent depending on local circumstances, the system is far from static and may be extended in response to local economic or other developments. UNDP (1989) cited a PNG fisherman as saying "We claim the areas where we have always fished, but if there is something of value in the deeper waters we will claim that too".

With the development of commercial fishing in the region, rights over non-traditional offshore resources, or areas that have traditionally never been fished, are now increasingly being claimed. In most countries a distinction is made between subsistence and commercial fishing, such that while the first may be readily authorised (especially to members of neighbouring communities or clan lines related to the resource owners) the second may be forbidden, or only permitted on payment of an access fee or some other form of royalty (especially in the case of "outsiders"). Making money from marine resource exploitation is viewed differently from the gathering of food.

Subsistence fishing operations tend to be characterised by strong CMT systems, often involving restricted entry into the fishery, social restrictions or prohibitions on fishing, and specialisation of activities by gender. These may be accompanied by specialised traditional knowledge, sometimes passed down through the generations and accompanied by stylised or ritualised procedures. However with increasing commercialisation both the customary management systems and the traditional knowledge base progressively deteriorate as economic pressures undermine considerations of restraint in harvesting, and as fishing becomes increasingly modernised or practised in non-traditional ways (for a more complete review of this topic, see Ruddle (1997)).

ANZDEC (1995) notes a progressive increase in "rent-seeking behaviour" by customary resource owners in PNG seeking to extract from commercial fishing vessel operators royalty payments that are frequently out of all proportion to the value of the resource or the profitability of harvesting. Disputes over royalty payments were partly responsible for the closure of the pole-and-line fishery in PNG during the early 1980s, the result of which was considerable loss of national earnings and employment. Customary resource owners have also prevented the development of commercial fisheries for un-utilised and traditionally unimportant resources in Vanuatu, Solomon Islands, New Caledonia and other countries of the region. Thus, while providing for very effective resource conservation - or preservation, when exploitation is reduced to zero - CMT can impede sustainable

fishery management, which under the UN Implementing Agreement implies some form of resource utilisation.

CMT may also impede the development of commercial fisheries because it involves large numbers of small management units which function independently and without coordination. Many PICTs 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. In fact such a system has many parallels with an international fishery involving many national jurisdictions. The main difference is that in most PICTs there is no domestic equivalent of UNCLOS which provides an agreed system for defining the jurisdictions and boundaries of CMT areas. As noted above, the fishery legislation of many PICTs does not even acknowledge the existence of CMT, let alone provide a framework for its operation.

Adams (1996) states: "Recently, much has been made of the small-island inhabitant's traditional links with the sea, and how community systems of marine tenure and management can mitigate problems of overfishing when introduced to communities which do not have such traditions. Even more recently there has been some backlash against this idea, where it has been pointed out that even the strongest traditions of reef custodianship have not prevented certain invertebrate resources from being decimated for export. As usual, both points of view have some merit".

'Western' regulatory systems of management, involving gear restrictions, size limits and other 'classic' fishery management measures, have generally met with limited success in PICTs because of resistance to their uptake by fishing communities, and because of the limited capacity of Governments to police them. CMT, on the other hand, is entrenched in local cultures throughout the region, so acceptance is much more widespread. In addition CMT systems seem to have functioned effectively for centuries, something which cannot be said of westernised approaches to fishery management, either in PICTs or elsewhere.

Although CMT has negative features, in that it can seriously impede commercial exploitation of fishery resources, these err in favour of the precautionary approach to fisheries management, rather than encouraging over-exploitation. By establishing an intimate, long-term relationship between the resources and its exploiters, CMT gives the exploiters an incentive to conserve for the future. In addition, the way in which CMT limits access to resources provides a good basis on which to develop sustainable management arrangements. In general terms, therefore, there would seem to be merit in strengthening CMT systems, or at least studying and learning from them, in order to retain and incorporate their strong points into contemporary fishery management arrangements.

3.4.3 National Government

One or more Government bodies is normally charged with the responsibility of implementing and enforcing the various fishery management regulations, policies and principles provided for under national legislation. Many countries have established a dedicated Fisheries Department or equivalent organisation for this purpose, although certain responsibilities may be shared with other agencies, such as Agriculture, Environment and Police Departments.

In most countries of the region the body nominally responsible for managing fisheries is also responsible for promoting their economic development. In most cases this latter role has in fact been given a much higher priority, as discussed in section 3.3.1. Most PIC Fisheries Departments see their roles as being to facilitate increased exploitation of marine resources, particularly for export, often by direct involvement in commercial activities. Another function to which many Fisheries Departments attach an inordinate amount of importance to the securing of donor-funded technical assistance projects, which may be viewed as another form of income generation for Government. Both Departmental and individual staff performance may be assessed on these bases. Fisheries management, when considered at all, may be perceived as a brake to economic development, and contrary to the main aims of the Department.

As a result, few countries of the region are managing their coastal fisheries in any meaningful way. PICTs in the main do not have in place coastal fishery management goals, strategies or plans, despite the fact that in some cases national legislation requires these. This is partly because of complacence,

or a perception that management is not required and the resource will look after itself, and partly because, in any case, PICTs generally lack capability in fisheries management. The historical focus on economic development of fisheries means that most fisheries officers are conceptually adjusted to the idea of catching and selling more fish, rather than to management.

Regional and international organisations, including SPC, FFA, SPREP, USP, FAO and others have in recent years been attempting to address these issues by organising field research projects, supporting the development of fisheries management plans, carrying out training programmes and organising conferences relating to aspects of fishery and coastal zone management in the region. Such activities have raised awareness of the rationale and need for management among Government officers, but so far have not resulted in very tangible results at the national level.

3.4.4 Local Government

Several of the larger PICTs have Provincial or State Governments which have authority over certain matters of local interest. In addition, most countries have Rural or Island Councils or other forms of local government. In all cases decentralisation laws give local governments some degree of control over fisheries and marine resources. In most countries this relates only to resources in local or coastal waters, although there are endless examples of disputes between national and local governments regarding the extent of their respective jurisdictions.

In general, the problems applying to National Government fisheries management institutions and capabilities are magnified when taken to the local level. Local governments have more limited human and financial resources, and, usually, greater internal conflicts of interest between economic development and fisheries management priorities. In some countries local governments may also be politically unstable and prone to regular reorganisation of boundaries or institutional structures.

A common argument for delegating fisheries management authority, however limited, to local governments is that these authorities are closer and more accessible to coastal communities, more sensitive to their needs, and may be in a better position to consult with the general public or enforce legislation. In practice, however, delegation of fisheries management authority to local governments seems to complicate and impede the sustainable management of coastal fisheries, since it involves neither the resource users themselves, nor professional fishery officers or trained managers. In addition, local government responsibility over fisheries or resources that extend beyond the boundaries of their jurisdictions may create a miniature ‘international fishery’ situation at the domestic level and prevent the development of coherent management arrangements for resources that need to be managed on a national basis.

3.4.5 Co-management

Although national or local governments in PICTs have a legal mandate to manage fisheries, most of them have insufficient capacity or information to allow this to be done reliably. Artisanal and subsistence multi-species fisheries are too widespread and diffuse, and most PIC Governments have inadequate resources and manpower to allow for fishery monitoring. In addition, Government systems are not reactive enough for management to be able to respond to the needs of the fishery.

CMT is a far more responsive system with many positive aspects. Nevertheless, Governments cannot afford simply to assume that fishing communities will automatically use marine resources wisely (particularly when the need for cash is increasing and subsistence fishing is being transformed into commercial activity) or will apportion access to them in an equitable manner.

A compromise arrangement is co-management, in which government assumes certain responsibilities, such as the development of basic regulatory structures and the provision of information and support to the community, while the community itself takes most of the responsibility for day-to-day maintenance of resources and management decision-making.

Such a system allows government resources to be directed towards the tasks that cannot be effectively carried out by communities themselves - linking communities, distributing information derived from the outside world, backing up local resource management decisions at points of trade or export, and mediating or arbitrating conflicts, particularly with outsiders. Also, since it involves the whole local community, not just the fishing community, it can take into account the requirements of other local interests, such as those involved in tourism or other forms of marine resource use.

In discussing co-management, Adams (1996) states: "Essentially, this is the system that is already in place in many Pacific Island nations, although it requires strengthening in several aspects (notably flexibility of regulation, information dissemination, and more formal recognition of community responsibility) and it may not always be recognised as such, even by Governments. It is not perhaps a system that could be transferred wholesale to all small-island countries, particularly those whose fisheries are highly commercialised or where communities do not claim traditional ownership of coastal areas... However, it is a system that is working in many islands and, provided it receives more formal recognition at the Government level, promises much hope for the future". Although there are few formally-established co-management arrangements currently in place in PICTs, many countries, organisations and communities are now looking more closely at possible co-management regimes for specific fisheries throughout the region.

3.5 Conclusions

Although the region's coastal fisheries provide food, income and jobs for Pacific Islanders, and contribute to PIC economies through import substitution and generation of export earnings, their sustainability is uncertain due to two main threats, overfishing and habitat degradation.

In many of the most accessible localities increased fisheries production from coastal areas cannot be expected and many strongly targeted or more vulnerable species or areas are overexploited. Population growth, among the highest in the world in some PICTs, will lead to increases in fishing pressure and decreased yields, especially in urban areas. Additional fishing pressure will result from increased international demand caused by rising prices and trade liberalisation. The situation in regard to habitat degradation is worsening and the ability of coastal ecosystems to absorb further deleterious changes may be diminishing.

Although these issues are becoming increasingly known to PIC fisheries and planning officials, corrective or mitigating action to date has been limited. This is attributable to limited fisheries management capacity in PICTs, inadequate knowledge about the production potential and exploitation status of particular resources, and prioritisation of other issues over fisheries and coastal zone management. There is often complacency and a lack of political will or ability to institute fisheries management.

Many of these issues vary in their details from country to country and need to be addressed at a national level. However the overall problems are common to most PICTs and their collective effect represents a threat to the region as a whole. There is therefore a strong rationale for taking action at a regional level, particularly in regards to:

- awareness-raising on fishery and coastal zone management issues;
- exchange of technical information on fisheries and coastal zone management issues;
- comparative research to enable the conduct of comparative resource surveys using standardised survey methodology and the development of management 'rules of thumb';
- development of appropriate national and international instruments to control trade in export commodities derived from overexploited marine resources; and
- ecosystem-level research on fisheries;

There is a need for PICTs to protect coastal resources to prevent further degradation and loss of productivity. Two ways of approaching this problem may be:

- promotion of management arrangements for coastal fisheries. In many cases this will probably need to be through the introduction of co-management arrangements (joint management by government and resource-owning or exploiting communities); and
- diversion of existing and new fishing effort away from coastal resources and towards the more plentiful oceanic resources described in section 4.

Again a regional approach to these issues would facilitate comparative research and development efforts and accelerate the adoption of these increasingly urgent coastal fisheries conservation strategies.

4 Oceanic Fisheries

4.1 Principal characteristics of oceanic fisheries

4.1.1 General

In terms of volume and value, fisheries in the Pacific Islands region are dominated by the industrial harvesting of tuna. Most of the catch comprises skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) tunas with smaller amounts of bigeye (*T. obesus*) and albacore (*T. alalunga*). The preliminary 1995 catch estimate for these four species in the SPC Statistical Area, is 958,231 t (Lawson, 1996).

Fishing is through the use of technology-intensive and capital-intensive industrial fishing methods introduced to the region by distant water fishing nations (DWFNs) aiming to supply international markets. Shortage of technology, capital and skills means that most PICTs cannot participate directly in this type of fishing to any great extent. Harvesting thus continues to be mainly by DWFNs, who, since the introduction of 200-mile EEZs, are now obliged to pay for access when fishing in areas of Pacific Islands national jurisdiction. Domestic commercial tuna fishing activity is developing gradually in the region, and some artisanal fisheries take small quantities of tunas from coastal waters, but landings from these fisheries are a minor proportion of the total.

