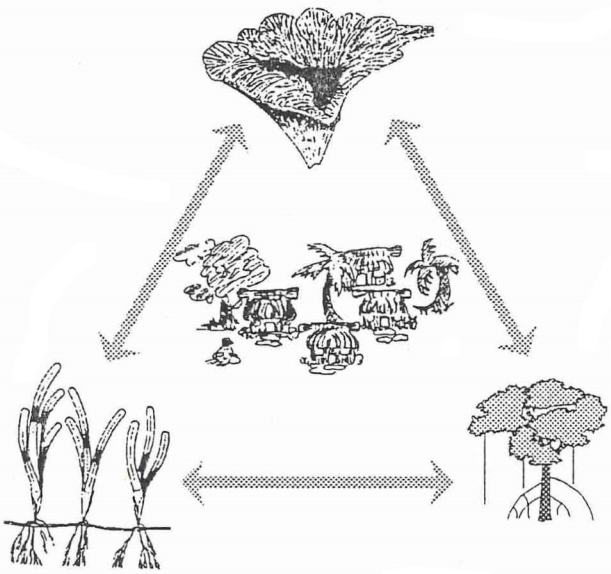
Marine Studies

The International Ocean Institute

The University of the South Pacific

Pacem in Maribus

Management and Development of Coastal Fisheries in the Tropics



MODULE 1

The Coastal Fisheries Environment of the Tropics

STUDENT MANUAL

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CHAPTER 1
Introduction

In most tropical countries, particularly island nations, a large fraction of the population lives along the coast. In continental areas and on large islands, many of the larger cities are situated along coastlines, and in all small-island states practically everyone lives at or near the coast. Therefore, most development which occurs in such countries has the potential to produce some form of impact in the marine environment near the coast. It is coastal land and the sea adjacent to the coast that is generally thought to hold the greatest potential for sustainable development., so the wise management of the coast is an essential goal for all tropical nations if a **sustainable** future is to be ensured.

There are few terms used in the context of natural resource harvesting that are more difficult to define than '**sustainable**'. As generally used in this context, the term 'sustainable' can include three components: human population, economics, and natural resource. It's definition includes *the ability of a resource to sustain human populations at present or projected levels*. It is sometimes used in the context of *the ability of a resource to sustain income levels derrived from resource harvesting at present or projected levels*. From the perspective of the resource, 'sustainability' may be taken to mean *capable of maintaining long-term yields of the resource at a relatively constant level without substantially reducing productivity very much below levels that would be experienced in an unharvested resource*. While all aspects of these definitions are easily conceptualized, it is almost impossible to determine in the short-term whether a resource is being harvested on a sustainable basis or not.

The term **overfishing** is another one that is often used in the context of fisheries, the precise definition of which depends on the interest group concerned. Overfishing may be defined generally as fishing a resource or resources at levels which substantially reduce productivity and yield to the fishery to levels very much below levels experienced in a pristine resource, or which brings about major changes in the ecosystem. Four types of overfishing have been recognized:

- growth overfishing
- recruitment overfishing
- economic overfishing
- ecosystem overfishing.

Growth overfishing occurs when the larger individuals in a population are progressively removed, so that the average size in the catch gradually decreases over time. Eventually, fish will be harvested at a less than optimal size and this reduces overall yield to the fishery. **Recruitment overfishing** occurs when the biomass of fish capable of reproduction (the spawning stock) is reduced to a level that substantially reduces the recruitment of new individuals to the population. **Economic overfishing** occurs when fishing takes place above the level at which profits begin to decline and reach a point at which the cost of operating the fishery is more than the revenue it generates. This can occur rapidly in an open-access situation. Economic overfishing can occur as a result of biological overfishing, or overcapitalization. It can also occur when there is an oversupply of a particular species or type of fish, substantially

reducing the market price of the product, usually in response to a rapid investment which increases the supply of product to the market. **Ecosystem overfishing** occurs when fishing critically affects the relationships among species within an ecosystem. It is probably prevalent in most tropical reef-based fisheries. While ecosystem overfishing is easy to conceptualize, it is almost impossible to assess since species interactions are difficult to determine, and it is difficult to ascertain what constitutes a 'normal' coral reef community.

The achievement of sustainable harvests in fisheries demands an understanding of the ecology of inshore marine ecosystems, their importance in human affairs, how these ecosystems are affected by human activity, and the management implications of that knowledge. **Chapters 2-5** of this unit provide the basic introduction to inshore tropical ecosystems, review their importance to human affairs, examine human factors threatening them, and present a brief summary of the management implications of this knowledge. These chapters can be grouped together under the heading "Coastal Ecosystem Types in the Tropics."

Three kinds of ecosystem spring to mind when a biologist is asked to think about tropical ecosystems in the inshore region: coral reefs, mangrove forests, and seagrass beds. Coral reefs are well known for their tremendous diversity of associated flora and fauna, their very high levels of productivity, and their great beauty. Perhaps mangroves and seagrass beds are less well known, but they also contain many species found in no other ecosystem, are very productive, and possess their own kind of beauty.

Six other broad types of ecosystems exist in the tropics: rocky shores, sandy beaches, intertidal mud-flats, deep lagoon bottoms, nearshore pelagic ecosystems, and deep reef slopes. Although rocky shores and sandy beaches are important and interesting ecosystems in the tropics, they will not be dealt with here. Intertidal mud-flats are usually colonized by seagrasses, and as such can be treated together with seagrasss beds even though there are often considerable areas that are not occupied by seagrasses. The bottoms of deep lagoons are covered in calcareous sediment derrived almost entirely from the erosion of reef material, mainly through the activities of living organisms. This forms an important but largely unstudied environment in the tropics. The nearshore pelagic ecosystem is another inshore ecosystem that is important in the tropics, for it is there that many of the species that inhabit mangroves, seagrass beds, and coral reefs spend part of their lives and obtain some of their nutrition. Deep reef slopes are important ecosystems because they yield important fisheries resources, such as some of the deep-water snappers (Lutjanidae). Again, the are relatively poorly known, and will not be dealt with further here. This module will concentrate on coral reefs, seagrass beds and mangrove forests.

Tropical ecosystems are very important in human activity, particularly in the area of natural resource harvesting, yet in most tropical areas, very little effort is made to conserve these ecosystems from the point of view of wise and sustainable utilization. While traditional tenure and other cultural devices have provided some degree of conservation in many areas, such devices are breaking down in most places, and Western principles are usually not successfully employed for conservation purposes. In many areas, coastal ecosystems are threatened by unmanaged or poorly

managed human activity. In **chapters 2-5** we will examine these ecosystems, outline their importance in human affairs, and explore some of the threats which they are facing.

Inshore fisheries in the tropics may be defined according to a number of criteria, including scale, the ecosystem in which the resource is harvested, and target species. Fisheries managers and policy planners should be encouraged to think about coastal fisheries from a number of perspecitves. Each of the above criteria for defining fisheries furnishes a different perspective, and highlights a different aspect of the problems which managers must solve if fisheries are to be sustainable. **Chapter 6** presents coastal fisheries in the tropics according to these three criteria, and examines the management implications of the different perspectives.

Most coastal communities in the tropics are substantially dependent on inshore fisheries to provide the dietary protein, and monetary needs of daily life. However, over many years there has been a transition taking place from subsistence-level fishing towards increasing commercialization of inshore natural resource harvesting. This change brings with it an increasing pressure on inshore natural resources and an increasing danger of overharvesting. **Chapter 7** examines the importance of the inshore at the village level, and how changes in village-level fishing patterns can influence the resources being harvested. These changes create particular problems for fisheries managers, and may represent the greatest challenge for development in many troical areas.

Coastal communities have been interacting with the marine environment since prehistoric times, so a considerable abount of knowledge of the nearshore environment has been built up over this time. It is only within the last 10-15 years that biologists and resource managers have begun to realise that this traditional knowledge can be put to use in the management of the inshore region. This informal knowledge base can be particularly important in countries lacking resources or capital for carrying out expensive, large-scale research projects as a basis from which to make management decisions. Using local knowledge can be a valuable alternative to scientific research, provided such knowledge is used cautiously and verified through independent checking. While this is not a topic discussed further in this unit, it is important for fisheries managers and policy planners to be aware of the tremendous contribution that village-level knowledge of coastal resources can make to the management process.

The layout of this unit is similar for all chapters after this one. Each chapter begins with a list of objectives, which are designed to guide your study. You should refer to those objectives at all stages of work on this module. Following the "Objectives" is a statement of the "Background Required". If any of the background concepts are unfamiliar to you, then you should make an effort to study some background material before beginning your study of this unit. Each chapter is provided with "Study Questions" which should be answered as you study the readings and other teaching-and-learning materials provided with this course. It is a good idea to write out the answers to these questions in a notebook, and to include illustrations in your answers as much as possible. The answers to these questions will serve as your revision notes for the course. At the end of some chapters, you will find questions suitable for discussion after you have studied the reading material. At the end of this

module you will find a glossary of all technical terms used in this document. If you do not know the meaning of a technical word, please refer to the glossary for clarification.

CHAPTER 2
Coral Reefs

OBJECTIVES

When you have completed this chapter you should:

- be able to recognize and characterize the coral reef ecosystem
- be able to state the environmental factors required for coral reef development
- be able to state how coral reefs maintain high levels of productivity in nutrient poor waters
- be able to discuss the rôles of different types of organisms in the construction of coral reefs
- be able to define the four main types of coral reefs
- be able to state the ecological and socio-economic inportance of coral reefs
- be able to characterise the main human threats facing coral reefs
- be able to state the natural-resource management implications of your knowledge of coral reefs.

BACKGROUND REQUIRED

The following background knowledge will greatly facillitate your understanding of the material in this chapter:

- the concept of nutrients as applied to plants in the sea
- an understanding of the sea as a salty medium (salinity)
- the concepts of ocean waves, sea swells, and wave action
- the concept of limestone.

STUDY QUESTIONS: Coral Reefs

These study questions are provided to guide your study, and should be answered as you study the readings and other material provided with this course. It is a good idea to write out the answers to these questions in a notebook, and to include illustrations as much as possible. These answers will serve as your study notes for this course.

> **HINT:** Wherever possible, try to organise your answer using a concept map, flow chart or other non-linear format.

1. List the environmental requirements for the development of coral reefs.
2. Describe the main groups of reef building organisms, and state in broad terms the approximate contribution of each group to the construction of coral reefs.
3. Explain the rôle of each of framework builders, fillers, and cementers in the construction of coral reefs. Cite examples of members of each group.
4. What is meant by bioerosion? What groups of plants and animals contribute to bioerosion? How does bioerosion contribute to the formation of calcareous sediments?
5. Name the four main types of coral reefs and state the relationship among them.
6. What is meant by primary productivity? Distinguish between gross primary productivity and net primary productivity. How does the primary productivity of coral reefs compare with that of other ecosystems?
7. What is meant by the term oligotrophic water? Explain how coral reefs maintain high levels of primary productivity in oligotrophic water.
8. Discuss the rôle of coral reefs in human affairs.
9. Identify the main threats facing coral reefs, and suggest the management implications of this knowledge in your own country or region.

Keywords: atoll, barrier reef, bioerosion, borer, burrower, calcification, calcium carbonate, coral reef, disturbance, eutrophication, framework builders, fringing reef, hermatypic/ ahermatypic, mutualism, nematocyst, nutrients, oligotrophic, patch reef, polyp, primary production (productivity), reef cementers, reef fillers, stony corals, subsidence theory, symbiosis, threat, zooxanthellae.

2. Coral reefs

2.1 *Environmental features*

Coral reefs are diverse and productive ecosystems which occur along most tropical coastlines throughout the world, wherever the physical conditions are conducive to their formation. A true coral reef is formed by coral, coralline and other calcified algae, and other reef building organisms growing on a base composed of the skeletons of dead coral and other organisms cemented together mainly by coralline algae and physical calcification.

Reef-building corals require a delicate balance of oceanographic conditions before they can occur in sufficient numbers to build reefs. The first of these is a sea temperature of 16-35 °C, optimum temperatures of 23-25 °C. This condition is met throughout most of the tropics (Fig. 1), except where cool currents or coastal upwelling keeps temperatures low, as happens off the west coast of Namibia, in Africa, and western Australia. Where currents bring warm tropical water to subtropical areas, coral reefs can occur at subtropical latitides (e.g. east coast of Africa, and Lord Howe Island).

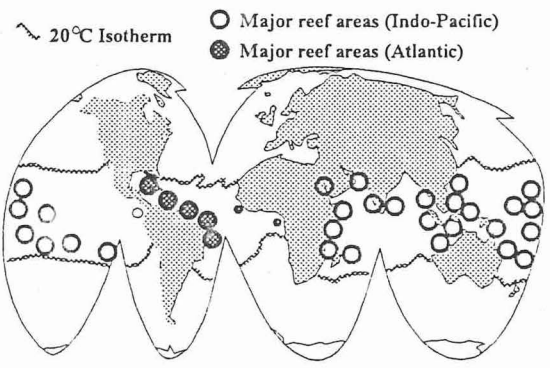

Figure 1. The occurrence of coral reefs in relation to the 20°C isotherm.

Another condition which must be met for the development of reef-building corals is the absence of major rivers which bring silt and fresh water down to the sea. Excessive silt reduces light, thereby inhibiting photosynthesis by the symbiotic algae which are found in coral tissues. Silt may also block the mouths of corals, preventing feeding and reducing gas exchange. Corals are very intolerant of reductions in salinity (they are **stenohaline**), and are therefore unable to form reefs near the mouths of rivers. In reefs that do occur near river mouths, they are usually interrupted by channels which are often used to provide access to harbours, and a means of crossing the reef in small boats.

Reef-building corals need light to support the symbiotic algae which they contain, so thay cannot develop in deep water below the zone in which sufficient light is available to support photosynthesis (**euphotic zone**). Thus they are usually restricted to water depths of less than 70m. It is for this reason that coral reefs are only found adjacent to land masses or on the summits of undersea mountains. Away from land masses, the water is too deep for reef-building corals to develop.

Corals develop best in **oligotrophic** water; water that is low in plant nutrients. While moderately high levels of nutrients do not harm corals directly, nutrients promote the growth of fleshy seaweeds with which corals cannot compete successfully

when nutrient levels are high. Most tropical waters are oligotrophic, and this makes coral reefs very sensitive to the addition of nutrients present in agricultural runoff and human sewage.

2.2 *Reef building organisms*

Although corals are prominant features of tropical reefs and are obviously important in reef construction, other organisms also play key rôles in the formation of reef structures. Calcified algae make major contributions to both the structure of the reef and the process of binding the structural materials together. For this reason, some biologists prefer to think of tropical reefs as **biotic reefs** rather than as coral reefs, although the use of this term has never been accepted by reef biologists in general.

Corals belong to the animal phylum Cnidaria, sometimes referred to as Coelenterata, which also includes the hydroids, jellyfish and sea anemones. The corals, together with the sea anemones and false anemones comprise the class Anthozoa, meaning literally "flower animals". Many other cnidarians have two stages in their life cycles the sessile **polyp** and the free-swimming **medusa** (jellyfish). The anthozoans have no jellyfish stage, but occur only as sessile polyps (Figure 2). Coral polyps reproduce asexually within a colony in a number of ways, including budding new polyps from the base of mature ones (Figure 3), splitting and upward branching. Sexual reproduction occurs with the release of eggs and sperm into the water column. Fertilized eggs develop into free-swimming, ciliated, planula larvae which constitute the only dispersal stage in corals (Figure 3). Coral polyps generally have a cylindrical body, with a mouth surrounded by a ring of tentacles on the upper side. A coral polyp has no anus, so the only way to empty waste material from its cul-de-sac digestive system is through the mouth (Figure 2).

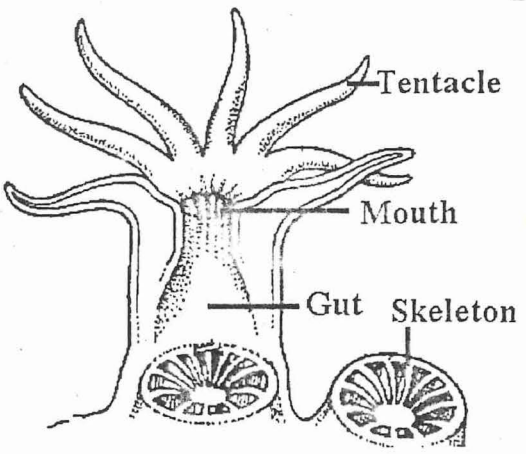

Figure 2. Structure of a coral polyp.

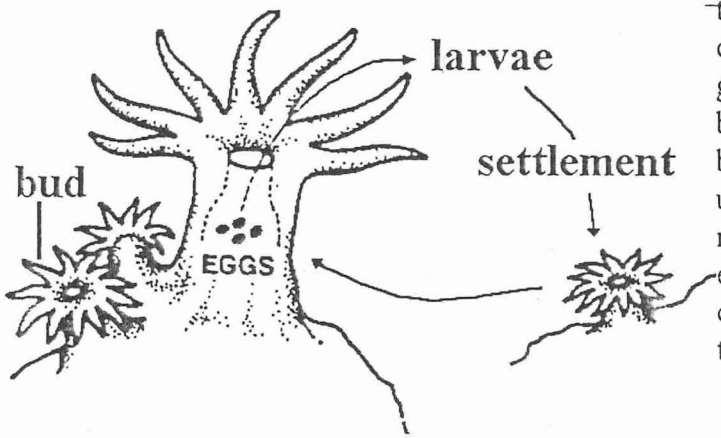

Figure 3. Life cycle of a typical reef-building coral.

Corals may be divided into four main groups: hydrocorals, octocorals (including the soft corals), black corals, and stony corals. The stony corals comprise the main group of reef-building corals. Each stony coral polyp is enclosed in a **calcium carbonate** cup, into which the animal can withdraw for protection from predators. The stony cup has numerous regular folds on the upper surface and the pattern of these folds gives each species its characteristic

ornate structure. Except in some solitary corals, the cups are cemented together into a colony, the form of which is also distinctive. Since most coral polyps feed at night, and are contracted during the day, all you are likely to see in the daytime is the calcium carbonate skeleton. All four groups of corals are represented on most tropical reefs, but the two most important groups are the stony corals and the soft corals, with only the stony corals building reef structure. Not all stony corals are involved in reef-building, and those that do construct reefs are referred to as **hermatypic corals**. Corals which do not contribute appreciably to reef construction are referred to as **ahermatypic corals**.

Corals are predators, and can use stinging cells, called **nematocysts,** in their tentacles to disable small zooplankton, which they then pass to their mouths (Figure 4). However, the reef building corals, and many soft corals, derive much of their nutrition from large numbers of single-celled algae, called **zooxanthellae**, that live within their tissues. The two groups enjoy a **mutualistic symbiotic** relationship: the algae photosynthesize and pass on some of the resulting food energy to the coral, while the coral provides the algae with a place to live, as well as with nutrients from its own waste products.

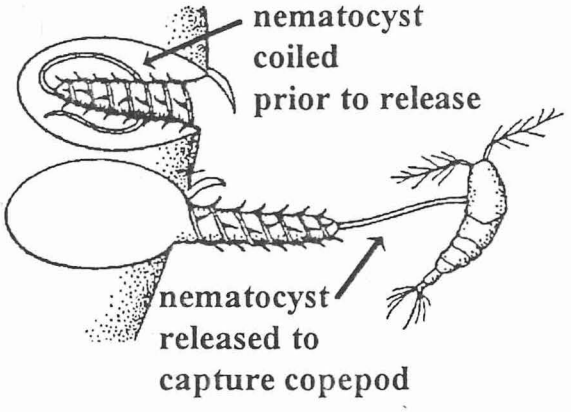

Figure 4. The stinging cells (nematocyst) found in coral tentacles in coiled and released positions.

Calcium carbonate, commonly referred to as limestone, comprises the bulk of the structural material in coral reefs. It is important to note that the term 'calcium carbonate' can be a bit misleading since 'calcium carbonate' also includes salts of cations such as magnesium and strontium, that substitute easily for calcium. Magnesium in particular can represent a large portion of the total cations that make up the so-called 'calcium carbonate.' Hermatypic corals lay down calcium carbonate as the mineral **aragonite**.

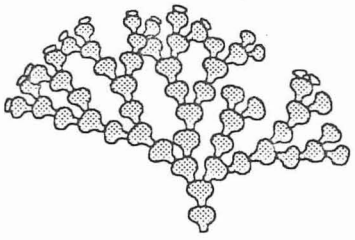

Figure 5. *Halimeda*, a calcified green alga.

In addition to the zooxanthellae, other algae are also important in reef con-struction. Several species of green, brown and red algae lay down deposits of aragonite and thus contribute calcium carbonate to the reef. Of considerable significance are certain calcified green algae, particularly species of the genus *Halimeda* (Figure 5). *Halimeda* produces calcified segments which break up and contribute mass to the calcareous rubble that eventually becomes incorporated into the reef structure.

A group of red algae known as coralline algae (Figure 6) are especially important in reef construction, as they lay down calcium carbonate as **calcite**. The corallines, members of the red algal order Corallinales, contribute considerable bulk to the calcium carbonate structure of the reef. Their more important rôle, however, is probably in acting as the cement which binds the reef materials together into a solid and sturdy structure.

> **Calcite** and **aragonite** are mineral polymorphs of calcium carbonate that have the same chemical composition, but differ only in crystal structures.

Many other organisms contribute smaller amounts of carbonate material to the reef, including foraminiferans, molluscs, bryozoans, and calcareous sponges. However, corals and calcified algae comprise the bulk of the carbonate structure of coral reefs.

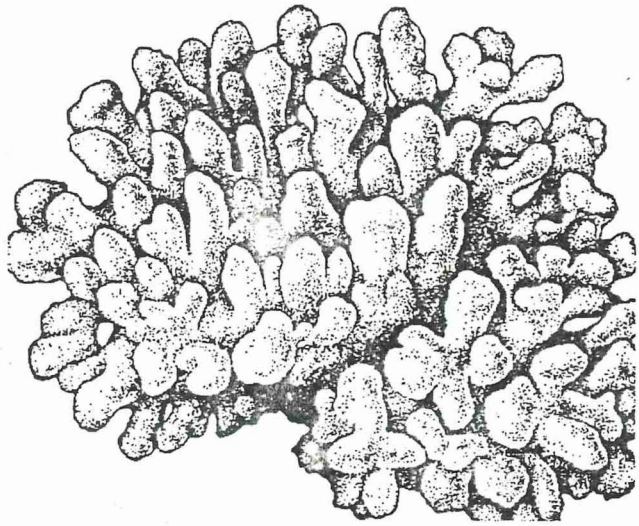

Figure 6. Typical coralline alga, *Lithothamnion* sp. (Source: Dawes, C. 1981 *Marine Botany*. John Wiley & Sons, Brisbane, p. 199)

2.3. *Framework builders, fillers & cementers*

It is useful to think of the organisms that contribute to the structure of coral reefs as either **framework builders**, **fillers**, or **cementers**. The main framework builders are the stony corals, whose three-dimensional growth form provides the essential structure to which other organisms add material. Fillers include a variety of organisms which fill in the spaces among the coral branches and in cavities created by erosion, either by growing there or by becoming lodged there as living or dead fragments. Important fillers of the coral reef structure include calcified green algae (e.g. *Halimeda*), calcified red algae (e.g. *Peyssonnelia*, Corallinales), foraminifera, broken pieces of corals, molluscs, bryozoans and many other calcified organisms. The cementers bind the mass of material produced by the framework builders and fillers into solid structure. The most important cementers of coral reefs are the crustose coralline algae, a group of red seaweeds that lay down calcium carbonate in the form of relatively hard and durable calcite.