Purse-seine is the major fishing gear type in terms of catch weight, having accounted for about 80% of the total catch from the SSA, or some 700,000 - 800,000 t/ yr, since 1990. The number of purse-seine vessels operating in the region grew remarkably from 1980 to 1992, and has been mainly responsible for the increase in the regional catch. Fourteen of the 148 purse-seiners operating in 1996 were locally based in PICTs, mainly under joint venture agreements (FFA, 1997).

Longline fishing, targeting mainly bigeye and yellowfin tunas, continues to generate annual catches from the SSA in the vicinity of 110,000-150,000 t/ year. Longlining using compact fishing gear and small vessels presents the main opportunity for PICTs to become directly involved in offshore tuna fishing, and establish domestic fishing fleets, which are now developing in a number of countries.

Pole-and-line fishing has declined somewhat in recent years (60,000 - 100,000 t/ year from the SSA, mainly skipjack, since 1990). Pole-and line fishing in the north WCPO is mainly by Japanese long-range vessels. Foreign companies have in the past established and operated pole-and-line fleets in a number of Pacific Island countries. In some countries these fleets and operations have ceased activity while in others they have been domesticated. Other PICTs have attempted to establish their own pole-and-line fisheries without foreign companies being involved. Countries in which pole-and-line fisheries have operated locally in one form or another include Federated States of Micronesia, Fiji, Kiribati, Palau, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, and Palau.

Troll fishing, mainly for albacore, in the southern convergence zone around 40°S, also contributes a small proportion (about 10,000 t in 1995) of the catch (Lawson, 1996). This fishery takes place on the high seas and within the EEZ of New Zealand, although the vessels may make port calls or transship catch in PICTs.

Industrial tuna fishing vessels of 26 different nations - 15 PICTs and 11 DWFNs - have operated in the region during the last 25 years, and vessels of 21 countries operated in 1995. However the vast majority of the regional tuna catch is harvested by the vessels of four DWFNs - Japan, Korea, Taiwan and the United States. Fleets of these nations collectively harvested 800,220 t, or about 84% of the total regional catch, in 1995 (Lawson, 1996). The numbers of vessels operating in each of the major fleets are shown in table 7 (section 4.5.3).

The landed value of tuna catches from the region was estimated at about US$1.2 billion in 1994 (World Bank, 1995b), US$1.5 billion in 1994 (Hampton et al, 1995) and US$ 1.7 billion in 1995 (FFA, 1996b). Fees paid for access to these resources by DWFNs equate to less than 4% of this value (see section 4.4.2), but are nevertheless very important sources of revenue for certain Pacific Island Governments, especially in the Micronesian countries.

Although the purse-seine fishery took about 84% of the total catch volume in 1992, it accounted for only 51% of the total value, while the longline fishery, with only 10% of the volume accounted for 41% of the value (World Bank, 1995b). The final destination of purse-seine caught tuna are canneries, while longline tuna is mainly destined for the higher-value sashimi market in Japan.

The majority of the region's tuna catch comes from the highly productive WCPO fishing area that straddles the EEZs of Palau, Federated States of Micronesia, Nauru, Papua New Guinea, Marshall Islands, Kiribati and Solomon Islands, and the adjacent areas of high seas. However tuna are a mobile and widely distributed resource whose populations extend beyond the Pacific Islands region in all directions - westwards into Indonesia and the Philippines, northwards to Japan, eastwards into the waters of the eastern Pacific, and southwards into the EEZs of Australia and New Zealand, as well as into the high seas zones lying in each of these directions.

4.1.2 Fishery area and jurisdiction

The Pacific Islands tuna fishery straddles many EEZs and high seas areas, including:

- the EEZs of the 14 independent Pacific Island member countries and territories of the South Pacific Forum (Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Solomon Islands, Tokelau, Tuvalu, Vanuatu and Samoa).
- the EEZs of Australia and New Zealand, the two metropolitan members of the South Pacific Forum;
- the EEZ of France, in respect of the French territories of French Polynesia, New Caledonia and Wallis and Futuna;
- the EEZ of the USA in respect of the US State of Hawaii; the US territories of American Samoa and Guam; the US affiliated Commonwealth of the Northern Mariana Islands; and the US minor possessions of Wake, Howland, Baker, Jarvis and Palmyra Islands;
- the EEZ of Japan in respect of the waters surrounding Okinawa and the Japanese possession of Minami Tori Shima;
- the eastern part of the Indonesian EEZ;
- the EEZ of the Philippines;
- the partially-enclosed high-seas enclaves between Papua New Guinea and Federated States of Micronesia, and between Solomon Islands and Kiribati; and
- the major unenclosed areas of high seas in the central and eastern Pacific.

Because the region's tuna fisheries and stocks, and the ecosystem of which they form a part, traverse so many EEZs and areas of high seas, management needs to take place on an international basis. The large number of jurisdictions involved (and the fact that the high-seas areas are currently not under any jurisdiction) make management of the fishery a complex matter.

Major steps forward have nevertheless been made through the use of the South Pacific Forum Fisheries Agency as a vehicle for the discussion and development of management tools for the fishery. The countries of the Forum collectively have under their control a significant proportion of the WCPO. This area encompasses large parts of the most productive purse-seining grounds as well as good fishing grounds for longline and pole-and-line fishing. Even though there are also major high seas zones within this area which fishing vessels can access freely, most DWFN fishing fleets would not be viable if they were restricted just to the high seas areas. The need by these fleets for access to the EEZs of the region is a powerful tool which PICTs have been able to use to extend their management influence de facto to high seas areas.

As the major harvesters, some DWFNs, especially Japan, have claimed the right, provided for by UNCLOS and the IA, to participate fully in any regional tuna fishery management arrangements that may be developed. This position is resisted by most PICTs who not only perceive external involvement in the management of tuna resources that lie partly within their own areas of national

jurisdiction to be contrary to their national interests and sovereignty, but are also concerned that DWFNs have failed to show adequate concern for fishery sustainability in the past. Failure to reach agreement on a way in which the interests of all parties can be accommodated has hindered the development of regional tuna fishery management regimes so far. As the fishery continues to grow, and concerns about impacts of over-exploitation on target and by-catch species become more extensive, the need for such management arrangements is increasing. In addition, the provisions of the IA now require that PICTs and DWFNs take steps to advance the development of a management regime.

In recent times some countries have begun to look at the possibility of extending fisheries jurisdictions, or even EEZs, beyond the 200-mile zone currently provided for by UNCLOS. The political debate on this topic is currently in its early stages and implementation, if it were to happen at all, would need to be viewed as a long-term process. However such a move by PICTs would significantly improve the probability of success, as well as the likely ease of implementation, of future management arrangements for the regional tuna fishery.

4.1.3 Production

The size of the regional tuna fishery has been increasing steadily over the past two decades, as shown in table 5. The total catch from the SSA, rose to a high of over 1 million metric tonnes in 1991 and has stayed slightly below this level since then.

Table 5. ***Tuna catch by major species in the SPC statistical area (Lawson, 1996.***

	Catch (thousands of metric tonnes)				
Year	**Skipjack**	**Yellowfin**	**Albacore**	**Bigeye**	**Total**
1976	167.5	62.0	30.0	42.8	302.4
1977	200.2	73.6	35.9	41.1	350.8
1978	230.0	86.0	30.4	27.9	374.3
1979	186.4	82.7	25.4	39.1	333.7
1980	211.8	104.5	39.8	41.6	397.7
1981	254.6	110.2	31.1	28.2	424.2
1982	266.6	111.2	28.8	29.0	435.6
1983	426.1	141.3	20.2	26.5	614.1
1984	434.8	129.4	19.6	32.2	616.0
1985	367.3	124.6	27.3	40.5	559.6
1986	431.1	126.4	32.5	34.5	624.4
1987	406.9	183.2	23.7	40.7	654.5
1988	541.6	127.9	33.2	35.7	738.3
1989	531.3	181.2	47.5	34.2	794.2
1990	589.3	202.8	31.0	52.1	875.2
1991	759.1	229.3	24.6	36.7	1,049.6
1992	686.4	275.4	41.2	44.0	1,047.0
1993	535.8	284.3	34.3	49.4	903.8
1994	663.2	263.4	38.5	59.3	1,024.4
1995	666.8	215.8	38.3	37.3	958.2

In addition to the four target species of tuna, a diverse assemblage of non-target oceanic species is taken as by-catch (unwanted catch taken incidentally). In some fisheries these other components of the epipelagic ecosystem may comprise nearly half the catch, and comprise up to 60 species including several types of billfish (marlins, sailfish and swordfish), sharks and other oceanic fish species and, occasionally, marine reptiles and even seabirds. Much of this incidental take is of limited or no

economic value (or is unwanted because retaining it would reduce the restricted space available for storage of the more valuable components of the catch) and is discarded at sea. This issue is discussed in more detail in section 4.2.

Despite growing concern over the ecological impacts of incidentally harvesting these unwanted species, and the wastage associated with the practice of discarding, the abundance, biology and exploitation status of tuna by-catch species remains virtually unknown. More detail on this topic is provided in section 4.3.3.

The preliminary estimates shown in table 5 suggest that the total tuna catch in the SSA decreased by 6% between 1994 and 1995, and by almost 9% since 1991. However, this is not thought to be indicative of over-fishing. Operational, economic and oceanographic factors are more likely to be responsible for the decline, as they have been in the past. For instance, in June 1993, by region-wide agreement, all purse-seine fleets were required to cease transshipment of fish at sea, and this resulted in a reduction in catches of about 15% in the first instance. In addition, economic or political factors have led to the closure of certain specific fishing operations.

In fact, large scale research on the target species of tuna over the past 20 years indicates that catches could probably be increased further, at least for skipjack and yellowfin, the two principal species. There is, however, concern in some PICTs (e.g. Kiribati) that the large tuna catches made by industrial vessels may adversely impact those of local small-scale fishermen. There is also concern that, even though the target species may be amenable to increased exploitation, other by-catch species, for which comprehensive catch and other data is not available, may be more fragile. It is possible that unintentional overfishing of these species could occur if the fishery continues to expand (or even if it does not).

4.2 By-catch and discards

4.2.1 General

Like all fishing methods, tuna harvesting leads to the accidental capture of non-target species, or by-catch. Different methods take differing amounts and types of by-catch, some of which is retained and some of which is discarded at sea because it has no economic value. Some of the catch of target species, i.e. tuna, may also be discarded at sea, for a variety of reasons.

Several species or species groups taken as by-catch are of concern either because of their economic value to other resource users, or due to their ecologically fragile, threatened, or endangered status:

- **Sport fish**. Many of the species taken as by-catch, including some marlins, sailfish, wahoo, mahimahi and certain sharks, have actual or potential value in recreational fisheries around the region, including in the developed nations of Australia, New Zealand, Hawaii and Japan and the west coast of the US and Latin America. Several PICTs (Guam, Northern Mariana Islands, Vanuatu, New Caledonia, Fiji, French Polynesia, Tonga) also have locally-based sport fisheries, while others are hopeful of developing them as tourist attractions. Recreational fishing is economically important in developed nations and, increasingly, in less developed ones.

  The sport fishing community in developed nations is wealthy, influential and highly organised, and has frequently aligned itself with environmental groups in order to lobby for restrictions on commercial fishing activities, especially in coastal waters. An argument that has been successfully used to justify such restrictions is that fish caught by recreational fishing provide far more in the way of economic spin-off benefits to local communities than do fish caught commercially. For instance, it has been estimated that a marlin with a commercial sale value of US$500 would generate about US$45,000 in revenue to the local economy if caught in Hawaii's tourist-based game-fishery (Pooley, 1991). While this may be an extreme example, it underlines the fact that recreational use of fish

stocks is increasingly considered as a better option than commercial use in developed countries.

Sport fishermen and recreational fishing organisations thus continue to be vocal in their opposition to the capture of sport fish species by industrial fishing vessels.

- The quantity of **sharks** taken as by-catch is unknown, but thought to be considerable, especially in longline fisheries. Although not extensively studied, most sharks are thought to be long-lived, slow-growing and have a low reproductive capacity. These characteristics suggest that shark populations could easily become seriously overfished to the point of population reproductive failure, thus leading to major changes in oceanic ecosystems. This potential threat to shark populations, which is receiving increasing attention by the environmental community, has recently been reviewed on a regional basis by Sant and Hayes (1996) and on a worldwide basis by Rose (1996).

  Shark carcases are rarely retained but most longline vessels keep the fins, which are a high-value product used in Chinese cuisine. The practice of finning the sharks ensures that, even when captured alive (as is often the case), they will not survive after being discarded. Even if shark stocks proved not to be threatened by fishing, the simple waste of biomass that results from this practice runs counter to notions of rational resource use. For this reason the practice of finning by longliners has been banned in some countries.

- **Marine reptiles** (turtles) and **marine mammals** (certain porpoises and whales) are captured occasionally by tuna fishing vessels. Although it appears that they are usually released alive, a certain proportion is probably killed by the fishing gear or retained for consumption or sale by the vessel. This is an issue of environmental concern because all species of marine turtle and many marine mammals are classified as endangered by the International Union for the Conservation of Nature. International trade in turtle products is banned under CITES.

- Certain **seabirds**, including albatrosses (*Diomedea* spp.) and petrels (*Procellaria* spp.) have a habit of trying to steal the bait from longline hooks as they are released from the boat and before they can sink. The birds frequently become caught and subsequently drown. This problem appears to be most common in higher latitude fisheries, e.g. in Australia and New Zealand, and much less extensive in the tropical longline fishery.

  Discard of target tuna species also sometimes occurs, usually because the fish are too small, have been damaged during capture, or have otherwise been reduced in value to the point that they are not worth keeping. The degree of discarding varies considerably according to the fishing method, fleet and area.

  Data on both by-catch and discard levels in tuna fisheries are poor, for several reasons:

- vessel logsheet data in the main does not provide good detail on either issue, because:

  i. filling out logsheets is an unwelcome chore to most skippers, and getting any data at all is an uphill battle;

  ii. the main priority to date has been to obtain data needed for stock assessment of target species;

  iii. fishing vessel operators, already reluctant to report the details of their operations to a central authority, are even more reluctant to provide information on events and practices which they fear may have negative repercussions for themselves;

- logsheet data are supplemented by observer reports, but the level of observer coverage for most fleets is still low. In addition, there remains the possibility that fishermen will modify their behaviour, at least in relation to discard practices, when observers are on board.

By-catch issues in the WCPO are reviewed in detail in Bailey, Williams and Itano (1996), who consider that tuna by-catch and discards in the pole-and-line, troll and hand-line fisheries are relatively minor, and that the major issues are with the higher volume purse-seine and longline fisheries. The next two sections are based on their report.

4.2.2 Purse-seine

Logsheet reporting of by-catch and discards from purse-seine vessels is poor. Less than 1% of the over 70,000 purse-seine sets carried out between 1975 and 1991, and for which logsheet data is held by SPC, report any by-catch, whereas observer data indicates that most sets have some level of by-catch.

Purse-seine by-catch includes at least 46 fish species, including 6 types of billfish, and 5 species of shark. The most common by-catch species observed are amberjack (*Seriola rivoliana*), mackerel scad (*Decapterus macarellus*), rainbow runner (*Elegatis bipinnulata*), drummer (*Kyphosus cinerascens*) mahimahi (*Coryphaena hippurus*) and ocean triggerfish (*Canthidermis maculatus*). Observer records show that Pacific blue marlin (*Makaira mazara*) is the most common billfish species taken. At least three species of marine turtle are also occasionally taken, but observer reports indicate that these are usually released alive. Seabirds do not appear to be taken as by-catch in purse-seine fisheries.

Observer data suggests that, for certain fleets operating under certain conditions (fishing around floating logs) by-catch may average 7% of the catch, but that the overall average for the fishery is slightly less than 1%. There is considerable variation among fleets due to differences in fishing tactics and areas, with most by-catch being taken around floating logs or other debris or, to a lesser extent, around fish aggregation devices. As a general rule Asian purse-seiners make a higher proportion of their sets around floating logs than American vessels, and thus take a higher proportion of by-catch. However the quality of reporting makes the estimates unreliable and true by-catch rates could be higher than presently supposed.

Very little of the by-catch from purse-seine fishing appears to be retained, although swordfish and other good eating or saleable fish may be kept if doing so does not interfere with the fishing operation.

Discard of target tuna species also occurs, but is an irregular and unpredictable feature of the fishery. Reasons for discards are well known and include:

- the tuna caught are too small for canning;
- the tuna have become soft or smashed. This usually occurs when very large hauls of over 100 tonnes are made and the fish at the bottom of the net become crushed by the weight of those on top, or soften during extended handling. Under such conditions it may take many hours to transfer the catch from the net to the vessel's freezers, during which time some of the fish may rot in the water;
- gear damage or equipment breakdown, which results in the catch being lost overboard;
- occasionally, on the last set of a trip, the vessel will catch more than its requirements and be obliged to discard some due to lack of storage space.

Bailey, Williams and Itano (1996) estimated that only about 0.24% of the total tuna catch, equivalent to 5,594 tonnes of tuna, was discarded by purse-seiners between 1975 and 1991. Given the size of the overall catch this is a trivial amount. In addition, the proportion of by-catch may be declining as technology and the skill of the fishing operators continues to improve.

4.2.3 Longline

Logsheet reporting of by-catch and discards from longliners is even worse than for purse-seiners, except perhaps in regard to billfish. Catches of billfish are often recorded by longliners and logsheets have been used to attempt to describe billfish distribution and abundance. However other species, including sharks, are often ignored even though observer data suggests that the quantities of shark caught may be similar to that of tuna in some cases.

Observer coverage on longline vessels is also poor, being in the main more recent and less extensive than for purse-seiners. Observer data nevertheless indicates that tuna longline by-catch may commonly include over 50 species of fish. These include 6 types of billfish (although it should be mentioned that certain longliners regard some billfish as a target species and retain them for sale) as well as 21 species of shark (of which the blue shark, *Prionace glauca*, is the most common), 7 non-target scombroids and 21 others, of which mahimahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*) and barracuda (*Barracuda* spp) are predominant. Marine turtles are taken occasionally, but usually appear to be released alive whenever possible. In the higher latitude longline fisheries certain seabirds, including albatrosses (*Diomedea* spp.) and petrels (*Procellaria* spp.) may be hooked and drowned. There is little information on the numbers caught in this way in the tropical fishery, but the problem is thought to be far less extensive than in temperate zones.

The proportion of by-catch in longliners varies widely according to variations in the longline style being used, with fishing gear, bait and other operational factors all playing a part. Latitude and fishing area also appear to play a part both logsheet and more limited observer data indicate a trend in the proportion of by-catch from 7% between 10°N and 10°S, through 13% between 13°S and 35°S, to 51% between 35°S and 45°S (Bailey, Williams and Itano, 1996). The extent of by-catch harvesting and discarding by longliners is poorly known, but is thought to vary widely among fleets adopting different practices. In general, a proportion of the billfish by-catch and a few other species tend to be retained, sharks are finned and discarded, and most of the remaining by-catch is discarded. A longline vessel targeting a particular species of tuna may treat other tuna species as by-catch, and discard them.

Like purse-seiners, longliners also discard some of the target species caught, but logsheet and observer data give widely divergent estimates of the extent of this practice. SPC logsheet data holdings for the period 1975-1991 indicate that less than 0.2% of the target catch was discarded, while observer data suggests an average of 11.3% prior to 1993. Reasons for discarding target species include: damage due to shark or killer whale attack on the hooked fish; undersize; poor quality (some longline fisheries require the fish to be landed alive); wrong species; and freezer malfunction leading to deterioration of stored fish.

It is noteworthy that the issue of discards is often less significant in the case of locally-based longline fleets in Pacific Island countries. These vessels often have opportunities to sell by-catch species on domestic markets and are not constrained by storage space limits in the same way that distant-water longliners often are. As a result, although domestic longline fishery development in PICTs may not solve the problem of by-catch, it may help reduce the wastage caused by the practice of discarding. However, landing of by-catch on local markets may have other undesirable consequences, such as economic competition with local small-scale fishermen.

4.2.4 Reducing by-catch and discards

Reduction of by-catch generally requires modification to the fishing gear or operation. Examples of such innovations in the tuna fishery include the various porpoise escapement techniques and devices developed by purse-seiners which allow them to release marine mammals unharmed from the net. In longline fisheries, the capture of sharks is significantly reduced when the hooks are attached using nylon traces rather than the more commonly used steel wire.

Other fisheries have also seen the development of by-catch reduction technology which may be relevant to tuna fishing. For instance bird scarers, bait-throwing devices and underwater bait-launching tubes are being introduced into certain bottom longline fisheries so as to make the bait less accessible to seabirds. Similar improvements may ultimately be possible to tuna longline gear.

Fishermen often stand to gain as much as anyone in reducing by-catch since this generally leads to better fishing performance or less work. Many by-catch reduction innovations have been developed through cooperative programmes between government or environmental research groups and industry, or by the industry itself. However in other situations the converse may apply. In Pacific Island longline fisheries, for example, sale of shark fins is traditionally a perk of the crew, who are therefore likely to strongly resist any attempts to reduce the incidental capture of sharks. A reduction in shark by-catch is likely to have a more important impact on the earnings of Pacific Islanders employed as vessel crew than on the earnings of foreign fishing vessel operators.

A fundamental need is improved information on catches of by-catch species, particularly in the purse-seine and longline fisheries. This will allow more informed assessments of the exploitation status of these species and determination of the extent to which conservation action is needed. Bailey, Williams and Itano (1996) make specific suggestions for the future monitoring of the purse-seine and longline fishing activity, and identify increased observer coverage as the main solution to obtaining better estimates of by-catch and discards in these and other industrial tuna fisheries.

4.3 Status of stocks

4.3.1 General

For most species of tuna and many of the major by-catch species a single, Pacific ocean-wide stock, in which a mingling of fish takes place gradually over time, is assumed. With the exception of albacore, results from genetic studies and, to a lesser extent, tagging experiments on tuna species indicate that, by and large some degree of mixing does occur, even among fish in widely separated areas (WPRFMC, 1995).

It is possible, however, that sub-stocks of some species may exist, in which mixing is incomplete and does not occur within a single generation. Some studies support the idea of stock discrimination between the eastern and western Pacific. For purposes of stock assessment the boundary between these two stock areas is notionally assumed to be a straight line running north-south at 150°W. This demarcation is consistent with available biological data on tuna spawning and movements, and neatly separates the eastern and western Pacific surface fisheries (SPC, 1995b).

4.3.2 Target species

The following paragraphs are based mainly on SPC (1997) and WPRFMC (1995):

- **Skipjack** may comprise a single stock in the Pacific in genetic terms, but given the likelihood of restricted exchange between the eastern and western Pacific, as evidenced by tagging studies, it is probably appropriate to consider skipjack in the WCPO, i.e. west of 150°W, as a single stock for assessment purposes.

  Although current levels of fishing catch and effort are high, with total WCPO catches at around 890,000 t in 1995, fishing mortality seems to account for only a small proportion of stock attrition because of skipjack's high rates of reproduction, growth and natural mortality. Thus, while the MSY has yet to be determined, the stock appears to be under-utilised and is thought to be able to sustain increased fishing pressure.

- Semi-independent **yellowfin** stocks may exist in the WCPO, which are considered relatively distinct from eastern Pacific yellowfin. For stock assessment purposes the WCPO stock is defined as ranging from the Philippines and eastern Indonesia to about 150°W.