2.4. *Physical calcification*

Physical calcification also plays a rôle in the formation of the cement that binds reef materials together. For example, calcium carbonate can precipitate within small spaces and chambers that contain organic material and are cut off from the surrounding seawater. This process, called **cryptocrystallization**, is common inside empty cells and small chambers left by released reproductive structures in coralline algae, as well as inside other similarly small spaces. It is thought that the release of ammonia during the decay of organic matter is responsible for the precipitation of calcium carbonate. In

addition, primary carbonate skeletal material may be extensively recrystallized, especially as aragonite alters to the more stable calcite.

2.5. *Reef promotors*

A large diversity of plants and animals inhabit coral reefs, and make a variety and of contributions to the maintenance and function of the reef ecosystem. An essential component of a healthy reef ecosystem are the **herbivores** - animals which eat mainly plant material. On the actively growing part of the reef, plant material consists almost entirely of algae, both microscopic forms and seaweeds.

The main herbivores on coral reefs are commonly fish and sea urchins, but molluscs such as limpets and chitons, and crustaceans such as amphipods and some crabs, can also have impacts on the structure of the reef ecosystem. If you snorkle or dive on a reef anywhere in the world, as long as it has not been overfished, you will see large numbers of herbivoreous fish foraging along the reef surface. These include parrotfish, surgeonfish, damselfish, rabbitfish, and many others. Sea urchins are usually most abunda[illegible] on the shallower parts of the reef, where their numbers may be so high that one can [illegible] walk on the reef top at low tide without treading on urchins. Most of the herbivor[illegible] particularly fish, probably feed on tiny seaweeds called turf (see page 15) that grows mainly on areas of dead coral and is kept mown by the continual grazing activities [illegible].

Since th[illegible] 1970s, several experiments have been conducted in which herbivores were removed or excluded from areas of reef. In all cases, the experimental areas soon become overgro[illegible]n and smothered by fleshy seaweeds. Thus, reef health depends on the constant rem[illegible]al of algae by herbivores.

Many different kinds of **predators** - animals which consume other animals - also inhabit reefs, and play rôles in promoting a healthy ecosystem. Unlike herbivores, however, their individual and combined effects on the health of the reef have not often been the subject of experimental studies. It is known, however, that reefs on which the predators have been over exploited tend to be dominated by excessive numbers of sea urchins. The sea urchins reduce algal turf, and may prevent the growth of new coral colonies by grazing on newly settled coral polyps.

2.6 *Reef destruction*

The growth of coral reefs is a result of a balance between two competing processes: reef accretion and reef degradation. Just as reef accretion occurs mainly by biological activity with some physical calcification, reef destruction also occurs via biological and physical means. A number of living organisms contribute to the breakdown of reef structure in a process known as **bioerosion**. Types of organisms bringing about bioerosion include:

- borers and burrowers;
- consumers of organisms with calcified skeletons, or organisms which live within calcified material.

Burrowers and borers include fungi, algae, sponges, molluscs, sipunculid and polychaete worms, crustaceans, and sea urchins. Except in certain living organisms, a green, blue-green, red or grey staining within calcareous material is ubiquitous on coral reefs and indicates the presence of boring algae. Most calcareous material, such as coral skeletons and coralline algae, is penetrated by boring algae almost as soon as it is laid down. Despite their ubiquity, and their recognized importance in the erosion of reef material, very little work has been done on these algae, particularly from an ecological perspective.

The most important invertebrate borers are probably the clionid and related sponges, which penetrate pure carbonate substrates such as coral skeletons, shells, and coralline algae. Sponges are thought to dissolve only small amounts of material from the reef but, by weakening the carbonate structure and making it easier to erode, they contribute to the formation of large quantities of coarse silt and fine sand. They may contribute from 2% to 30% or more of the particles making up silt and fine sand in coral reef areas.

Some species of sipunculid and polychaete worms make burrows in reef substratum, creating areas of weakness, and in the process contribute to the susceptibility of reef material to damage from wave action. The main boring molluscs are bivalves, such as *Lithophaga* and *Gastrochaena*. Some bivalves make primary borings, while others settle in previously bored holes and enlarge them as they grow. An assortment of crustaceans can excavate burrows in reef substratum, but the main borers in this group are barnacles of the genus *Lithotyra* which burrow upwards under shallow intertidal ledges.

At least eight groups of fish are consumers of calcareous organisms. The best known of these are the parrotfish, which feed on coralline algae, endolithic algae within coral skeletons, as well as upright fleshy algae and turf. Their contribution to reef degradation and sediment formation is phenomenal, with sediment production values of 0.1-0.2 mm $year^{-1}$ averaged over wide reef areas perhaps being a reasonable estimate. Ogden (1977) estimated that striped parrotfish alone produced 4.6 kg m^{-2} $year^{-1}$ on a reef in Panama. Pufferfish also consume calcareous material since many of them are predators on live coral and may excavate part of the skeleton in the process of feeding. Their contribution to bioerosion is not known, but it is probably less than that of parrotfish.

Sea urchins also feed partly on calcareous substrate, particularly coralline algae, and some may also excavate burrows. Burrowing sea urchins riddle reef substrate with cup-shaped depressions in shallow water in many areas, and may thus weaken the reef material and contribute to further erosion by wave action. Ogden (1977) has estimated sediment production of 4.6 kg m^{-2} $year^{-1}$ for *Echinus* in the US Virgin Islands.

Physical processes of reef destruction are mainly through background wave action, as well as extreme wave surge created during tropical storms (cyclones, hurricanes). Waves pounding against the reef often break loose pieces of coral and other calcareous material, which may then pound against other material causing further

erosion. The effects of tropical storms will be discussed under *Catastrophic mortality* below (section 2.8).

2.7. *Types of reef*

Coral reefs may be divided into four main types: fringing reefs, barrier reefs, atoll reefs, and patch reefs. **Fringing reefs** are generally close to the coast of islands or continents, with or without a shallow lagoon between the reef and the shore. They do not usually extend more than about 500m offshore, but they may reach further from the coast opposite small embayments. **Barrier reefs** and fringing reefs are not distinct entities, but rather they grade into each another. However, a barrier reef is usually defined by a greater distance from shore (e.g. > 1 km) and by having a deeper channel or lagoon separating the reef from the coastline. **Atolls** are more-or-less ring-shaped reefs that enclose a shallow or deep lagoon, and break the surface in deep oceanic water, often far from other land masses. **Patch reefs** are small reefs that usually occur within lagoons behind barrier reefs or within an atoll.

Fringing reefs, barrier reefs, and atolls have common origins (Figure 7). Consider a volcanic island that arises in tropical oceanic water, far from other land masses. Soon after its formation, the island's shallow underwater bedrock would be colonized by hermatypic corals and other reef-building organisms. Soon a fringing reef would form, encircling the island. With time, the land mass sinks, and as it does so, the reef grows upward at the same rate as the land subsides. Since small volcanic islands

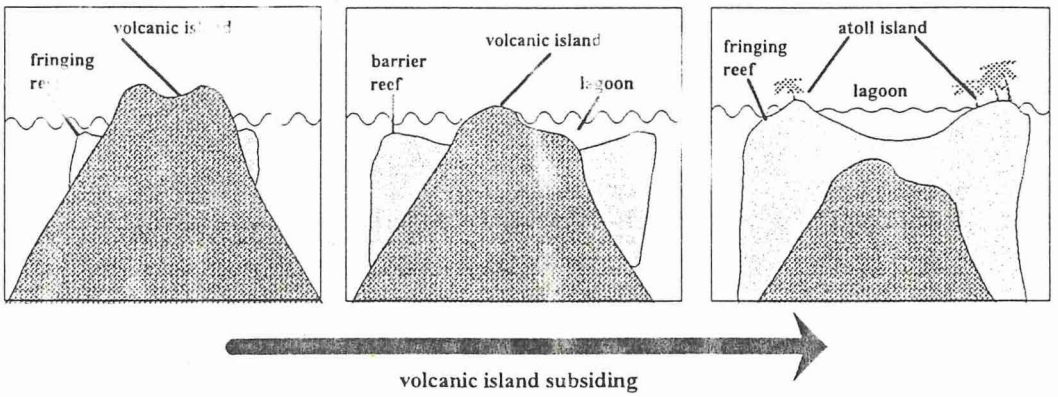

Figure 7. Stages in the development of an atoll reef.

are often cone-shaped, as they sink the distance from the reef to the shoreline increases, and eventually the fringing reef becomes a barrier reef. Eventually the volcanic part of the island disappears beneath the surface of the water, leaving a ring-shaped atoll. Calcareous rubble and sand is continually thrown onto the reef, and can build up land on parts of the reef, and this is why atolls usually have low islands. This theory is known as the **subsidence theory**, and was developed by Charles Darwin following his five-year voyage around the world in the *Beagle*. It is now known that sea-level rise following glaciations can produce a similar effect.

The sequence of development *fringing reef* → *barrier reef* → *atoll* does not apply to all reefs. On large islands and continental margins, subsidence will only produce the sequence *fringing reef* → *barrier reef*, for atolls only develop on small

volcanic islands that are subsiding. Even then, not all fringing reefs become barrier reefs, for not all land masses are subsiding.

Fringing reefs and barrier reefs occur in both the Atlantic and Indo-Pacific regions. The two most extensively developed barrier reef systems in the world are the Great Barrier Reef off northeastern Australia and the Belize Barrier Reef in the Caribbean. Atolls are common features of the Indo-Pacific, but are rare in the Atlantic.

2.8. *Catastrophic mortality*

Most tropical areas where coral reefs occur fall within 25° north and south of the equator. The regions 7-25° on either side of the equator are prone to violent tropical storms, referred to as huricanes, typhoons, or cyclones. Less powerful storms also occur around equatorial latitudes, so most reefs suffer occasional catastrophic mortality from these natural events. Damage to reefs by tropical storms is an important cause of coral mortality, and this mortality plays a key rôle in reef ecology. It might be hard to imagine how catastrophic mortality can actually increase diversity on reefs, but in many cases that is exactly what happens following a severe storm.

In the absence of **disturbance**, a few species often come to dominate parts of the reef. Severe storms create patches where space is available for colonization, and these patches soon become occupied by species that may be different from those that dominate the undisturbed patches. The degree of mortality from, and response to, cyclone damage depends on depth, the reef zone, the time since the last major disturbance, and certain characteristics of the species involved. However, patchy catastrophic mortality to the organisms on the reef generally increases the variety of species as long as the disturbance doesn't happen too often.

> **disturbance** - any relatively discrete event in time that disrupts ecosystem, community or population structure and changes resources, substrate availability, or the physical environment (Pickett & White 1985).

Corals and other calcareous organisms that become broken up during severe storms contribute to the formation of coral rubble, which may accumulate in certain areas of the reef and provide habitat for a number of species that seem to occur predominately in rubble. Some of this rubble is eventually incorporated into the reef as filler material that is cemented together by coralline algae. Some rubble may pile up on the reef, and in some cases can lead to the formation of small islands. For example, a rubble ridge 2-3 metres high and several hundred metres long was deposited on the reef in just a few hours on Upolu in Western Samoa in 1990. Some of the rubble is eventually broken down to sand.

One might think that, because coral reefs are well able to cope with, and may even benefit from severe disturbance, they are easily able to cope with severe human disturbance as well. This is, unfortunately, **not true**, because human disturbance usually occurs persistently and with a high frequency. Severe storms occur irregularly and with a low frequency. Reefs are generally unable to cope with persistent human

disturbance, and may be unable to recover from it for a long time after such disturbance ceases.

2.9. *Coral reef productivity*

The waters that surround coral reefs are **oligotrophic** - very low in nutrients - yet coral reefs rank among the most productive environments on earth. How high productivity levels are achieved despite low nutrient concentrations is a fascinating ecological phenomenon. To understand primary productivity on coral reefs, we need to understand the nature of the primary producers.

nutrients - dissolved inorganic ions found in seawater and sediment that are needed for metabolic processes by plants.