  Despite considerable scientific research the MSY of these stocks is still not well known. Estimates based on surface (purse-seine) and sub-surface (longline) fisheries provide different perspectives. Although the total WCPO yellowfin

catch fell back to 335,000 t in 1995 after reaching 380,000 t in 1994 it appears that these stocks are not yet fully utilised.

- **Bigeye** stock assessment work carried out to date has assumed a single Pacific-wide stock, but the available biological data and fisheries statistics could probably just as easily be accommodated in a clinal or overlapping sub-population model. Population genetics work is currently under way to clarify stock structure but for the present time a single Pacific-wide stock continues to be assumed, with alternative hypotheses also being borne in mind .

  The Pacific-wide bigeye catch (i.e. including other areas of the Pacific as well as the WCPO) now approximates 150,000 t per year, which is close to some estimates of MSY, and the stock is considered fully utilised. Because juvenile bigeye are known to associate strongly with flotsam, increasing purse-seine catches around flotsam and fish aggregating buoys raises concern about potential overfishing.

- **Albacore**. Based on an equatorial discontinuity of distribution, apparent separate spawning areas in the north and south Pacific, and the near-absence of any records of trans-equatorial movement of tagged fish, albacore are believed to constitute separate stocks in the northern and southern Pacific. The southern stock is believed to have a Pacific-wide distribution.

  In recent years, study of catch per unit effort trends led to the belief that southern Pacific albacore stocks were fully or over-exploited, and that expansion of surface fisheries targeting juvenile fish could have a detrimental impact on the abundance of adult albacore (WPRFMC, 1995). However considerable improvements have been made in albacore stock assessment over the past year, as a result of which it is now concluded that there is no evidence of current levels of fishing adversely affecting the stock, and that these levels of fishing can be sustained (SPC, 1997),

An important feature of tuna behaviour is their occurrence in mixed schools. Tuna of several species but of the same size are often found schooling together, usually accompanied by billfish and other predators, and sometimes in association with floating objects such as logs and other debris, or with large animals such as whales or whale sharks.

4.3.3 By-catch species

As noted earlier, the stock status of most by-catch species is known poorly or not at all. The best studied species are some of the marlins and billfish, whose life-histories have been partially researched by sport-fishing organisations.

The following paragraphs are based mainly on WPRFMC (1995), Weber (1996) and Mooney-Seus and Stone (1997):

- **Black marlin** (*Makaira indica*) are found in the Pacific and Indian Oceans, often close inshore. There is some evidence of several populations around the Pacific rim, as well as interchange between the Pacific and Indian Oceans. An important spawning ground is located in the Coral Sea off north-eastern Australia, and supports a seasonal game-fishery. Confusion between black marlin and blue marlin in the statistics submitted to FAO has prevented progress in formally assessing the status of this species.

- **Pacific blue marlin** (*Makaira mazara*) are thought to belong to a single, ocean-wide stock whose current status is unclear. The total annual Pacific catch in recent years is estimated to be around 20,000 t. A recent MSY estimate of 20,000 t/ yr. was 2,000 t/yr. less than previous estimates. During the 1970s the stock may have been over-utilised, but as longline fleets have changed fishing methods to target deeper-swimming bigeye tuna the incidental catch of blue marlin has decreased. There may have been some recovery of the stock,

evidenced by an increase in the average weight of blue marlin taken by Japanese longline fishery since 1975.

- **Striped marlin**. Separate north and south Pacific sub-stocks of striped marlin (*Tetrapturus audax*) are hypothesised on the basis of a north-south separation of spawning grounds, except in the equatorial eastern and western Pacific. These fish spawn in the western Pacific, are recruited into the Mexican fishery of the eastern Pacific, and move westward as they mature. In the north Pacific, semi-independent sub-populations are thought to blend over time. Regional catch is thought to be about 10,000 t. MSY is unknown, but the stock is considered under-utilised because there has been no decline in yield under increased levels of fishing pressure.

- **Broadbill swordfish**. The stock structure of broadbill swordfish (*Xiphias gladius*) in the western, central and south Pacific is unclear. About 18,000 t are thought to have been caught in the northwest and eastern central Pacific, and about 24,000 t Pacific-wide. The distribution of catches indicates the possibility of, at least, north and south Pacific stocks. Changes in the longline fisheries have cast doubt on the way previous MSY estimates were calculated, and current catch levels have exceeded the two previous Pacific MSY estimates. To date, however, no indication of decreasing swordfish size has been found in the Hawaii fishery, and stocks do not appear to have been exploited on a Pacific-wide basis to the extent that would cause a declining trend in catch rates.

- **Indo-Pacific sailfish.** Three populations of sailfish (*Istiophorus platypterus*) have been hypothesised, two in the western Pacific and one in the eastern.

- **Shortbill spearfish**. There may be separate northern and southern populations of spearfish (*Tetrapturus angustirostris*). Low levels of landings in longline fisheries suggest that this species is either little affected by fishing, or not very naturally abundant.

- **Mahimahi.** North and south Pacific stocks of mahimahi (*Coryphaena hippurus*) are apparently separate. No estimates of MSY are available for this species but the risk of overfishing this species is probably slight at present because of the apparent high natural turnover, high growth rate and short life span (maximum 4 years).

- **Sharks**. Little to nothing is known of the population structure of pelagic sharks in the Pacific. Much of the available information concerns natural history, reproductive biology and shark attacks. Very little is available on the ecology and behaviour of these animals, or on such factors as recruitment, growth, fecundity and natural mortality that are required for the estimation of abundance and population dynamics.

4.4 Management issues

4.4.1 Access arrangements

PICTs derive tuna fishing access fees through a number of agreements whose characteristics and details vary widely. In some cases individual companies or single vessels may negotiate access or fishing licences, while in others collective arrangements may be made by national Governments, fishing associations, or other bodies on behalf of entire fleets. These arrangements may be bilateral (i.e. with a single PIC) or multilateral (i.e. with a group of PICTs). In some cases joint venture arrangements may be made between foreign fishing interests and business or government entities in the licensing country in order to secure access for, or enable local registration of, FFVs.

All but one of the access agreements currently in force are bilateral, with DWFN Governments, fishing associations or companies independently negotiating access to each PIC EEZ in which they hope to fish. Countries with bilateral access to EEZs in the region currently include China, Korea, Taiwan, the Philippines and Australia. In addition firms based in the Philippines and Singapore have gained access for purse-seine vessels of the former Soviet Union. Some PIC Governments or business entities, including those in FSM, Fiji, Kiribati and Tuvalu also have agreements to fish in the zones of other PICTs.

DWFNs in the past used a “divide and conquer” approach which permitted them to take advantage of poor coordination and exchange of information among PICTs in order to negotiate favourable terms of access for themselves. Linkage of aid projects to the successful negotiation of bilateral fishing agreements (or, conversely, cancellation or reduction of aid projects because of fishing disputes) was also common in the past and is still practised by some DWFNs, although this may be officially denied.

Multilateral arrangements are seen by most PICTs as a tool through which they can secure greater access fee returns, more easily oblige DFWNs to comply with regionally agreed management approaches, and gain greater control over high seas areas as well as their own EEZs. They have also been viewed as a stepping stone towards regional management arrangements. However the only regionally-agreed access arrangement so far is the *Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America with the United States* (the US Treaty) which provides access for the US purse-seine fleet to the waters of all FFA Pacific Island member countries.

The original US Treaty was agreed in 1987, and was extended for a further ten years in 1992. At this time the terms were altered to increase the fee payment to US$ 18 million annually, and the number of vessels authorised to fish was increased to 55, of which five are reserved for US-PIC joint ventures. Funding for observers on up to 20% of the trips made in the region by US purse-seiners is also included. Under the terms of the treaty all FFA members receive a minimum payment whether or not any part of the US tuna catch comes from their waters. The treaty arose as a political response to a period of friction over US fishing practices in the region, and is financed in large part by the US Government, with only a portion of treaty payments being made by the fishing vessels themselves.

Despite the special circumstances which led to its establishment, and under which it operates, the US Treaty is widely perceived as having been a successful model which has led to high levels of access fee returns for PICTs, reduced surveillance and enforcement costs, and very good fishery relations between the US and PICTs. Similar multilateral arrangements with other fleets, particularly Japan and Taiwan, are being pursued by FFA on behalf of its member countries, following strong statements of support for such arrangements from the 1994 and 1995 South Pacific Forum Meetings. Statements from those meetings also insist that no Forum member should be worse off under a multilateral arrangement than under present bilateral agreements, a logical requirement but one which adds complexity to the process of developing mutually acceptable options.

Efforts to develop further multilateral arrangements have met with only partial success, however. Recent efforts have concentrated on Taiwan and Korea as a result of apparent interest in such arrangements from within those countries. Japan, however, continues to counter regional proposals for a multilateral access treaty with an advocacy for an international tuna management agency, of

which Japan and other DWFNs would be full members, and which PICTs fear would undermine regional influence over control of the resource. Japan has maintained this stance since the topic of a multilateral arrangement was first raised over a decade ago, and has consistently refused to enter into negotiations on the subject. There is no sign of any change in Japan's position at the present time. In addition, in the case of the Taiwanese longline fleet, interest in a multilateral arrangement has partly been generated by the refusal of some countries to renew further bilateral agreements, and is already beginning to appear as if it may be short-lived.

Despite the range of access agreements currently in place, and the length of time that DWFN access to regional EEZs has been conditional on licensing and the payment of fees, it is apparent that significant non-licensed fishing by vessels from some of the DWFNs continues to occur in the region. This is made easier for FFVs to carry out and more difficult for PICTs to detect and enforce due to the enclaves of international waters situated in the most productive fishing areas, and over which Pacific Island countries have no authority to control FFV activity. The high seas enclaves serve as convenient sanctuaries from which 'rogue' FFVs can illegally access the resources of adjacent EEZs with little likelihood of detection or apprehension.

4.4.2 Access fees

Today PICTs are in a stronger position to obtain better terms of access from DWFNs. Gradual introduction of more stringent data reporting requirements have led to a better understanding of FFV catch rates and economics, which has assisted PICTs in their negotiations with DWFNs. PICTs negotiating positions have been further strengthened by the activities of the Forum Fisheries Agency, which has facilitated communication among PICTs of information on terms and conditions of access, as well as providing technical advice and support during the negotiations themselves.

There is nevertheless thought to be considerable scope for improvement in the returns to PICTs from access agreements. Access fees paid by all DWFNs to regional countries for tuna fishing amounted to approximately US$ 40 million in 1992 and about US$56 million in 1993, during which year the total catch was valued at approximately US$1.2 billion (World Bank, 1995b). The average apparent return was thus about 4.4% of the value of the catch, although because of under-reporting and unlicensed fishing, actual yields are probably in the region of only 2-3%.

Table 6 indicates the percentage of the catch value paid back in access fees by the four major DWFNs operating in the region.

Table 6. ***Access fees paid by major fishing nations, 1993 (World Bank, 1995b.***

Fleet	Access fee (percentage of catch value)
USA	10.0
Japan	5.0
Taiwan	3.7
Korea	2.2
Average	**4.4**

Access fees from the US represent approximately 10% of the value of the US catch. Excluding the US from the calculations reduces the average access fee paid by the remaining three nations to about 3.7% of the value of the catch. This seemingly low level of fees received by the coastal states has attracted much debate, with the PICTs feeling that their resources are being under-priced and the DWFNs claiming that this is a fair rent given the price volatility of tuna and the high risk and capital requirements of the industrial fisheries sector (World Bank, 1995b).

After the USA, Japan appears to be paying most in output value while Korea and Taiwan pay the least. Korean vessels, for example, paid 11% of total access fees in the region for a share of 21% of the total catch. It appears therefore that there is a fair variation on fee payments across countries, although the subject merits a more detailed analysis which takes into account, for example, the

proportion of the catch each fleet takes on the high seas, and the distorting influence of the generally higher fee levels paid by Japan for access to the Australian Fishing Zone.

The way in which access payments are made varies from country to country and agreement to agreement. Waugh (1995) discusses the advantages and disadvantages of several different access payment mechanisms, as follows:

- tax on the value of the catch;
- tax on vessels or number of trips;
- lump sum tax;
- payments in kind;
- royalty or tax on profit;
- auctioning the rights to fish.

According to Waugh (1995), the first three methods are used in most agreements in the region. The fourth, which covers fishery access-linked aid programmes, is widely used as an adjunct to many agreements. The last two methods, while simple in theory, are not applied in the region at present: in the first case due to the high cost of monitoring; in the second because the market is insufficiently competitive, and due to the high probability of collusion between DWFNs.

4.4.3 Fishery interactions

The tuna fisheries of the WCPO involve the fishing fleets of many nations using a range of different fishing gears to exploit common fish stocks at various stages in their life cycles. This situation creates the potential for a wide range of interactions, in which the activities of one group of resource users impact those of another group. Most interactions are essentially negative or undesirable, since the usual situation is that one group of users has the potential to remove fish that might otherwise be caught by another user group.

Hampton (1993) defines three general classes of interaction:

- competition for fish at the same stage in their life cycle in the same general area by two or more fisheries;
- the effect of fishing a stock at an early stage of its life cycle upon a fishery that exploits the stock at a late stage, typically with a different gear; and
- the effect of fishing a stock in one area upon a fishery that exploits the stock elsewhere.

These three categories encompass the whole range of tuna fishing methods in the Pacific Islands and south east Asia (purse-seine, pole-and-line, longline, troll and hand-line), all of the fishing styles (industrial, small-scale commercial, recreational and subsistence) and all of the tuna species that support major fisheries in these areas (skipjack, yellowfin, bigeye and albacore).

Important interaction issues identified by Hampton (1993), and some of the countries or areas impacted by them at the time of writing, included:

- interaction between large-scale fisheries operated by DWFNs using different gear types (e.g. the large-scale interaction between purse-seine and pole-and-line fisheries, and the impact of the DWFN purse-seine fishery on the DWFN distant-water longline fishery, throughout the WCPO);
- the effect of DWFN fisheries on locally-based commercial fisheries (e.g. the impacts of DWFN purse-seining on local pole-and-line fisheries in Palau, Solomon Islands, Kiribati, and Fiji, and the impact of the DWFN purse-seine and longline fisheries on locally-based small longliners);
- the effect of industrial fisheries on artisanal and/ or subsistence fisheries (e.g. longline, purse-seine and pole-and-line fishing on local fisheries in the majority of PICTs);

- the effect of fisheries in different EEZs, especially neighboring ones, on each other;
- the effect on each other of different fishing companies operating in the same EEZ, for example in Solomon Islands and Fiji where two or more locally-based fleets have developed.

Interactions between DWFN fisheries have implications for license revenues and related benefits that accrue to PICTs from these activities. Interactions that impact on local commercial fisheries clearly have potential negative effects for locally-based fishery production and employment. Interactions that affect artisanal and subsistence fisheries may have the broadest, most insidious and least easily-quantified economic and social consequences, including the potential to undermine dietary health, household food security and national trade balances.

Controlling interaction issues to ensure that net benefits from fishery resources are maximised will be one of the most difficult elements of the overall process of managing the international tuna fishery in the region. For instance a study carried out in response to concerns raised by local fishermen in Kiribati (Hampton et al, 1995) found that at a small scale of spatial resolution (one-degree squares, equivalent to an area of 3,600 square nautical mile), there were detectable negative correlations between the catches of US purse-seiners and local fishermen, implying that purse-seining was having a negative impact on local fishermen's catches. At a larger spatial scale the correlation was positive, implying that larger-scale oceanographic or other factors (such as inter-annual variation in tuna abundance caused by El Niño-type oceanographic events) were having similar impacts on the catches of both purse-seiners and local fishermen. The study concluded that such interactions could be minimised by creating exclusion zones of 60 nautical miles or more around the areas where local fishermen operated, but recommended that the economic implications of such a move be carefully considered.

To date interaction issues have arisen mainly as consequences of separate, largely unconnected industrial fishery developments events aimed at increasing overall production. In the future, as the region's tuna resources become exploited more heavily and the potential to further increase production is reduced eventually to zero, control and manipulation of the fishery to improve economic benefits will assume greater importance, and this will require an understanding of the economic consequences of fishery interactions.

At present such interactions are poorly understood. Hampton (1993) noted that some of the data required to assess many interaction issues (detailed catch and effort, tagging and biological data) existed but that restrictions on its availability had hindered thorough analytical treatment. Other forms of needed data remain unavailable and can only be obtained through collaborative research programmes involving some the countries affected by the interaction issue being studied.

4.4.4 Western Pacific Warm Pool

Sherman (1994) discusses fishery research in the context of LMEs which comprise "relatively large regions of ocean space, on the order of 200,000 sq. km. or larger, characterised by distinct bathymetry, hydrography, productivity and trophically dependent populations". LMEs have been described as regional units for the conservation of fisheries in accordance with the legal mandates of UNCLOS, and also provide a framework for the achievement of UNCED commitments (Lehodey, 1996).

Research programmes carried out to date have permitted the definition of 49 LMEs. They are primarily coastal in nature, albeit extending considerable distances seaward in some cases. Areas of open ocean seem to have received little attention so far. However, Longhurst (1995) has recently defined four ecological domains and 56 biogeochemical provinces in the pelagic ecosystem based on both biotic and physical oceanographic conditions. One of the provinces is the WPWP, so called because of its major physical characteristic, the high heat content of the upper mixed layer, where sea surface temperature typically exceeds 29°C.

With minor modifications the boundaries of the Warm Pool as proposed by Longhurst (1995) correspond to the area of the WCPO tuna fishery. If slightly extended to include the area from 15°N to 15°S and 120°E to 160°W, the Warm Pool produces 100% of the purse-seine catch, 90% of the

pole-and-line catch and about 60% of the longline catch taken in the SSA. Tuna tagging experiments carried out by SPC demonstrate very little escapement of tagged fish from the Warm Pool (SPC unpublished data cited in Lehodey, 1996). These characteristics strongly suggest the maintenance and retention of a very large biomass of tunas within the area.

The presence of the most productive tuna fishery in the world in an area characterised as a "thick layer of warm very infertile westward-moving water" (Wauthy, 1986) seems paradoxical. However, although low in primary productivity itself, the Warm Pool appears to be enriched by advection or horizontal displacement of productivity from other areas, particularly the eastern Pacific, from where plankton are transported westwards by the equatorial system of latitudinal currents and counter-currents (Lehodey et al, submitted). As a result, the Warm Pool displays high secondary production and harbours concentrations of oceanic anchovy (*Encrasicholina punctifer*) and other small pelagic species which serve as forage for tuna.

The boundaries of the Warm Pool are dynamic, moving in response to oceanographic features. Its eastern edge is subject to east-west displacement over more than 20° of longitude (about 2,500 km) as a result of the El Niño and La Niña oceanographic phenomena. These phenomena are themselves part of the global weather system and as such will probably be affected by global climate change, in ways which are at present far from obvious. Lehodey et al (submitted) demonstrate that the "gravity centre" of tuna abundance as extrapolated from the catches of the US purse-seine fleet also undergoes east-west displacement in direct parallel both to the east-west movements of the 29°C sea surface temperature isotherm, and to variation in the Southern Oscillation Index (a measure of the difference in barometric pressure between the eastern and western Pacific rims). These features were used by Lehodey et al (ibid.) to predict longitudinal changes in tuna abundance with a high degree of certainty. Tuna populations thus appear to shift in keeping with the displacement of the Warm Pool, which itself shifts as a result of major oceanographic and climatic influences.

Apart from the highly visible commercially-exploited elements of the Warm Pool, there are many other biotic components to this pelagic ecosystem, including various trophic and ecological levels of plankton, and numerous species of fish and sharks, marine mammals, reptiles and birds. As noted earlier at least 50 species of finfish, 20 species of sharks and a handful of marine reptiles are taken as by-catch in the tuna fishery, and many others are thought to be present but not to feature in commercial catches. Very little is known of these other components of the ecosystem, and even less of the system dynamics. At the moment the distributions, population structures, levels of exploitation, and ecological roles of the various non-tuna inhabitants of the Warm Pool can only be guessed at (Lehodey, 1996).

In view of these characteristics, this highly productive and unique area would seem to merit classification as a LME along with, for example, the Kuroshio, Humboldt and Benguela current LMEs, where high biomass yields are driven by similar large scale environmental processes. The area appears to encompass a functional ecological unit, including fish stocks, their prey, predators, and various physical factors, which is of global significance. The sustainable utilisation of the Warm Pool's resources could be enhanced if the various components of the ecosystem were to be studied and managed as a coherent whole rather than in isolation from each other, and if the likely impacts of global climate change on the distribution and abundance of these resources were elucidated.

4.4.5 Research

Scientific research and monitoring of the regional tuna fishery is done mainly by the Oceanic Fisheries Programme (OFP) of the South Pacific Commission. Through several previous incarnations the OFP has been involved in scientific research on tunas in the region since the mid-1970s. Two major international tuna tagging programmes have been carried out, the first of which focused on skipjack and the second on yellowfin, and data gathered during these programmes is responsible for much of what is known about tuna growth, distribution and migration in the region.

In addition, the OFP is the depository for catch and effort fishing data provided by both domestic and DWFN fishing vessels operating in the region. Most of this data is provided by FFVs to national governments as part of their licensing requirements, and is passed on by those governments to SPC. Some data, such as historical information on the activities of US and Japanese vessels in the region, has also been provided voluntarily by government agencies of those two countries. Japan also

provides data on fishing by its fleets on the high seas, although this data is in aggregated from, rather than original logsheets.

Vessel logsheet information is supplemented by data gathered by scientific observers deployed under national observer programmes or by the regional programme run by the OFP. Port samplers may also be stationed at tuna canneries and major tuna transshipment or offloading points where, among other things, they provide a means of verifying the logsheet data reported by fishing vessels. Information obtained from these various sources is compiled into a number of linked computerised databases. Much of the OFP's work consists of updating the databases, producing regular and ad hoc summary reports on the various components of the regional fishery, and using the data as a basis for ongoing research on the region's tuna stocks.

Data is provided to SPC in confidence and, unless the data provider authorises, may not be released in its raw form to any third party. In most cases the Commission has discretionary authority to release aggregated data (which prevents analysis of certain features, such as the operating performance of individual fishing vessels) in support of what it considers to be bona fide research projects, and aggregated data on non-FFA member countries may be made available in this way to the Forum Fisheries Agency[5]. In some cases (e.g. that of Japan), however, the prior agreement of the data supplier is required before the Commission can release even aggregated data.

A major factor which has assisted the OFP to acquire such a large and valuable body of data has been the fact that its use is essentially restricted to biological research. SPC is ostensibly a non-political organisation and, officially, has a neutral role in terms of fisheries management. Much of the data that has been voluntarily provided by DWFNs would probably not have been made available to an organisation with a direct role in management, since the data could easily be used to the detriment of the provider. In addition, much of the data provided to PIC Governments by DWFN fleets under bilateral access agreements may not have been so easily negotiated if DWFNs thought that the data would be made available to a regional management organisation rather than to a research body.

The OFP also manages the Standing Committee on Tuna and Billfish and acts as a secretariat to the Yellowfin Research Group and the South Pacific Albacore Research Group. These committees are informally constituted, with participants being invited as individuals rather than Government or agency representatives, and meet on an ad hoc basis as required. They serve as peer review bodies which examine research findings on tuna fisheries and make recommendations in regard to tuna research or management requirements to the governing bodies of SPC and FFA. The various scientific committees each have their own aggregated databases, some parts of which may be restricted to uses determined by the relevant committee, rather than being integrated into SPC's larger data holdings.