Primary productivity is the amount of organic matter synthesized by photosynthesis in plants. It is usually presented as grammes of carbon synthesized per square metre per day ($gCm^{-2}d^{-1}$). **Gross primary productivity** is the total amount of organic matter produced, while **net primary productivity** is the excess organic matter produced after plants have used some for respiration. Net primary productivity may be used for growth, reproduction, or storage, and is therefore available to drive food chains.

A vast array of primary producers inhabit coral reefs: zooxanthellae, symbiotic dinoflagellates within coral tissues; other endosymbiotic algae in other organisms; filamentous algal turf - fine thread-like algae on dead coral and other surfaces; macrophytic brown, red and green algae; calcified coralline red algae; seagrasses; benthic diatoms; and boring algae in coral skeletons and other calcareous material.

Zooxanthellae within coral skeletons have given production values of the order 985-3723 $gCm^{-2}year^{-1}$ (Kanwisher and Wainright 1967). Coralline algae have given net primary productivity values of the order 240-370 $gCm^{-2}year^{-1}$ on the Indo-Pacific and Caribbean reefs (Marsh 1970, Wanders 1976). Foraminiferans containing algal symbionts can also be important producers, yielding net production values of 157-485 $gCm^{-2}year^{-1}$ in sand patches on the reef (Sournia 1976). Algal turfs are abundant on coral reefs, and are characterised by the fact that they are intensively grazed by fish and invertebrates, and therefore have a very rapid turnover of biomass. By being small and finely branched, they have a large surface area to volume ratio, and live close to the bottom where they accumulate sediment that contains nutrients. Therefore they are efficient users of reef nutrients, and are able to grow very fast. They can have primary production levels in the range 1800-2500 $gCm^{-2}year^{-1}$ in shallow forereef and backreef environments (Littler & Littler 1984).

The total primary productivity of all groups of primary producers on coral reefs is thought to be about 2000-5000 $gCm^{-2}year^{-1}$ (Mann 1982). Maximum productivity values may even reach 12 000 $gCm^{-2}year^{-1}$. This is a phenomenal productivy level, in excess of the highest productivity levels achieved in the best agricultural land even with intense fertilization. It also contrasts markedly with the productivity of the adjacent phytoplankton, which contribute a mere 18-50 $gCm^{-2}year^{-1}$.

A number of features of coral reefs and their biota permit such high production in oligotrophic waters. A considerable fraction of the primary production on tropical reefs is carried out by symbiotic zooxanthellae (Figure 8). While zooxanthellae release some organic compounds to the coral tissue, they also obtain some essential nutrients from the coral, including ammonia, nitrates, phosphates and other metabolites. Thus, the zooxanthellae and coral recycle nutrients within the coral tissue (Figure 8). Further inputs of nutrients to the coral-zooxanthellae system come in the form of plankton and other organic material ingested and broken down by the coral. It is thought that this efficient nutrient cycling system, with additional input from coral feeding, accounts in part for the high productivity of coral reefs (Figure 8). Similar mutualistic symbioses involving other reef organisms (e.g. foraminifera, soft corals, hydrozoans, tunicates) also contribute to reef productivity in a similar way.

The fixation of nitrogen by blue-green algae (Cyanobacteria) also plays a rôle in enhancing reef productivity. Webb and Wiebe (1975) showed that blue-green algae at Eniwetok Atoll, mainly *Calothrix crustacea*, could fix 1.8 kg N ha^{-1} day^{-1}. This nitrogen was transferred to the rest of the community via three main pathways: 1) grazing by fish and invertebrates, and the resulting release of nitrogen by egestion and excretion; 2) the breaking off of algal filaments by wave action and their availability as detritus; 3) the release of dissolved organic matter (including organic nitrogen) by the algae (Mann 1982).

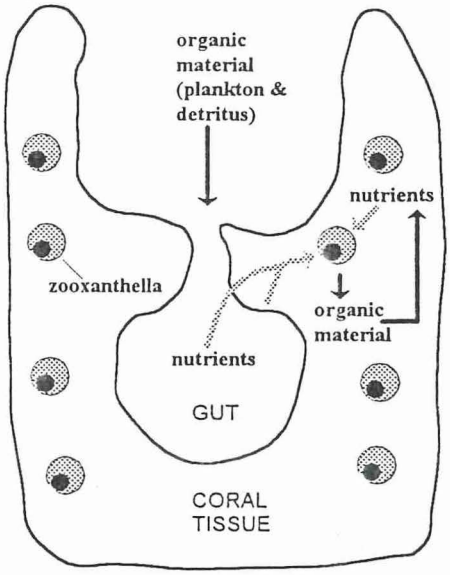

Figure 8. Nutrient cycling and input to zooxanthellae within coral tissues.

Another factor contributing to the high rates of primary production on coral reefs is the interaction between turf algae and herbivores. Continuous grazing by herbivores, particularly herbivorous fish, promotes the development of rapidly growing turf algae, many of whom survive through creeping systems that are close to the substratum and difficult to graze. These thin, hairlike and small-bladed growth forms generally produce creeping root-like (rhizoidal) systems from which the plants are able to regenerate upright parts following grazing by non-excavating herbivores. Because they are small and finely branched, they have a high surface area relative to their volume, and are efficient at the uptake of the nutrients needed for growth. Being thin, they do not carry a heavy load of non-photosynthetic tissue that has its own energy demands, so the products of photosynthesis are efficiently used for growth. Being small, these algae are close to the bottom, and can trap sediment particles that can be mineralized by micro-organisms to yield nutrients. Turfs are also commonly inhabited by nitrogen fixing blue-green algae which contribute nutrients and enhance production.

2.10 *Coral reefs & human affairs*

The importance of coral reefs in human affairs in countries blessed with this natural resource is so vast that only a very simplified treatment can be given here.

Probably the most important function of reefs, from a human perspective, is that they provide a barrier that protects coastlines from the erosive power of wave action and storm surge. Thus they prevent coastal erosion, and particularly reduce the impact of tropical storms on coastal towns and villages. Coral reefs provide shelter to many of the best harbours in tropical regions, thus playing a major indirect rôle in commerce. Many small-island countries (e.g. Kiribati, Marshall Islands, Tuvalu, Maldives) owe their very existence to land built up from the matter produced by the erosion of reef material.

Aside from reef fisheries, reefs provide many other natural resources, including shells, coral souvenirs, black coral jewellery, as well as organisms containing substances of medicinal value. For some countries, such as the Maldives, the only material available for building is coral blocks and sand derrived from coral reefs. In Fiji, coral reef sand is mined, and used for the production of cement for the building industry. Shells and hard coral skeletons are harvested throughout the tropics, and either sold to tourists as souvenirs, or exported as part of the curio trade. Income derrived from the harvest of black coral for jewellery is important in some parts of the world (e.g. Philippines and Maldives), where it is collected and processed for export.

Most tropical inshore fisheries owe their existence to the presence of reefs, and they directly exploit fish and marine invertebrates from the reef itself. Reefs are particularly important to subsistence fisheries, with most coastal villages throughout the tropics being largely dependent on reef resources to meet their protein needs.

While reef catch composes 5-20% of overall fish production in much of Southeast Asia, on smaller islands — especially in the Pacific — reefs may provide directly up to 70% of the catch. It is thought that carefully managed reef fisheries can yield 15 metric tonnes per square kilometre annually. However, attempting to achieve this level of yield without knowledge of local ecological conditions could be a very dangerous strategy. Reef fisheries will be discussed further in Chapter 6.

Perhaps the greatest direct monetary value of reefs is their potential to attract tourists. Tourism has developed rapidly as an industry during the past two decades, and today there are very few tropical countries that do not depend heavily on foreign currency earned through tourism. To a large extent, successful tourism depends on having healthy coral reefs, which are visited by snorkellers, divers, tourists in glass-bottom boats, and sports fishers. Healthy reefs also provide the natural sand input that maintains the white sandy beaches to which tourists are attracted.

2.11. *Threats to coral reefs*

Coral reefs are ecosystems that often receive considerable impact from human activity (Figure 9), and are under serious threat of degradation throughout the tropics. Some of the threats facing reefs involve the direct consumption of reef material, reef builders, or reef helpers. The removal of reef material, mainly for building, is a serious threat to reefs in many tropical areas. This is particularly a problem on low islands where there is often no other material available for use in construction. For example, in the Maldives, coral mining takes place for nearly all construction, and coral rock extracted from living reefs is even used in road building. It has been estimated that 9

446 m^3 of coral rock has been mined over the past 13 years on Male alone. This has already brought about beach erosion, and the transportation and deposition of sand in other areas. Kenchington (1983) reported that a small reef in Male that was once popular with divers had been almost entirely destroyed in only a few years. Brown and Dunne (1986) showed that healthy reefs had live hard coral cover in the range 11-60%, while mined sites had only about 1% live coral cover. Almost all other reef organisms are also reduced or absent in mined areas. They estimated that reefs may take up to 50 years to recover healthy populations of marine organisms, and some reefs may not recover at all. It has been estimated that if the present rate of coral mining continues, the coral supply in Male will be completely exhausted by 2014.

The uncontrolled harvesting of coral for the curio and aquarium trade can also lead to damage to reefs. The Philippines is one of the few countries that still exports vast amounts of coral for the ornamental coral trade. Localized damage has occurred on some reefs, particularly in Cebu (UNEP/IUCN 1988, Vol. 2). There are even reports that up to 75% of the reefs in Philippines are now destroyed or on the verge of destruction. The collection of corals for the curio trade has resulted in widespread damage to reef areas in Kenya, with many of the more popular species probably being overexploited (Brown 1977, Kendall 1984). The relatively uncontrollable nature of the trade in corals and shells to tourists, and the relatively large profits incurred by otherwise poor people, means that careless collecting methods and reef trampling may exacerbate the damage caused by overharvesting.

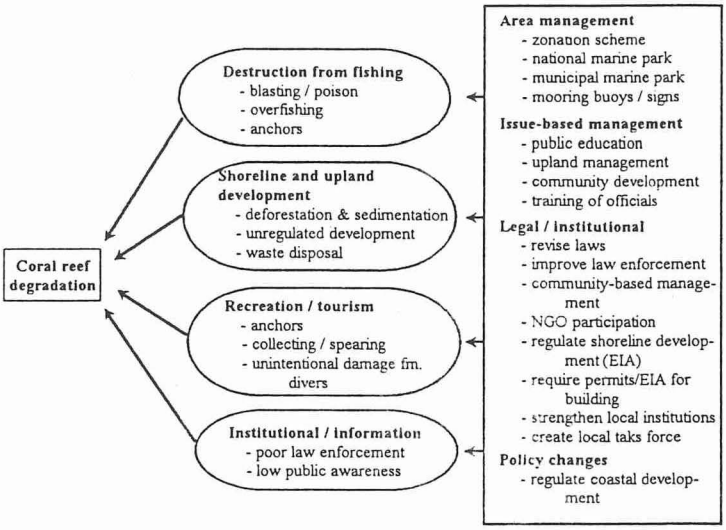

Figure 9. Coral reef management issues and problems in Ban Don Bay, Thailand, together with strategies or management actions to address them [SOURCE: modified after Garces (1992: 41)].

A very serious threat to coral reefs, and probably the most common one worldwide, is the over-harvesting of fish and other living resources of the reef. Although it is well known that many reefs are overfished, the exact effect of overfishing on reef structure is largely unknown. There are many examples where reef species have been overfished, forcing fishers to become increasingly mechanized so they can move further away from their home base in search of more pristine fish stocks. For example, some commercial fishers from the Suva area of Fiji's main island, Viti Levu, make illegal nocturnal forays to the Great Astrolabe Reef in search of species that are no longer abundant in the intensively fished area around Suva.

Differences in the structure of coral reef communities between heavily exploited reefs and marine reserves in Kenya suggest some of the impacts of

overfishing (UNEP/ICUN 1988, Vol. 2). Reefs protected from exploitation have abundant fish, plenty of live coral, and relatively few sea urchins. Heavily exploited reefs have few fish , little live coral, and lots of sea urchins. Abundant sea urchins can prevent the recruitment of hermatypic corals from planktonic larvae, and slow reef recovery, even when the overexploitation of fish ceases.

The use of fish poisons as a harvesting method constitutes a special case of resource over-harvesting because poisons are not specific either by species or by size of fish. As a result, poisons kill juvenile and adult fish equally. The loss of juveniles greatly reduces the production of the resource, and severely curtails future yields to the fishery. Dynamite fishing is even more destructive, as it not only kills juveniles of all species, but also causes considerable damage to the reef itself.

An important non-consumptive threat facing reefs throughout the tropics is pollution. Three main sources of pollution affect reef areas: sewage, siltation, and oil. Sewage threatens reefs in two ways: nutrient enhancement and increases in silt. Since reefs only develop in oligotrophic water, the addition of nutrients by sewage and its effluent can promote the overgrowth of the reef by fleshy algae. The addition of unnaturally high nutrient levels to an ecosystem, and the resulting overgrowth by certain algae that can tolerate high nutrient levels, is referred to as **eutrophication**. Eutrophic waters often suffer oxygen depletion due to the rotting of unusually high quantities of algae, and this can cause widespread kills of reef animals. Reefs which have become eutrophic are effectively 'dead' as far as further reef growth is concerned, until long after the source of pollution is removed.

Siltation from sewage pollution, runoff from agricultural and deforested areas, and improper mine-tailings disposal can produce considerable stress on reef organisms, and in extreme cases may even bury parts of the reef under a heavy load of sediment. Deforestation through logging and from poor agricultural practices, as well as the destruction of mangroves, can produce serious silt-loading of reef waters. Although reef corals have some mechanisms for coping with natural patterns of siltation, excessive sediment loading of coastal waters will produce stress that can eventually kill the coral polyps. Silt can clog the mouths of coral polyps, and prevent feeding and gaseous exchange. It can also shade polyps and reduce rates of photosynthesis by symbiotic zooxanthellae.

The negative impact of siltation on reefs is often exacerbated by the runoff of fertilizers, pesticides, and many other pollutants from the land. Fertilizers can contribute to eutrophication, while pesticides and industrial pollutants can kill reef organisms directly, or reduce their ability to cope with other stresses.

The effects of oil on coral reef areas are fairly well known. The reef flat area, which may be exposed to the air at low tide, is particularly sensitive to physical fouling by the tar-like components of oil. Physical fouling from a single spill is probably far less serious than the widespread toxicity to reef organisms caused by cleanup using chemical detergents.

A number of activities associated with coastal development in the tropics can have negative impacts on coral reef systems. The development of housing, industrial

airport and resort areas on land adjacent to coral reefs inevitably leads to the disturbance of soils, and the runoff of sediment. In many small-island areas, causeways are constructed to join neighboring islands to facilitate human movement among the islands. Their construction, if not well managed to minimize environmental impact, often produces heavy sediment loading of nearby water, as does the construction of coastal roadways and bridges.

The recreational use of coral reefs, if not properly monitored and controlled, can be as deleterious as any other human activity. The sediment loading from runoff and sewage disposal problems mentioned earlier are but two of the harmful effects of uncontrolled tourist development. Dredging for marinas associated with resort development can also contribute to sediment loading, and alter water circulation patterns.

Recreational users themselves, mainly tourists, can have tremendous impact on reefs. Boats which ferry divers to the best dive sites can increase sediment loading by resuspending sediments within the lagoon if it is shallow, as is the case in the Florida Keys, USA. Large numbers of boats create pollution in the form of outboard exhaust, although this is really only a serious threat in grossly overdeveloped areas such as the Florida Keys. Inexperienced boat handlers who are unfamiliar with water depth patterns may run aground on the reef, causing coral breakage, but again this is only a serious problem where there are exceptionally high numbers of recreational boats.

A more serious problem is anchoring on the reef. Anchors can damage coral colonies when they land on them, but more damage is probably done by anchor dragging and the movement of the chain that is usually attached to small boat anchors. Anchoring in areas without coral is certainly less damaging to the reef, but may disrupt other habitats such as seagrass beds or rubble. The most effective solution to anchoring problems is simply not to anchor at all, or to have permanent moorings installed at frequently visited sites.

Divers can also damage reefs independently of the damage caused by their boats. The biggest problems are a lack of awareness of protruding gear that can snag delicate corals and break them, poor buoyancy control, and lack of awareness of fin position. A few divers, unaware of the importance of organisms, even dead ones, in the ecology of the reef, break corals or take shells as souvenirs. In areas that are dived intensively, this can represent a real threat to the health of the reef.

Tourists also provide a ready market for pieces of coral, shells and other souvenirs taken from the reef by the local inhabitants. Some of the animals which produce the most beautiful shells are important predators or grazers on the reef, and play vital rôles in the maintenance of a healthy ecosystem. While the gathering of curios can be a valid source of income for villagers in resort areas, if it is not managed for sustainability, this activity can lead to reef degradation.

Coral bleaching is a phenomenon that has captured some media attention in recent years. Bleaching is the loss of endosymbiotic algae by corals and other invertebrates, usually considered a stress response to a variety of environmental perturbations such as extremes of light, temperature and salinity. Coral bleaching has

apparently been increasing throughout the tropics in recent years, and many biologists believe that it is a result of increasing global temperatures. However, many environmental stresses are known to cause bleaching, and there have even been cases of bleaching as a result of unusually *low* temperatures. The immediate causes of individual bleaching events are almost impossible to determine, but it does seem likely that stresses associated with human-induced environmental modifications in the sea are involved in at least some of the reported instances.

Many coral reefs over much of the Indo-Pacific region have been attacked at some time during the past 20 years by outbreaks of the crown-of-thorns starfish (*Acanthaster planci*). This starfish feeds on the coral polyps of live corals, and leaves dead, bleached skeletons in the wake of its passing. In some areas, massive 'herds' of *Acanthaster* have been known to move along reefs, or from reef to reef across sandy bottom, at rates of 3 km per month. In other areas, however, low densities of *Acanthaster* are present on the reef and do little damage. The cause of *Acanthaster* outbreaks, and why some areas are affected and other are not, remain unknown, although several possible causes for the infestations have been suggested. These include:

- pollution
- overfishing of reef fish
- overharvesting of triton shell
- recurring natural cycle
- related to freshwater runnoff which increases nutrients and phytoplankton production and hence larval survival.

There is some evidence for and against all of these possibilities, and the real cause of *Acanthaster* aggregations remains unknown. However, it seems unlikely that all outbreaks have the same immediate cause. Nevertheless, the possibility cannot be ruled out that such population explosions may be related to the combined effects of many forms of human impact on the marine environment.

The death of large tracts of reef corals may not necessarily be entirely negative, and *Acanthaster* explosions certainly reset the clock in terms of the composition of the reef community. When the corals have been killed over a large area by *Acanthaster* feeding, the typical reef fauna disappear, and the coral skeletons are soon colonized by opportunistic fleshy algae, and later by soft corals and other invertebrates. Coralline algae soon colonize, and begin to form a solid cap over the dead coral skeletons. It may take several years, but eventually new hermatypic corals begin to settle on the coralline algae encrusted skeletons, and the reef begins to look more like it did prior to *Acanthaster* infestation. However, many years are required for a full recovery to coral domination in the active reef zone.

2.12. *Summary of management implications (coral reefs)*

1. Coral reefs are important for a number of ecological and economic reasons, and therefore their conservation (wise use) should be considered a priority in coastal zone management.

2. In many areas, coral reefs are dependent on mangroves and seagrasses for their continued existence as healthy, productive ecosystems. Therefore, managers should strive to maintain healthy mangroves and seagrass beds in areas where they exist behind coral reefs.

3. The recovery of reef areas that have been killed by sewage and other types of pollution should be encouraged through improved treatment and removal of the effluent outfall to deeper water.

4. The use of fish poisons and dynamite should be banned, and programmes to educate village fishers as to their negative effects on sustainability of reef resources should be implemented.

5. In granting permission for the development of tourist resorts, coastal planners must ensure that sediment production during development is controlled, proper sewage treatment and disposal is incorporated at the design stage, diving activities will not be allowed from anchored boats except if those boats are tied to permanent moorings, and that dive-tour operators will teach reef etiquette to all divers using the resort's facilities.

6. A conservation levy should be collected from the patrons of coastal resorts and used to provide funds for conservation measures, including enforcement as well as public and diver education about key issues concerning reef and other coastal environments.

7. Coral reef areas should be set aside or incorporated into reserves or national parks to ensure the long-term conservation of some coral reefs in a natural state, against which human impacts in other areas can be assessed.

8. Removal of the pamphlet and small notices that are included with this book, having them copied, and then distributing them via all tourist operations taking divers for recreational dives on coral reefs would be a contribution towards minimizing diver-related damage.

CHAPTER 3
Seagrass Beds

OBJECTIVES

When you have completed this chapter you should:

- be able to recognize and characterize the seagrass bed ecosystem
- be able to state the main adaptations of seagrasses to life in the seagrass environment
- be able to characterize the rôle of algae in seagrass beds, and discuss the limitations of this knowledge
- be able to characterize the fauna of seagrass beds, including epifauna, surface fauna, infauna and migratory fish
- be able to state the ecological and socioeconomic importance of seagrass beds
- be able to state the main human threats facing seagrass beds
- be able to state the natural-resource management implications of your knowledge of seagrass beds.

BACKGROUND REQUIRED

The following background knowledge will greatly facilitate your understanding of the material in this chapter.

- basic knowledge of the nature and structure of coral reefs
- the concept of nutrients as applied to plants in the sea
- the concept of primary productivity
- the sea as a salty medium (salinity)
- the concepts of ocean waves, sea swells, wave action and shelter from wave action
- the nature of mud.

STUDY QUESTIONS: Seagrass Beds

These study questions are provided to guide your study, and should be answered as you study the readings and other material provided with this course. It is a good idea to write out the answers to these questions in a notebook, and to include illustrations as much as possible. These answers will serve as your study notes for this course.

> **HINT:** Wherever possible, try to organise your answer using a concept map, flow chart or other non-linear format.

1. What are seagrasses?
2. Under what environmental conditions would you expect the extensive development of seagrass beds?
3. List five requirements for an angiosperm to be able to exist in the marine environment, and state how seagrasses meet these requirements.
4. What rôle do algae play in seagrass beds?
5. What are the main types of animals present in seagrass beds?
6. List the main ecological functions of seagrass beds, and state what features of seagrasses allow them to perform these functions.
7. Describe the fate of energy fixed by seagrasses and associated algae in the nearshore ecosystem.
8. Explain why seagrass beds are important in human affairs.

Keywords: community, detritus, dissolved organic matter, epiphyte, food web, hydrophilous pollination, infauna, meiofauna, primary productivity, rhizome, seagrass.

3. *Seagrass Beds*

3.1. *Environmental features*

Seagrass beds are major features of both temperate and tropical seas throughout the world, but they are best developed and most diverse in the lagoonal systems that are associated with coral reefs. Seagrass dominated communities occur in both the intertidal and subtidal zones within lagoonal systems, although they are usually more lush in the subtidal zone.

Seagrass beds form dense carpets with as many as 4000 plants or upright parts per square metre. While seagrasses may occur to depths of 60m, in most areas seagrass beds are only well developed in relatively shallow water. Seagrasses occur on all types of substratum, from fine mud through sand to bedrock, and may be found in sheltered sites as well as places exposed to the full onslaught of ocean waves. Seagrass beds, however, are best developed on poorly sorted muddy sand or sandy mud bottoms in areas sheltered from the full force of wave action, and they may occur under estuarine as well as fully marine conditions.

3.2. *Seagrasses and their adaptations*

Seagrasses are monocotyledons that are not true grasses (true grasses belong to the family Poaceae), but are rather more closely related to the lily family. There are about 48 species of seagrass which fall into two families: the Hydrocharitaceae (3 genera and 14 species) and the Potamogetonaceae (9 genera and 34 species) (Table 1). The greatest number of species (c. 75%) occur in the Old World, with the highest concentration of species in the Indo-West Pacific region. One of the most important features shared by all seagrasses is their adaptation to submergence in salty water.