A structural problem facing the OFP is that of sustainability. The OFP receives only a small amount of financial support from the SPC's core budget and is financed mainly from extra-budgetary sources which are not assured in the long-term. At present there is no guaranteed sustainable mechanism for providing scientific advice and analysis in support of the region's tuna fishery management efforts.

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5 The Forum Fisheries Agency now receives the same logsheet data as SPC in regard to fishing that takes place in the waters of its own member countries, but does not have the wider data coverage of SPC.

4.5 Management arrangements

4.5.1 General

Each country and territory of the region has its own fishery management legislation and regulations, through which it controls domestic fisheries development and grants access to the fishing vessels of other nations. This legislation, which has been reviewed in detail by Campbell and Lodge (1993), varies considerably from country to country in line with general development and economic policies. Some countries aim to maximise licensing revenue, while others prioritise domestic or on-shore development through policies which favour local or joint venture investments.

In addition, there have been and continue to be considerable efforts to develop regional-level arrangements for the management of the international fishery. Four main management instruments operate at the regional level:

- the Wellington Convention;
- the Regional Register of Fishing Vessels;
- Harmonised Minimum Terms and Conditions of Access; and
- the Palau Arrangement.

Surveillance and enforcement is an adjunct to regional fisheries management. Three important recent and on-going regional initiatives in surveillance are currently in place or under development:

- the Niue Treaty;
- the Maritime Communications Network; and
- the Vessel Monitoring System.

Enforcement has been considerably enhanced by the regular surveillance flights throughout the region conducted by the Australian, New Zealand and French Air Forces. The Australian-funded regional patrol boat programme, under which Pacific Island Governments have acquired fishery patrol vessels and had police or military personnel trained in their use, has also contributed greatly to regional enforcement capacity.

International maritime boundary delimitation is also an aspect of regional cooperation with management implications.

These issues are discussed in more detail in the following sections.

4.5.2 Wellington Convention

The 1989 Convention for the Prohibition of Fishing with Long Drift Nets in the South Pacific prohibits nationals and vessels of signatory nations from engaging in the use of long drift nets (i.e. over 2.5 km in length) in the convention areas, which includes not only the EEZs of signatory nations but also the adjacent high seas areas. Concern on this issue originally arose over drift net fishing for albacore in the South Pacific. There are also restrictions imposed on transshipment and port access to drift net vessels. Although the nations involved in the original fishing (and some PICTs) have refused to sign the convention, it appears that there has been no fishing for albacore with long drift nets in the convention area since 1991.

4.5.3 Regional Register of Foreign Fishing Vessels

The Regional Register is a listing maintained by FFA of FFVs licensed to fish in the region. The primary mechanism by which it assists management and enforcement is the requirement for “good standing” on the Register prior to licensing of a vessel by any regional country. Good standing is conferred on a vessel upon registration, but can be withdrawn on application by a regional country in circumstance such as the committing of serious fishery offences. If good standing is withdrawn the

vessel will not be licensed in any of the participating countries and is therefore effectively prevented from fishing anywhere in the region.

The Register currently lists 1,332 tuna longliners, purse-seiners, pole-and-line vessels and miscellaneous support craft, as shown in table 7.

Table 7. ***Approximate numbers of licensed fishing vessels currently operating in the Pacific Islands region during the licensing period 1 September 1995 - 31 August 1996 (FFA, unpublished data).***

Flag	Longliner (<100 GRT)	Longliner (>100 GRT)	Purse-seiner	Pole-and-liner	Total
Japan	179	298	35	58	570
Korea	0	105	29	0	134
Taiwan	91	36	43	0	170
China	159	149	0	0	308
United States	1	5	48	0	54
Pacific Island	1	3	11	0	15
Philippines	0	0	13	0	13
Other	19	46	3	0	68
Total	**450**	**642**	**182**	**58**	**1,332**

The Register is a good but not 100% accurate guide to the number of industrial fishing vessels currently operating in the region. Although the Register includes some vessels which have not yet applied for fishing licenses from PICTs, it does not include PIC national vessels fishing domestically, FFVs licensed to fish in non-member countries, FFVs fishing exclusively on the high seas, or, of course, vessels fishing illegally. The Register thus probably underestimates the size of the tuna fishing fleet operating in the region (Gillett and McCoy, 1997).

Regional Register information is made available to FFA member countries in hard copy or electronic form on a monthly basis. It continues to be a useful enforcement mechanism in support of FFA member countries' efforts to secure reasonable compensation from vessel operators for illegal fishing activities. For example, in 1992 twelve DWFN vessels (from Japan, Korea and Taiwan) had their good standing revoked (or had such revocation threatened) under regional register provisions. Over US$ 1 million was paid by the vessels owners to secure reinstatement to the register.

4.5.4 Harmonised Minimum Terms and Conditions for Foreign Fishing Vessel Access

Minimum Terms and Conditions (MTCs) were last revised and accepted by the Forum Fisheries Committee in April 1990, although some provisions are being implemented progressively. Earlier provisions have been incorporated into all access agreements and are gradually being incorporated into national legislation. The MTCs include:

- **Uniform vessel identification**. All vessels must comply with FAO standards for fishing vessel markings. This is to facilitate identification and to make license swapping difficult.
- **Catch and position reporting**. DWFN fishing vessels are required to report the vessel's position and catch on board to the regional country each Wednesday when in the country's zone and prior to entry and departure. As with all MTCs, licensing countries can impose more stringent reporting requirements.
- **Transshipment**. Since 1993 all catch transshipments must be reported and may only occur at a time and place nominated by the licensing country.

- **Catch and effort logsheets**. Standard logsheets for reporting catch and effort have been adopted for all the gear types used by DWFNs in the region. These must be completed and returned to the licensing country within 45 days of trip completion.
- **Observers**. The licensing country may place an observer on board, fully at the cost of the vessel operator. The observer carries out scientific, compliance, monitoring and other functions, and his activities may extend to periods during the voyage when the vessel is fishing in high seas areas.
- **Appointment of an agent**. An agent must be appointed by the flag state or fishermen's association to be resident in the regional country.
- **Foreign fishing vessels in transit**. Provisions as to secure stowage of fishing gear while in transit are included.
- **Flag state or fishermen's association responsibility**. These provisions ensure that the relevant flag state or association will take action to ensure compliance with the terms of the agreement and with PIC legislation in general by national or member vessels.

4.5.5 Palau Arrangement

The Palau Arrangement for the Management of the Western Pacific Purse-Seine Fishery places a specified ceiling on the number of tuna purse-seiners, currently 206, licensed to operate in the region. The limit has not yet been reached, the maximum number of vessels operating in any year having been 197. The Palau agreement was recently modified to allow for a progressive reduction of 10% every three years in the number of foreign purse-seiners, in favour of PIC-based vessels. The first implementation of this modification occurred in April 1997 when Federated States of Micronesia reduced the number of Taiwanese purse-seine licences from 42 to 40.

4.5.6 Niue Treaty

The Treaty on Cooperation in Fisheries Surveillance and Law Enforcement for the South Pacific Region was signed by Forum countries in July 1992. The Treaty is intended to act as a head arrangement to provide the framework for regional cooperation in fisheries surveillance.

The Niue Treaty is based on article 73 of UNCLOS and primarily addresses cooperation in the implementation of harmonised minimum terms and conditions of access, exchange of information, surveillance and enforcement, prosecutions and enforcement of penalties. Parties also have to ensure that, in their access agreements, flag States assume responsibility for compliance with the laws and regulations of the coastal State (UN, 1992).

It is expected that subsidiary agreements, usually on a bilateral basis, will be developed under the Niue Treaty enabling parties to cooperate in such matters as the exchange of information, sharing of surveillance assets, simplification of extradition and evidentiary provisions, and empowerment of each others officers including, where relevant, extension of the surveillance and enforcement activities by one party into the territory of the other (e.g. hot pursuit from one zone into another).

4.5.7 Vessel Monitoring System (VMS)

The proposed VMS involves the installation of equipment on board each licensed fishing vessel, which is designed to transmit position and catch information automatically to a central monitoring point, thereby eliminating delays inherent in the current system, which can amount to as much as nine months. The system should produce valid position reports, but catch data, which must be entered by the vessel crew, will still be subject to question. Similar VMS systems have operated in New Zealand since 1992, and in Australia since 1996.

Finalisation of the regional VMS design was completed in early 1996 and a commercial tender process for implementation of the system completed later that year. The system is expected to enter into operation in 1998.

4.5.8 Maritime Surveillance Communications Network (MCSN)

The MCSN aims to provide a discreet communications link between FFA and member countries to enable fisheries and surveillance information to be transmitted throughout the region in a timely and semi-secure manner. This includes licence data, catch records, regional register data, etc. The MCSN is satellite-based, with each participating regional country theoretically able to access a central database of fisheries information located at FFA headquarters, which has been designated the regional surveillance centre.

Unfortunately a range of technical problems have persistently plagued the network and the system thus far has proved disappointing. Following an internal review of the network in 1995 FFA is now considering the option of incorporating maritime surveillance data transfer capability into the VMS, rather than maintaining the MSCN in its present form (FFA, 1996b).

4.5.9 Boundary delimitation

Boundary delimitation between the adjacent maritime zones of regional countries is still largely uncompleted. The agreement on the definition and precise location of boundaries is important in fishery management issues, country's claims, and the division of fee payments under the provisions of multilateral treaties. Allocation of the payment of such fees under regional access agreements (currently only the United States Multilateral Treaty, but possibly others in the future) depend upon determination of the proportion of fishing catch and/ or effort which occurred in each country's zone, which is itself dependent on boundary location.

There are approximately 48 common boundaries between PIC EEZs, but only 13 have been mutually agreed to date. As an interim measure, to allow progress with fishery management arrangements, provisional boundaries, which relate only to fishery issues, have been agreed in cases where final boundary delimitation is not yet complete.

4.5.10 Future management arrangements

The FFA continues to be the major vehicle through which multi-country fisheries management issues, particularly those pertaining to the regional tuna fishery, have been addressed to date. FFA provides technical and logistical support to its 14 PIC member states in areas relating to regional cooperation in tuna fishery development and management. The agency employs economists, lawyers and industry specialists as advisors and analysts, has promoted the use of sophisticated international telecommunications systems for monitoring purposes, and uses seconded Australian and New Zealand military personnel in connection with its surveillance work.

FFA is also directly involved in both regional and bilateral negotiations with DWFNs, and has had an active role in the development of all the existing regional tuna management arrangements. The agency tends to take a pro-active role in these matters and has historically been a strong advocate of the right of PICTs, as resource owners, to manage their fishery resources without DWFN involvement in the decision-making process.

The adoption of the UN Implementing Agreement in August 1995 (see section 1.4) has had important implications for FFA's work. The IA places pressure on countries of the region to ensure that existing international management instruments, such as the Arrangement for the Management of the Western Pacific Purse-Seine Fishery, conform to the IA's definitions of competence and precaution, which, for various technical reasons, they presently do not (Geen and Bergin, 1995).

In addition, the IA requires international management regimes to be put in place for straddling stocks. Nandan (1995) (cited in Geen and Kaufmann, 1996) states that the IA has the following two major implications for FFA members countries and the DWFNs:

- the need to establish a mechanism (organisation or arrangement) for cooperation between the FFA members countries and the DWFNs; and
- the need to enhance the cooperation amongst FFA member countries by establishing common conservation and management policies and practices for the management of the resources of their respective EEZs.

Nandan (1995) also notes that "if the coastal states of the region do not take early initiatives themselves, they may find that they are confronted with a proposal for a regional organisation from one or more DWFNs on terms that may not be entirely satisfactory to the states of the region".