Table 1. Families and genera of seagrasses and their distributional areas.

Family	Genus	Main distributional area
Hydrocharitaceae	*Enhalis*	Indo-West Pacific
	Halophila	Tropical, temperate Australia, introduced to Mediterranean
	Thalassia	Tropical
Potamogetonaceae	*Amphibolus*	Temperate Australia
	Cymodocia	Mediterranean, Indo-West Pacific
	Halodule	Temperate Australia & Chile
	Heterozostera	Mediterranean, Australia
	Posidonia	North Pacific temperate
	Phyllospadix	Tropical
	Syringodium	Indo-West Pacific
	Thalassodendron	Temperate zones
	Zostera	

Arbor (1920) and den Hartog (1970) listed five requirements for an angiosperm to be able to exist in the marine environment:

- adaptation to life in saline (salty) medium
- growth when completely submerged
- anchoring system able to withstand the forces of wave action and tidal currents
- hydrophilous pollination (pollination aided by water)
- successful competitors in the sea.

Many physiological, anatomical and morphological characteristics of seagrasses are adaptations to meet these five requirements.

The need for physiological adaptations to life in a saline medium is obvious when one considers that seagrasses evolved from land plants, and most land plants are unable to tolerate even small quantities of salt. In contrast to land plants, some sea grasses can tolerate a salinity range from 0 parts per thousand (°/oo) to 93 °/oo (3x seawater concentration). Not all species tolerate all salinities equally well, and differential salinity tolerance may be a factor promoting different species distributions along salinity gradients, for example, going up estuaries or in an area with a gradient of increasing soil salinity resulting from variation in evaporation rates.

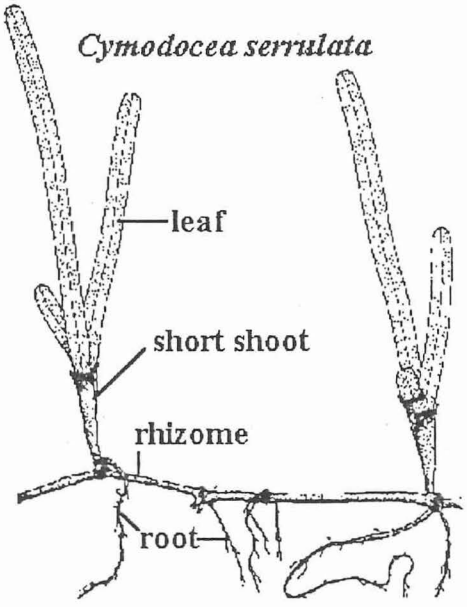

Figure 10. Growth form of typical seagrass (Source: **Phillips, R.C. & Meñez, E.G. 1988. Seagrasses.** ***Smithson. Contrib. Mar. Sci.*** **34: 1-104).**

Since they are often present in areas with some degree of water motion due to wave action or currents, seagrasses need an appropriate anchoring system. They have well developed horizontal stems called **rhizomes** (Figure 10), which usually occur below the substratum and in close association with one another (Dawes 1981). Two ranks of leaves may arise directly from the rhizome, or from small erect branches off the rhizome called **short shoots** (Figure 10). Roots are abundant and develop on the rhizome as well as on the lower parts of the short shoots. The combination of rhizome and roots serve as anchorage and for the uptake of nutrients.

Leaves are well adapted for submerged growth. They are flat, ribbon-shaped, or cylindrical in cross section and are generally soft and pliable. As is common in hydrophytes (plants which grow in the water), the leaves, rhizomes, short shoots, and roots are well endowed with **aerenchyma**. Aerenchyma is specialized tissue having a regular arrangement of air spaces, called **lacunae**, that both give flotation and permit gas exchange throughout the plant. Leaves have a very thin cuticle, which allows gas and nutrient diffusion into them from the surrounding water.

Seagrasses have flowers and pollination systems that are well adapted for pollination by water. In most genera, pollination takes place under water by pollen grains which are elongated into a filamentous shape. The filamentous nature of pollen grains facilitates transport within the water medium. *Halophila* and *Thalassia* have spherical pollen grains, but they remain joined together in long chains, giving the same effect as having elongated, filamentous pollen grains. In most species, flowers are small, white and are borne at the base of the leaf clusters. The stamens (male parts) and pistils (female parts) extend above the petals to facilitate pollen release and pollination respectively.

A number of features of seagrasses give them a competitive edge, particularly in muddy and sandy habitats. The anchoring function of the rhizomes and roots has already been noted. Most seagrasses persist and recover from disturbances by vegetative growth. Rhizomes often develop in close proximity to one another, and create a tangled mat that is difficult to remove. So stable are these tangled mats of seagrass rhizomes that they may even resist damage during tropical cyclones (hurricanes).

3.3. *Algae of seagrass beds*

A large variety of micro- and macroalgae occur in seagrass beds, either attached to the seagra blades, to small stones, to animal shells, anchored in the sediment by rhizoid mas s, or free-living on the bottom. Larkum (1977) reported over 100 species of a gal ep: hytes on two species of seagrasses in Australia, with *Ulva lactuca*, *Colpom nia sin osa*, *Ectocarpus confervoides*, and *Laurencia obtusa* being the most abunda t species. Harlin (1980) recorded over 450 species of macroalgae that can occur as sea grass epiphytes. McRoy and McMillan (1977) noted that the ecology of algae in s agrass beds was little studie and this remains true today, particularly as far as pr mary production ecology is con erned.

Algae can amount to as much as 52-96% of the standing stock in seagrass areas, with values within the range 10-50% of macrophyte biomass being common (McRoy & McMillan 1977). From my experience of diving and snorkling in seagrass beds in the Caribbean Sea, the Atlantic, Indian, and Pacific Oceans, and the Mediterranean Sea, I would estimate that algae growing among the seagrass, but not attached to it, can commonly account for up to half of the plant biomass. Therefore, the contribution of macroalgae to the total production of seagrass beds must be substantial.

A number of studies have tried to estimate the productivity of algae associated with seagrass beds, but most have given uncertain results. One of the best of the ear studies was by Jones (1968), whose results suggest annual net production values f 200 g C m^{-2} $year^{-1}$ for **epiphytes** on *Thalassia* in Florida, USA. This is about 20% f the net production for tropical seagrasses themselves. How this figure would chan e by the incoprporation of other algal associates of seagrass is not known.

Thin crustose coralline red algae that are epiphytic on the leaves of seagrass s and associated algae in some areas can be important producers of carbonate sediment. Walker and Woelkerling (1988) showed that a calcium carbonate standing stock c

200 g m^{-2} or 200 tonnes km^{-2} was present in epiphytes on seagrass blades in Shark Bay, Australia. Carbonate production by seagrass epiphytes in Shark Bay corresponded to an increase in sediment depth of 0.5 mm y^{-1}. Since these epiphytic corallines are thin, fast-growing, and turn over rapidly, they may well be among the most prolific calcium carbonate producers known.

3.4. *Seagrass fauna*

Seagrass beds provide habitat for many species of invertebrates and fishes. Numerous invertebrate species occur on the leaves of seagrasses, with Harlin (1980) providing a list of 180 species that have been recorded as epifauna. Of particular significance among the seagrass epifauna are the **meiofauna**. These are small animals, mainly crustaceans and nematodes, between 63 μm and 1 mm in length. They are often important components of the diets of juvenile fish, and other fish with small mouths, and may be part of the reason seagrass beds are used as nursery areas for some species.

Several invertebrate species are infaunal within the mud of the seagrass bed. These include a variety of polychaete worms, bivalve molluscs, and other burrowing organisms. In Fiji, the bivalve mollusc, *kaikoso* (ark shell - *Andara cornea*), is harvested by women who roam the seagrass beds and mud flats at low tide.

Many invertebrates occupy the mud surface among the seagrass blades, or spend at least part of their time on the mud surface and part of their time buried. Several species of sea urchins inhabit the mud surface within seagrass beds, and one species in particular, *Tripneustes gratilla*, is harvested for local consumption throughout the tropical Pacific where is is often considered a delicacy. Upsidedown jellyfish, *Cassiopea* sp (known as *drose* in Fiji), is a sessile medusa that is common among intertidal seagrass beds, and is collected in some areas and eaten as a delicacy. In Fiji, the sea hare (*veata* - *Dolabella auricularia*) inhabits shallow seagrass areas, where it spawns among the seagrass leaves. It is harvested, and some of its internal organs are removed for consumption as a delicacy. Its egg masses are also collected and consumed as *se ni kavere*.

A number of fish species predominate in seagrass beds, perhaps the most common types of economic significance being the mullets. Sand sharks, flatfish, skates and rays, and many others also occur. Pipefish are common inhabitants of the seagrasses themselves, where they feed primarily on epiphytic meiofauna. Several reef fish make use of adjacent seagrass beds as a nursery area during their juvenile stages.

3.5. *Seagrass beds and human affairs*

From the results of scientific investigations in both tropical and temperate areas, it is known that seagrass beds serve a number of important ecological functions:

- trap and stabilize bottom sediments, and increase water clarity
- high primary productivity
- direct food source for many animals, including some commercial species
- provide detritus to the food web

- habitat for many species of fish, invertebrates and algae, including epiphytic species
- act as nursery areas for the juvenile stages of species which are ecologically important or are commercially harvested in other ecosystems
- nutrient stripping
- provide organic matter to initiate sulfate reduction and an active sulfur cycle.

The trapping and stabilization of bottom sediments, and the consequent increase in water clarity is an important ecological function. Clearer waters improve light penetration, and consequently increase photosynthesis and rates of organic matter production. Sediment trapping contributes to coastal accretion, while sediment stabilization helps prevent coastline erosion, especially under storm conditions. The removal of terrigenous (originating on land) sediment from lagoonal and estuarine water is a very important function of seagrasses, and may be essential in some areas to allolw sediment-sensitive corals to exist on adjacent reefs.

The **primary productivity** of seagrass ecosystems and their contribution of organic matter to inshore food webs are substantial. Many studies have reported **net primary productivity** values in the range 2-18 $gCm^{-2}d^{-1}$, with tropical and subtropical lagoons showing the best productivity values. It is difficult to assess the actual net productivity of seagrass beds, including their associated and epiphytic seaweeds, but Mann (1982) suggests annual net productivity values of around 1000 gCm^{-2} for tropical seagrass beds. The food value of this production to marine animals is substantial, and much of it enters coastal food webs, many of which include humans.

A number of animals use seagrass biomass directly as food. The main direct grazers of seagrass and associated algae are probably amphipods, sea urchins, parrotfishes, some surgeonfishes, ducks and geese, sea turtles, manatees, and dugongs. Dugongs use their snouts to shovel out clumps of seagrass, and create open patches within the meadow. Much of the primary production of seagrass beds, however, passes through food chains based on detritus and dissolved organic matter (DOM). In this respect, herbivores may be important as initiators of the detrital pathway, since they often damage seagrass blades, which are then lost as a result of water motion.

As seagrass leaves die and are broken off, they are colonized by bacteria and fungi which begin the process of decomposition (Figure 11). Leaves are then colonized by microfauna and meiofauna which feed on the bacteria and fungi, as well as on dissolved organic matter released by the decomposing leaves. The leaves are eaten by detritivores, whose main nutrition comes from digesting the microbiota, microfauna, and meiofauna. Detritivores provide food for a variety of fish and invertebrates, and in this way much of the animal life in the seagrass bed is supported by detrital energy pathways in the food web.

Decaying leaves, as well as consumers at all levels, release dissolved organic matter into the water. This DOM supports planktonic microorganisms and promotes the growth of some phytoplankton. Microorganisms and their predators contribute to the planktonic food web, and help support the suspension feeders, such as infaunal bivalve molluscs, in the seagrass bed. Energy, biomass, and nutrients are also exported from the seagrass bed into adjacent ecosystems as DOM as well as floating leaves and leaf particles in the currents which flow over the bed, and by animals which migrate through the area during foraging.