The management instruments already developed by PICTs represent a step towards such arrangements but fall far short of what will eventually be required to ensure resource conservation under the terms of the IA. It is in the interests of PICTs to continue to take the lead role in this process in order to maintain their position as leaders rather than followers in regard to the structure and role of the future international tuna fishery management regime. If FFA member countries are able to put in place management arrangements which conform to the requirements of the IA for their own EEZs then the IA provides for these arrangements to be extended to, or used as a model for, management of the adjacent high seas areas. There is thus a strong strategic interest in PICTs developing such in-zone arrangements.

In order to progress this issue the Forum Fisheries Committee (FFC), which guides FFA's work, has established a Sub-Committee on Management Arrangements (SCMA) which has now met four times and has completed its deliberations. The Sub-Committee has put forward proposals relating to in-zone and high-seas management structures for the WCPO tuna fishery which will be considered at a full meeting of the FFC in May 1997. Essentially the Committee has proposed the eventual establishment of two separate but linked consultative structures or bodies:

- a first entity which will determine management arrangements within the collective EEZs of FFA member countries, and to which only those countries may be party; and
- a second body which will determine management arrangements for high seas areas in the WCPO, and to which both FFA member countries and other nations may be party.

June 10-13 1997 saw the convention of the second Multilateral High-Level Consultation on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific (MHLC), a dialogue which brought together Forum countries and DWFNs to investigate mutually acceptable arrangements for the management of fisheries on the high seas. The MHLC is seen as the means through which the second of the two above-referenced bodies may be developed, while the first is expected to arise through modification of existing regional arrangements involving FFA and SPC.

During these developments, emphasis has been placed on the need for new management arrangements to use existing regional organisations as far as possible, rather than creating new organisations or permanent bodies. To achieve this requirement, as well as for practical purposes, the new structure assumes that FFA will act as the Secretariat for the in-zone management body and perhaps also for the high seas management body, with the SPC OFP providing scientific support services to FFA. Various species-based scientific committees, as well as working groups on MCS and fishery statistics, would be established in support of each of the two bodies, and these may in some cases subsume those committees currently convened by SPC.

A review of regional institutional arrangements in regard to fisheries carried out in 1994 (Herr et al, 1995) recommended that the OFP be separated from the SPC and integrated more closely into the management-related functions of the FFA. This was seen at the time as being desirable from the point of view of creating a formal relationship between the research and management functions of the tuna fishery, a linkage which at present does not exist. However, the administrative and political difficulties and sensitivity of restructuring and physically relocating the OFP out of SPC and into FFA are considerable. The current membership of SPC, and thus the OFP, is much broader than that of FFA (21 PICTs and 5 metropolitan SPC member countries as opposed to 14 PIC and 2 metropolitan members of FFA). Negotiating a new structure for the OFP in which current members may be asked

to relinquish their participation in the programme is unlikely to receive unanimous or even majority support.

This is not the first time that a rationalisation of the fisheries functions of the different regional organisations has been proposed. However, tacit recognition of the difficulties involved in merging the OFP and FFA seems to have led to the subject being once again dropped from the regional agenda, at least for the time being.

The institutional arrangements currently being proposed for management of the regional tuna fishery will rely even more heavily than they presently do on a guaranteed long-term source of scientific input if they are to meet the requirements of the IA. In recognition of this fact, as well as of the institutional difficulties of restructuring and relocating the OFP, Geen and Kaufmann (1996) have proposed that a memorandum of agreement be developed between FFA and the OFP such that the latter is charged with the formal responsibility to provide management-related scientific inputs to FFA. There would be financial implications to such an arrangement, since the OFP would need to engage extra staff to provide the required services. Methods of dealing with this additional financial requirement are currently under discussion.

Financing of international fishery management arrangements in general is also a subject of debate. Much of the work of FFA is financed through aid programmes, with only a small portion of costs being covered by Pacific Island member countries. This situation is even more pronounced in regard to the OFP where, apart from the tiny voluntary contributions of one or two PICTs, all the funding is from aid sources. Given that the tuna fishery is currently estimated to be worth about US$1.5 billion, and growing, many of the donors currently supporting the work of these organisations are understandably asking whether industry profits or PICT government revenues from tuna fishing might not be applied to cover a greater proportion of the costs of research and management. Article 24 of the UN Implementing Agreement provides for international donor support to the development of international fishery management regimes, but some observers argue that, in the case of the Pacific tuna fishery, the resource users should be required to pay at least some of these costs.

There are also some subtleties to the question of “user-pays” type financing of management arrangements. Geen and Bergin (1996) argue that it may be strategically wrong to allow DWFNs to provide direct financial support to the development of management arrangements in the region because this might confer leverage in the decision-making process. An alternative arrangement is for PICTs to assume the additional costs of management and then to pass these costs along to industry via increases in licence fees or through other mechanisms, so that DWFNs cannot claim to have directly financed the development of the management regime. Another mechanism proposed is a per-vessel fee which would be charged to FFVs in addition to the fee charged for listing on the FFA Regional Register.

4.6 Conclusions

Based on the best available information, the tuna stocks of the wider Pacific region are not believed to be biologically overexploited at this time. However the market-led growth of the tuna fishing effort in the WCPO during the last few years may be a matter of concern. The decline of fisheries elsewhere, the growing demand for fish due to population growth and affluence, and the desire of developing nations to use rich fisheries as a basis for economic development all are contributing to increasing fishing effort in the Pacific. The surfeit of extraordinarily mobile fishing vessels in the world oceans can transform uncrowded into crowded fisheries more quickly than fishery managers can react. Experience throughout the world shows that regardless of how healthy fish stocks may appear, sooner or later they will become over-fished if an open access policy prevails or if regulation remains inefficient.

Even if biological overfishing is still not occurring, technological improvements in vessels and gear can result in a greater fishing intensity than is economically efficient. The maximum economic yield of a fishery usually occurs at levels of effort below the biological maximum sustainable yield. It is therefore possible that the tuna fishery in the region may be overexploited in relation to the maximum economic yield even if it is not biologically threatened at this time (World Bank, 1995b).

Weber (1996) found “enormous and manifold gaps in international efforts to conserve large ocean fishes in the Pacific Ocean. The gaps may be divided into two classes: geographical and functional. Geographical gaps result from incomplete geographical coverage of fisheries for large ocean fishes by existing management regimes. Functional gaps result from the lack of authority or capability in an international regime to carry out some key element in conservation, such as enforcement or data collection and analysis”. At present management of the WCPO tuna fishery may be said to be deficient in both these areas.

PICTs nevertheless recognise the need for sustainable, environmentally sound harvest practices, and have in the past also taken a strong stance against DWFN/ FFV practices considered to be wasteful and unsustainable. The most prominent example was in 1991 when concerted action by regional countries was primarily responsible for the ban on the use of long drift-nets for tuna in the South Pacific. Recent decisions of the South Pacific Forum have repeatedly underlined the region’s commitment to the development of a management regime for the international tuna fishery in the Pacific that provides for resource conservation and sustainable utilisation in line with the provisions of UNCLOS and the Code of Conduct for Responsible Fisheries. Regional countries have also assigned priority to research activity directed at these concerns, although so far financial constraints have meant that most research has remained confined to the main target species.

Although a great deal of progress has been achieved to date in researching and managing the regional tuna fishery, there is a pressing need for additional research programmes to address the stock status of those two of the four main target species - bigeye and albacore - which may be most in danger of over-exploitation, as well as of many poorly-known by-catch species, including billfishes and sharks. This needs to be carried out in parallel with the development of a broader-based management regime which covers the entire geographical and biological range of the fishery and which meets recently agreed international requirements in regard to sustainable exploitation and conservation. There is also a need for further large-scale study of the WPWP LME, tailored to the development of an ecosystem approach to the management of the area.

5 Trans-Boundary Concerns

5.1 General

The Pacific Islands region is composed of archipelagic states, separated by large tracts of water. Only one PIC (Papua New Guinea) has a land border with another country (Indonesia) which is outside the region. Of the 49 international boundaries that regional countries have with each other and with non-regional countries, 48 are maritime. Not surprisingly, therefore, trans-boundary issues relating to management of the marine milieu, and the living resources therein, are numerous.

In addition to those issues relating to resources or human activities that straddle the maritime boundaries of the region, a second class of trans-boundary issues relates to problems which threaten the region, or sections of it, by virtue of their being common to many countries. The Global Environment Facility's Scientific and Technical Advisory Committee discussed the "Universal Practices Approach" at its Brainstorming Session on International Waters in September 1996 and noted that "...the international waters strategy would primarily focus on (mitigating) universal practices that, because of their widespread and universal character, have a cumulative effect that over time causes a threat for the global systems. Examples of such universal practices are waste dumping, all types of pollutants, coastal degradation, over-fishing, exploitation of freshwater resources, etc."

PICTs have traditionally demonstrated a strong commitment to regionalism through which they have taken a collective approach to shared or common problems. This philosophy has arisen for several reasons, not least the archipelagic nature of the region, which means that many problems are repeated from island to island or country to country, but also because of the small sizes and limited capacities of PICTs. Lack of critical mass in terms of human, financial and other resources is a strong rationale for activities to be carried out and services to be provided on a multi-country basis if they are to be viable. Examples that illustrate this point include not only the large number of regional organisations that have been established to provide technical services and support to PICTs on a collective basis, but also the multi-country arrangements that exist in regard to shipping (the Forum Shipping Line), tertiary training (the University of the South Pacific), fuel supply and other essential services. In view of the strong regional identity of the Pacific Islands region, many issues that may not strictly qualify as 'trans-boundary' in a zone made up of larger economic entities may still warrant treatment as collective concerns for PICTs.

Based on the earlier discussions, a number of specific living marine resource management issues with trans-boundary dimensions are identified as follows:

- research into and management of straddling fisheries or resources, including oceanic species, but also some coastal resources;
- a concerted study of the WPWP and identification and study of coastal marine ecosystems in the region, aimed at identifying ecosystem-level management approaches;
- improvement of national coastal zone planning and management capabilities through awareness-raising, technical support and training;
- comparative research on coastal resources and fisheries to boost basic knowledge of resource biology and fishery economics, and to permit development of standardised management guidelines for key fisheries;
- development of appropriate regimes for the management of coastal fisheries, with particular focus on co-management arrangements;
- promotion of fisheries development activities designed to divert existing fishing effort and channel new effort away from coastal fisheries and towards the more abundant offshore tuna resources; and

- development of international trade instruments relating to fishery products as a means of influencing demand for products based on overexploited species.

In many cases national fishery management concerns will reflect, or be a subset of, these regional issues. This is particularly the case in regard to the development and management of coastal fisheries and the coastal zone, where the trans-boundary issues identified arise largely due to their commonality. In other cases, such as the need for research on the WPWP, it is possible that the issues identified are of such a large scale that they would not be captured by a review of national level development and management problems.

The trans-boundary issues identified above are discussed in more detail in the following sections.

5.2 Straddling fisheries or resources

5.2.1 Description

Development of appropriate management arrangements to ensure conservation of the straddling stocks of highly migratory species exploited by the international tuna fishery of the WCPO (as well as of the LME on which it is based) is the region's major trans-boundary fishery issue. The various components of the international tuna fishery traverse the EEZs of at least 21-resource-owning states as well as large tracts of high seas areas, and are or have been exploited by the fishing vessels of at least 26 nations. PICTs have been instrumental in the development of management regimes for the various components of this fishery. Depending on the outcome of negotiations presently in progress, the currently developing management regime for tuna could become the first in the world to comply fully with the recommendations of the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks. Nevertheless progress continues to be constrained by the complexity and highly political nature of such regimes, and some institutional restructuring may be necessary on the part of the region's existing regional fishery research and management organisations to conform with the requirements of UNCLOS.

In the meantime, as management arrangements are developed step-by-step, the fishery continues to grow and certain components, particularly bigeye and albacore tunas and several by-catch species may be threatened with over-exploitation in the foreseeable future. Intensified research on these species is required so that problem areas can be addressed and given priority attention in the development of appropriate international conservation arrangements.