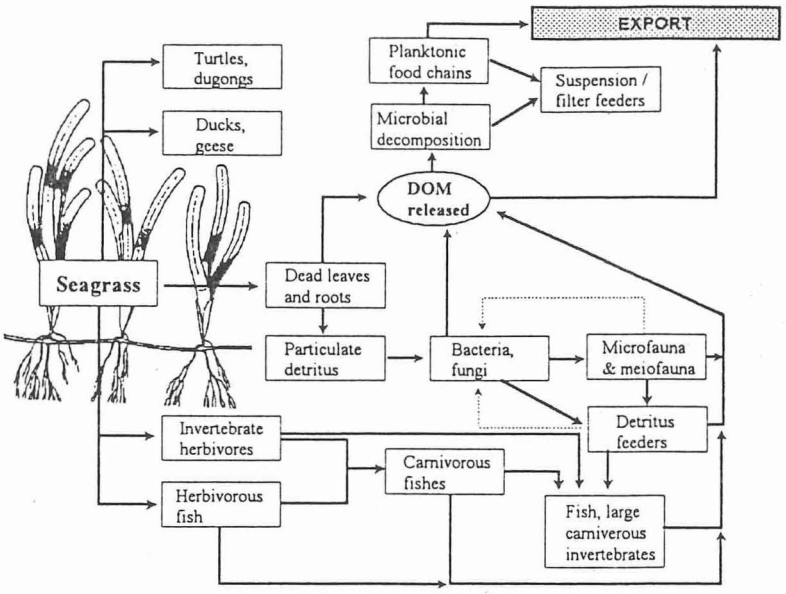

Figure 11. The fate of primary production by seagrasses in the seagrass ecosystem.

The importance of export from seagrass beds becomes particularly evident when one considers that Menzies *et al.* (1967) found 48 blades and fragments of *Thalassia* per photograph taken in 3160m of water, 500 to 1000km from the nearest seagrass bed. High densities of seagrass leaves have also been recorded in other deep-water areas, suggesting that the import of energy from seagrass beds may be important in food webs even in the deep sea.

A number of features of seagrasses contribute to their important function as habitat. The leaves provide a high surface area, and suitable attachment sites for epiphytic algae and invertebrates, including the important epiphytic meiofauna. The dense growth of seagrass leaves reduces water movement by currents and waves, and this creates relatively calm conditions at the level of the bottom. The shading of the bottom by the overstorey of leaves protects the bottom from excess solar radiation, and thus offers microhabitat to some shade-adapted or light-sensitive species. Seagrasses produce large amounts of O_2, and although O_2 is used up during decomposition, O_2 production may make seagrass beds suitable for high densities of some animal species. Finally, the food value of seagrasses and detritus derrived from them is able to support high densities of animals.

Seagrass ecosystems are important as nursery areas for the juvenile stages of species which are ecologically or commercially important in other ecosystems. For example, the commercially harvested shrimp, *Panaeus duoranum* in southern Florida, USA spends some of its early life in seagrass beds. Anyone who snorkles or dives in a seagrass bed will be well aware of the abundant juvenile fishes of many different kinds that find food and shelter there.

Seagrasses have an enormous capacity to strip nutrients from seawater and surface sediments. Water of terrestrial origin often contains high levels of nutrients leached from agricultural soils. The passage of nutrient rich water over seagrass beds reduces the nutrient content and this may contribute to the low nutrient conditions necessary for healthy coral reef ecosystems in adjacent areas. Nitrogen fixation also occurs by microorganisms associated with seagrass leaves and roots. Most seagrasses are able to take up nutrients from sea water at very low levels and this feature, in combination with associated nitrogen fixation, gives them the ability to grow well even in nutrient poor water.

Seagrass Threats

There is a lack of information on the overall condition of seagrasses. However, various studies indicate that they are being threatened in some areas. Major threats to seagrasses are water pollution by industrial wastes, thermal discharge and petroleum product spills, bottom trawling and dredge and fill operations.

Studies done in Australia indicate that seagrasses are very vulnerable. Industrial development and consequent discharge of effluent by a fertilizer factory between 1954 and 1978 resulted in 79 per cent loss of the seagrass population in Cockburn Sound in Western Australia. Dredge and fill operations caused a 65.4 per cent loss at Princess Royal Harbour and a 41 per cent loss at Oyster Harbour.

Source: *State of the Environment in Asia and the Pacific 1990*, UN Economic and Social Commission for Asia and the Pacific, Bankok, Thailand

3.6. *Threats to seagrass beds*

Although seagrasses are not harvested for human consumption, they face a number of threats as a result of human activity. These include:

- pollution from industrial and agricultural sources, as well as from sewage disposal
- dredging
- disposal of mining wastes
- sediment movement from boat propellors
- disruptions of ecological interactions as a result of overfishing
- fishing by draging (trawling) and hydraulic dredging

Seagrasses are abundant in shallow areas, and because they trap sediment particles, pollution tends to accumulate within seagrass beds. Because industrial and sewage pollution usually occur in areas subjected to dredging and other disturbances from excess sediment, it is generally impossible to separate out the impact on seagrass beds from either of these sources. In Tampa Bay, Florida, USA, about 80% of the seagrass stands were lost between 1880 and 1980, mainly as a result of increasing **turbidity** and toxicity of the water associated with tremendous increases in human populations, urbanization, and industrialization (Lewis *et al.* 1985).

Dredging shallow areas is often necessary to allow the shipping of cargo to coastal cities, and cities upstream along major rivers. This greatly increases the **sediment loading** of coastal waters. Phillips and Meñez (1988) cite studies which showed that dredging shallow bays in Florida, USA, where large seagrass beds occurred, disrupted the ecology of the area and resulted in erosion, siltation, and

increased sediment loading in water remote from the dredging site. In Fiji, coral sand is dredged from the Suva lagoon for use in the manufacture of cement. While this causes the destruction of seagrass beds in the dredged areas, and sediment erosion in the surrounding stands of the seagrass, *Syringodium isoetifolius* (UNEP/IUCN 1988), the wider effects of sand mining are not known.

The increase in human populations, and the increased agricultural development, urbanization, and development of coastal resorts have all contributed to increased sediment loading in rivers and coastal waters. Undoubtedly, this has increased the stresses on seagrass communities, and contributed to their overall decline in populated areas. Another source of sediment and toxicity in coastal waters is the disposal of mine waste, which often finds its way into rivers and is washed down to the sea (See Box, page 47).

In some areas, such as the Florida Keys, USA, the amount of boat traffic crossing the lagoon behind the offshore barrier/bank reef is such that vast quantities of sediment are resuspended within the seagrass beds that occupy the lagoon. This not only places stress upon the seagrass beds, but also contributes to the degradation of nearby coral reefs.

Ecological disruptions as a result of overfishing have probably affected seagrass beds in many areas, but such disruptions are almost impossible to identify, and the cause is even more difficult to prove. A number of cases have been reported of population explosions by sea urchins that have caused local destruction of seagrass beds by overgrazing. This makes it tempting to speculate that this was caused by overfishing urchin predators; however, the exact causes of such urchin outbreaks are almost impossible to pinpoint with any certainty.

Trawling within seagrass beds can be a major source of mortality to seagrasses in some areas. Shrimp trawling often takes place within seagrass beds, where it can disrupt seagrass beds directly by uprooting or breaking plants, as well as destroying the burrows of some seagrass dwellers. Sediment resuspension also occurs during trawling. In some places, the same area of bottom may be trawled as often as 10 times in one year. In the Washington State, USA, trawling in seagrass (*Zostera*) beds has been prohibited for several years, but most other places trawling in seagrass beds is permitted.

Summary of management implications (Seagrasses)

1. Seagrass ecosystems are important for a number of ecological and economic reasons, and therefore their conservation (wise use) should be considered a priority in coastal zone management

2. Seagrass beds are sensitive to changes in sediment transport patterns. Therefore, any coastal developments which might change sediment transport patterns should be considered by planners, and ways should be sought to minimize the damage of such developments to seagrass beds. In particular, means of preventing the increase in sediment loading of coastal waters should be sought.

3. Seagrass beds and their associated fauna are sensitive to certain pollutants, especially herbicides, industrial wastes, and contaminated sewage. Coastal developments should be planned in such a way as to minimize damage to seagrass beds from these sources.

4. Seagrass areas should be set aside or incorporated into reserves or national parks to ensure the long-term conservation of some seagrass beds in a natural state, against which human impacts in other areas can be assessed.

CHAPTER 4
Mangrove Forests

OBJECTIVES

When you have completed this chapter you should:

- be able to recognize and characterize the mangrove ecosystem
- be able to state the environmental factors required for mangrove forest development
- be able to state the common adaptations of mangrove trees to the mangrove environment
- be able to discuss the rôle of algae in the mangrove ecosystem
- be able to describe and discuss the fauna of mangrove forests
- be able to state the ecological and socioeconomic importance of mangroves
- be able to characterise the main human threats facing mangrove ecosystems
- be able to state the natural resource management implications of your knowledge of mangrove forests.

BACKGROUND REQUIRED

The following background knowledge will greatly facillitate your understanding of the material in this chapter:

- the concept of nutrients as applied to plants in the sea
- the sea as a salty medium (salinity)
- the concept of tides
- the concepts of ocean waves, sea swells, and wave action.

STUDY QUESTIONS: Mangrove Forests

These study questions are provided to guide your study, and should be answered as you study the readings and other material provided with this course. It is a good idea to write out the answers to these questions in a notebook, and to include illustrations as much as possible. These answers will serve as your study notes for this course.

HINT: Wherever possible, try to organise your answer using a concept map, flow chart or other non-linear format.

1). List the environmental conditions necessary for the development of mangrove forests.
2). Describe the common adaptations of mangrove trees to life and dispersal in the mangrove environment.
3). Describe the importance of algae in mangals.
4). List as many animal types as you can that are found only in mangrove areas.
5). Distinguish between the consumptive and non-consumptive importance of mangroves.
6). In your notebook, draw and complete the table below giving the consumptive and non-consumptive importance of mangroves

Consumptive uses of mangroves	non-consumptive importance of mangroves

7). Evaluate the socioeconomic importance of mangroves in the area in which you live or work.
8). What fisheries in your area depend on mangroves directly (i.e. are carried out mainly within the mangrove ecosystem) and indirectly (i.e. are carried out in other ecosystems for species that spend at least some of their lives within the mangrove ecosystem).
9). List the main threats to mangroves, worldwide. Identify threats to mangroves in the area in which you live or work.
10). How are mangroves managed in your area, and what can be done to improve mangrove management?

Keywords: convergent evolution, dissolved organic matter, export (energy), lentic, mangrove, mangal, mangrove forest, nursery habitat, pneumatophore, salinity, vivipary, xeromorphic.

4. Mangrove Forests

4.1. *Environmental features*

Mangrove forests, or swamps as they are sometimes called, are major features of tropical seas worldwide, occupying approximately 160 000 km^2. These forests require certain environmental conditions for their occurrence. Although a few mangrove trees can occur even on rocky shores in the tropics, a soft muddy bottom is a must for the development of extensive mangrove forests. Rivers carry silt-laden water down to the coast, where much of it settles out in estuaries, providing the ideal muddy environment for mangrove trees to take root. They usually do not penetrate a long distance up the river, because as the salt content (salinity) of the water decreases, they cannot compete with plants better adapted to fresh water. Mangroves are not just found in estuaries, however, for the most extensive mangrove forests develop along the coast behind a coral reef. Mangrove ecosystems are also referred to as **mangal**, which may be defined as forests and their associated biota occurring below extreme high water mark, structurally dominated by trees, shrubs and with a few non-woody herbacious plants and vines (after Morton 1990). According to Dawes (1981), the word mangrove is derrived from a combination of the Portuguese word for tree (*"mangue"*) and the English word for a stand of trees ("grove").