Other marine resources may also require trans-boundary approaches to their management where stocks are known to straddle the EEZs of more than one country. Examples include the ornate spiny lobster, beche-de-mer, prawn and other fisheries of the Gulf of Papua, which are jointly managed by Papua New Guinea and Australia, and the reef and lagoon resources of western Solomon Islands and eastern Papua New Guinea which straddle the international boundary dividing that archipelagic area. There may ultimately prove to be a trans-boundary dimension to the management of other resources which are presently considered only as national or local assets, a situation which would seem to be more probable in the case of small, adjacent EEZs than among large EEZs. For the time being these questions are only poorly understood and the extent to which they should be considered as trans-boundary issues is not known with any certainty.

5.2.2 Priorities for action

New scientific activities should be established to permit assessment and monitoring of the exploitation status of non-target or by-catch species taken in the regional tuna fishery, in particular billfishes and sharks, which in some cases may be heavily or over-exploited, or may be in danger of becoming so.

The necessary institutional restructuring needs to take place to allow the region's existing fishery organisations to become effective tuna fisheries management institutions operating on behalf of PICTs.

Studies should be carried out to establish the ecological linkages within and between coastal and oceanic marine ecosystems in the region (see also next section), and in particular to establish trans-boundary characteristics of coastal fishery resources.

Where coastal fishery resources are found to have trans-boundary dimensions, appropriate international management arrangements should be developed between those countries which share these resources.

5.3 Large marine ecosystems

5.3.1 Description

Recent research has shown the existence of a LME, the WPWP, which demonstrates ecological coherence in terms of its distinct bathymetry, hydrography, productivity and trophically dependent populations, and meets the criteria that have been used to define other LMEs identified as areas for attention under UNCED.

Further elucidation of the oceanographic and biological characteristics of the Warm Pool, the structure of the ecosystem within it, and its relationship to the world's largest tuna fishery, which it supports, are the major issues which will impact on future management of the fishery and in particular the conservation of the ecosystem's biodiversity. A programme of research and study of the Warm Pool should be designed in order to support the development of an ecosystem approach to management of the WCPO tuna fishery. This may permit appropriate sustainable use and conservation measures to be applied to all components of the ecosystem, and not just those elements which are most highly visible due to their being commercially exploitated, as at present.

Coastal fisheries would also benefit from an ecosystem approach to research and management of coastal marine ecosystems. In particular there is a need to better understand the physical extents of coastal ecosystems, the degree to which they interact with the oceanic ecosystem, the extent to which they are linked with other coastal ecosystems, and the impacts of coastal zone development on them. Such research will provide an improved knowledge base which, among other benefits, will permit identification of situations in which fisheries management can be carried out in a sectoral manner, and those in which an ecosystem approach is required.

5.3.2 Priorities for action

A programme of scientific research on the WPWP LME, tailored to the development of an ecosystem approach to the management of the area's resources, should be put in place.

Research aimed at identifying and describing LME in coastal areas of PICTs, particularly those where extensive CZD is occurring, should be undertaken.

Studies should be carried out to establish the ecological linkages within and between coastal and oceanic marine ecosystems in the region (see also preceding section).

5.4 Coastal zone planning and management (CZP & CZM)

5.4.1 Description

Despite past efforts to introduce them, the principles of integrated coastal zone planning and management have not yet taken root in most Pacific Island countries. In many PICTs the entire country could be defined as coastal zone for most purposes, and CZM becomes equivalent to national development planning. However the coastal dimension is not yet adequately accounted for in most national development plans.

Coastal systems, and especially the marine components, are nevertheless becoming increasingly degraded and there is a growing need for improved management of coastal development in many areas in order to avoid further damage. This is particularly true of urban and peri-urban areas, although rural and outer islands are not spared from coastal degradation.

There is a need to introduce the basic concepts and practices of coastal zone management to PICTs at all levels, from education and public awareness, through provision of appropriate technical advice and training, to the installation of responsible and accountable decision-making systems and establishment of political support for CZM. A regional programme of action to this end would allow comparative studies and trials, facilitate information exchange, and achieve economies of scale, and is thus a better alternative to disparate national programmes.

5.4.2 Priorities for action

A regional CZM capacity-building programme should be developed and implemented, and should contain elements of public information and awareness-raising, provision of technical advice and training, and improvement of decision-making mechanisms in regard to CZD.

National-level attempts to introduce coastal zone management plans and strategies should be encouraged and supported.

5.5 Comparative research on coastal resources

5.5.1 Description

Existing knowledge of most coastal fishery resources is insufficient to allow an understanding of their fishery characteristics or to develop management approaches based on a sound awareness of resource biology. Despite the fact that they are heavily exploited in many areas, therefore, lack of information on the responses of many coastal fishery resources to different levels of exploitation impedes the development of rational management regimes based on an understanding of resource dynamics.

In addition, economic studies of coastal and other small-scale fisheries in the region are few and far between, but will be important as a means of introducing fisheries management issues into the policy arena. Areas of focus for such studies could include the economic benefits of alternative management regimes for key coastal fisheries, the interaction between subsistence and commercial fishing, and mobility into and out of the fisheries sector.

There is a need for comparative studies of fisheries for the same species or species groups being prosecuted under different ecological and economic conditions and at varying levels of exploitation. A well-designed programme of such studies would elucidate the responses of key fishery resources to exploitation and other environmental characteristics, as well as to management through economic manipulation. It would also permit the development of broad resource management guidelines for key species or fisheries, based on observation of stock responses to different exploitation levels and regimes.

5.5.2 Priorities for action

Regional-level comparative studies of resource biology and fishery economics should be undertaken to permit the development and application of rapid tropical fishery assessment methods, as well as the development of broad management guidelines or ‘rules of thumb’ for key fisheries.

5.6 Development of coastal fishery management regimes

5.6.1 Description

Coastal fisheries are increasingly suffering from the effects of overfishing, especially in urban areas, but also in some rural or outer island zones. Financial and other incentives often lead to intensive harvesting beyond the capacity of the resource to sustain. Resource users may be unaware of the true limits to the carrying capacity of the resource they are exploiting. National fisheries departments, which have historically focused on fisheries development rather than fisheries management, are frequently not equipped to provide coastal communities with appropriate advice or assistance in this regard. Other unsustainable resource exploitation practices, such as the use of destructive fishing techniques, worsen the situation.

There is a need to improve the knowledge of both resource users and PIC fishery administrations in regard to the production capacity of coastal fisheries and the need for management. There is also a need to facilitate and catalyse the development of suitable management arrangements at local and national level. As in the case of CZM (see section 5.4) regional programme of action to address these issues would permit comparative studies and trials, promote, information exchange, and achieve economies of scale.

5.6.2 Priorities for action

Regional-level efforts should be made to promote widespread awareness among coastal resource users and administrators of the need for management of both commercial and subsistence fisheries in coastal areas.

Comparative studies should be undertaken to allow development of appropriate management regimes for coastal fisheries, especially co-management arrangements between government agencies and customary resource owners/ users.

5.7 Diversion of fishing effort from coastal to oceanic resources

5.7.1 Description

Part of the reason that coastal fishery resources are becoming increasingly heavily exploited is that they are relatively accessible to the coastal populations of PICTs, which themselves are growing rapidly. Although offshore tuna and other resources are more abundant, they are also less accessible, often requiring more costly and elaborate vessels and equipment, as well as a different set of fishing and other skills.

There have nevertheless been successful attempts to encourage Pacific Island fishermen to target offshore resources. These have taken place on several scales. Deployment of fish aggregation devices and the conduct of technical training programmes may aid artisanal and small commercial fishermen to exploit tuna resources that were previously inaccessible. Post-harvest training and product development may make such fishing activities more economically attractive, as also may programmes aimed at sport-fishery or game-fishery development. Parallel programmes to provide credit for boat and equipment purchase may permit fishermen to switch from coastal to offshore fishing, or to become involved in more profitable fishing enterprises such as commercial sport-fishing.

As coastal populations continue to grow there will be an increasing need to channel fishing effort offshore. There will also be an increasing domestic demand for seafood products which coastal fisheries are unlikely to be able to supply, thus providing another rationale for offshore fisheries development.

5.7.2 Priorities for action

Regional-level efforts to support all forms of domestic tuna fishery development should be reinforced, with a view to, *inter alia*, diverting existing and new fishing effort from coastal to offshore resources, and increasing the contribution of offshore resources to domestic fish supply and food security.

5.8 International trade in fishery products

5.8.1 Description

There are a number of situations in which the market or demand for a fishery product from the region is located in another country or regional trade bloc, and where the strength of this demand has led directly to the degradation of Pacific Island fishery resources. Examples include the trochus and beche-de-mer fisheries, whose market demand, which has led to the degradation of Pacific Island resources, is centered in SE Asia. Other examples include live reef fish, again in demand in SE Asian countries, and whose capture involves not only overexploitation but also the use of highly destructive fishing methods (Johannes and Riepen, 1995); and the increasingly heavily exploited reef and lagoon fisheries of Palau, Yap and other Micronesian areas which are being fished to supply the tourist markets of Guam and the Northern Mariana Islands.

International trade negotiations, collective bargaining between PICTs and importing states, tariff or non-tariff export and import barriers, or voluntary trade restrictions could modify market demand for these products, which in turn could impact on the level of exploitation of fishery resources in PICTs. International trade agreements or regulations could thus under certain circumstances be used as an indirect form of marine resource management, extending the principle used in CITES. A detailed study of the issue would be warranted in order to identify possible national and regional-level initiatives in this area.

5.8.2 Priorities for action

A study of trade-related aspects of coastal resource management should be carried out in order to evaluate the options for improving management of fragile or sensitive resources through amendments to national or international trade arrangements or agreements.

5.9 Recommendations for regional-level action

In response to the trans-boundary issues identified above, several specific regional-level actions are recommended for implementation through existing Pacific regional organisations.

Pacific Island countries should undertake the following actions at the regional level:

- continue to give high priority to, and take the lead role in, the development of management arrangements for both the in-zone and high seas components of the region's international tuna fishery;
- extend the scientific efforts of the SPC's Oceanic Fisheries Programme to permit assessment and monitoring of the exploitation status of non-target or by-catch species taken in the regional tuna fishery, in particular billfishes and sharks, which in some cases may be heavily or over-exploited;
- undertake the necessary institutional restructuring to allow the FFA, in conjunction with the SPC's Oceanic Fisheries Programme, to become effective regional tuna fisheries management institutions on behalf of Pacific Island countries;

- extend the scientific efforts of the SPC's Oceanic Fisheries Programme in order to undertake a comprehensive study of the WPWP LME, tailored to the development of an ecosystem approach to the management of the area;
- strengthen and support the efforts of the SPREP in promoting national-level integrated coastal zone planning and management, ensuring that coastal fisheries are fully accounted for in this process;
- extend the research mandate of the SPC's Coastal Fisheries Programme so as to permit the development and application of rapid tropical fishery assessment methods;
- extend the research mandate of the SPC's Coastal Fisheries Programme so as to provide for comparative studies of resource biology and fishery economics which will allow the development of broad management guidelines or 'rules of thumb' for key fisheries;
- strengthen and support the efforts of the SPC, the FFA and the SPREP to promote national awareness of the need for, and study suitable approaches to, management of both commercial and subsistence coastal fisheries, including through co-management between government agencies and customary resource owners/ users;
- support domestic tuna fishery development through the FFA and the SPC's Coastal Fisheries Programme with a view to, inter alia, diverting existing and new fishing effort towards these resources, and to increasing their contribution to domestic fish supply and food security; and
- • sponsor a study of trade-related aspects of coastal resource management and evaluate the options for improving management of fragile or sensitive resources through amendments to national or international trade arrangements or agreements.

Where necessary external financial support should be sought to allow implementation of these recommendations.

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