Mangroves need protection from the full onslaught of ocean waves, so they are only found in areas that are relatively sheltered from wave action. It is for this reason that they occur most commonly behind the protection afforded by the coral reefs that are found just off most tropical coastlines. Fringing reefs, barrier reefs, or atoll reefs surround most land masses in the South Pacific and afford the protection necessary for the development of mangrove forests along the neaby coastline. Thus, mangrove fringed islands and islets are a characteristic feature of the region.

All species of mangrove trees require warm water temperatures, hence their confinement to the warmer tropics and subtropics. Where ocean currents bring warm tropical water to higher latitudes, mangrove trees usually penetrate further into the subtropics than coral reefs, so in some areas they may occur without the protection from wave action afforded by reefs. In such cases, mangroves are almost exclusively restricted to estuaries and very sheltered embayments. For example, along the African coast mangrove trees occur well south of the tropic along the coast of Transkei, South Africa. In this region, however, coral reefs do not occur and mangrove forests are purely an estuarine phenomenon.

For a number of indirect reasons, mangroves also require tidal action. The tides inundate the mangrove soil with sea water, and this excludes other plants which might otherwise outcompete the mangrove trees. Tides also bring in nutrients and stir up those trapped in the sediments, and in so doing help the mangrove trees meet their nutritional requirements. In additiion, tidal action carries sea water up estuaries, thereby helping the inland penetration of mangrove forests and their inhabitants.

4.2. *Mangrove trees and their adaptations*

There are 13 genera in 11 families of mangrove trees worldwide, including one palm (Table 2). All families are represented by a single genus except the Rhizophoraceae, which has three genera. Biogeographers divide mangroves into two broad categories: the richer Old World mangals (Indo-West Pacific) with c. 60 species, and the New World mangal with c. 10 species. In the Indo-West Pacific region there is a gradient of species richness eastward and westward from the Malaysia-Indonesia archipelago. In the South Pacific, the Solomon Islands have 12 species, Fiji has 8 species, Tonga has 5 species, and Western Samoa has only 2 species (Figure 12). Further east, mangroves are absent altogether (e.g. Cook Islands, French Polynesia).

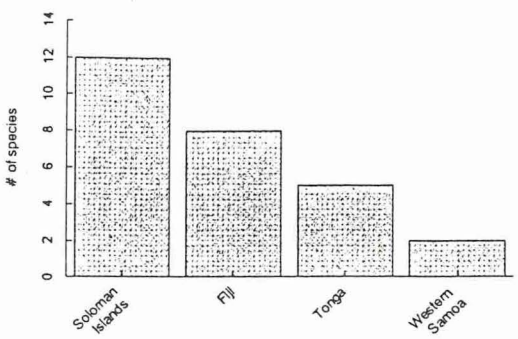

Figure 12. Number of mangrove species for selected South Pacific countries along a west-east gradient.

Table 2. Families and genera of mangrove worldwide, including their growth form (after Morton 1990).

Family	Genus	Growth forms
Rhizophoraceae	*Rhizophora*	medium to large trees
	Bruguera	mainly tall trees
	Ceriops	large shrubs & small trees
Avicenniaceae	*Avicennia*	trees or shrubs
Sonneratiaceae	*Sonneratia*	bushy trees
Combretaceae	*Lumnitzera*	slender trees
Meliaceae	*Xylocarpus*	large shrubs or trees
Myrsinaceae	*Aegicera*	large bushes or trees
Myrtaceae	*Osbornia*	bushy shrubs
Rubiaceae	*Scyphiphora*	bushy shrubs
Plumbaginaceae	*Aegialites*	shrubs or small trees
Euphorbiaceae	*Excoecaria*	small trees
Palmae	*Nypa*	small erect palms with trunk underground, horizontal

The trees belonging to different families which occur in mangrove forests show remarkable examples of convergent evolution, or similar adaptation to common environmental conditions in unrelated organisms. For example, mangrove trees generally lack taproots, but instead have well developed cable roots that spread out

horizontally just below the mud surface. These horizontal roots give rise to short anchor roots that descend vertically into the soil, as well as to short tufts of fine nutritive roots that are responsible for nutrient uptake.

In addition, the mangrove trees usually have roots that project above the surface of the mud, thus enabling them to obtain oxygen, which is lacking in the thick, sticky mud. Trees of the genus *Avicennia* produce extensive aerial roots which arise from the cable root system and project like pencils from the mangrove mud. These pencil roots are called **pneumatophores** in recognition of their oxygen procurement function. In *Bruguiera* and *Xylocarpus* (Figure 13) the cable roots are modified at intervals into thickenings or bends which extend above the mud. Since these aerial projections resemble knees in *Bruguiera*, they are usually referred to as **knee roots**, while is *Xylocarpus* they are often called **blade roots**.

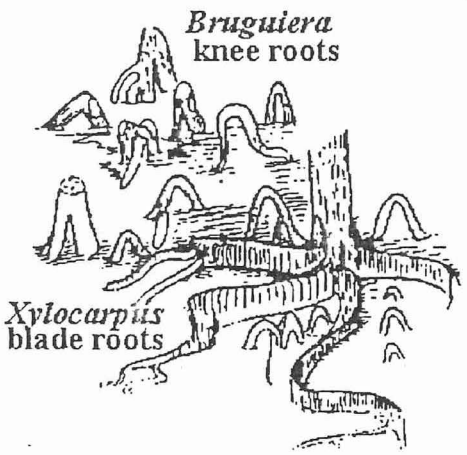

Figure 13. Aerial roots in *Bruguiera* and *Xylocarpus*.

Perhaps no other tree is regarded as being more characteristic of mangrove forests than the genus *Rhizophora*, with its very characteristic prop roots (Figure 14). *Rhizophora* does not produce cable roots like most other mangroves, but is instead supported entirely by its system of prop roots that are anchored only shallowly in the muddy sediment. In addition to the prop roots, *Rhizophora* also produces secondary aerial roots which grow downward from the limbs of the tree in search of the mud. The presence of tangled masses of these aerial and prop roots make the area of a mangrove forest that is dominated by *Rhizophora* almost impenetratable.

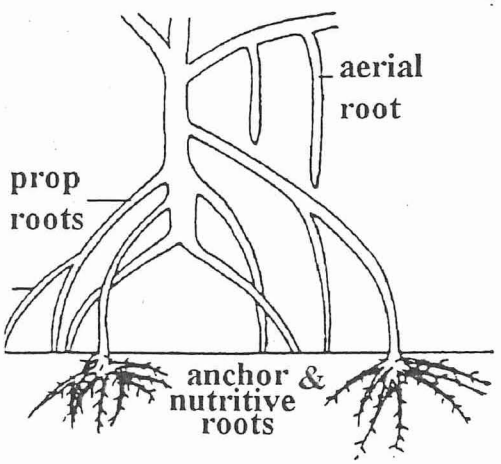

Figure 14. Prop roots, aerial roots, and anchor & nutritive roots in *Rhizophora*.

Since the above-surface roots of mangrove trees function partly in the uptake of oxygen, most of them contain air spaces called **lenticels** which are open to the outside environment. Lenticels are areas within the outer layer of tissue in which cell division is more active then elsewhere, and this results in the formation of the tissue rich in air spaces.

The soil of the mangrove forest and the seawater which bathes the trees' roots contain high concentrations of salt, which presents physiological problems for any plant growing there. Although most mangrove species can tolerate greater concentrations of salt in the sap than can most land plants, different mangrove trees have

developed a number of different mechanisms for dealing with the salt. Most species seem to be able to exclude most salt by special physiological adaptations in their roots which actively return salt to the environment, so the sap in these trees is much less salty than the water surrounding the roots. Members of the genera *Avicennia*, *Ageiceras*, *Aegialitis*, *Acanthus*, *Sonneratia* and *Laguncularia* have an additional mechanism for dealing with excess salt, for they posess salt-excreting glands on the either the lower surface (e.g. *Avicennia*) or both lower and upper surface of their leaves (e.g. *Aegicera*).

Some mangrove trees, including *Excoecaria*, *Lumnitzera*, and *Xylocarpus* are not good at excluding salt via the roots, so they accumulate it and deposit it as sodium chloride in their older leaves. Older leaves are shed quite frequently in these species, so the salt is gotten rid of when the leaves drop off the tree. *Bruguiera* is not a salt accumulator, since it has a very effective mechanism of eliminating salt via the roots, but it also sheds its leaves in this way, and this is thought to play a role in getting rid of the remaining excess salt.

Another example of convergent evolution is provided by the leaves of mangrove trees from different families, for most mangrove species have xeromorphic features. Xeromorphic features include any anatomical adaptations which protect leaves against water lo s. All genera have a thick-walled epidermis (outer layer of cells) which is covered y a thick waxy cuticle on the upper surface. In many genera, the lower surface is c vered by hairs which restrict air movement and reduce evaporation. In many species the gaseous exchange structures, the stomata, are sunken in shallow depressions to reduce the loss of water by reducing the rates of gaseous exchange. Leaf succulence, the presence of fleshy structures for water storage within the leaf, is another common feature of mangrove trees such as *Bruguiera* and *Rhizophora* and many other genera.

In several mangrove genera (e.g. *Bruguiera*, *Ceriops*, *Rhizophora*, *Kandelia*, and *Nypa*), the seedlings start developing while they are still attached to the parent tree. This type of development, where a young plant develops while it is still attached to the parent plant, is called **vivipary**. For example, in *Bruguiera* the seedling matures into a characteristic torpedo or cigar shape, which then drops off. I have observed that in soft mud, when the trees are tall and mature, the seedlings commonly impale themselves in the mud below the tree. More usually, however, they land on their sides and quickly send down a central root. As this root grows downward into the soil, the seedling is pulled upright, thus creating the illusion that it must have fallen in this position. If it falls at high tide the seedling may float around for a long time before making contact with the sediment and continuing its development into a tree.

Like *Bruguiera*, the propagules of all magroves are dispersed to new locations by water. A number of different botanical structures of the seedling, fruit, or seed provide the buoyancy needed for distribution in the sea water. In *Rhizophora* the radicle, or embryonic root, provides buoyancy. In *Avicennia* it is the pericarp, or wall of the fruit, that gives it flotation. In *Xylocarpus* the endosperm, or nutritional material within the seed, makes the seed float, while in *Pelliciera* the cotelydons, or embryonic leaves, provide this function.

4.3. *Mangrove algae*

A large number of micro- and macroalgae occur in association with mangroves, some on the above-ground roots and some free-living on the mud. The more obvious epiphytic microalgae in the mangal are diatoms and bluegreen algae (Cyanobacteria). They occur on the roots of mangrove trees, as well as epiphytically and entangled with macroalgae. Microscopic diatoms also occur on the soil, and are able to move by exuding mucilage. This left-over mucilage then acts as a binding agent which traps and binds fine sediment particles. Diatoms thus increase sediment accretion within the mangrove ecosystem.

Epiphytic macroalgae on mangrove roots tend to be fairly similar in form and structure all over the world, and consist mostly of turf-like forms. Three genera are particularly ubiquitous, and comprise much of the algal biomass within the mangal: *Bostrichia*, *Caloglossa*, and *Catanella*. A variety of other filamentous and small-bladed algae also occur.

Many of the free-living macroalgae are simply washed into the mangal from adjacent areas, and continue growth in the sheltered mangrove habitat. Some develop peculiar growth patterns when growing unattached, and often reproduce by vegetative means such as fragmentation.

Algae play a vital rôle in mangrove ecosystems. Most texts say that there is little direct grazing on mangrove algae, and that most algal production in mangals enters food webs through detrital pathways. However, grazing by small herbivores such as amphipods and isopods, is difficult to estimate. A variety of other organisms feed directly on mangrove macroalgae. Nevertheless, detrital pathways are very important, and macroalgae associated with mangroves may be as important as leaf litter in fueling detrital food chains in some areas.

Cyanobacteria, or blue-green algae, also play important rôles in the mangal as nitrogen fixers, just as they do in coral reef and seagrass ecosystems. There have been relatively few estimates of nitrogen fixation rates in mangrove forests, but estimates from southern Florida, USA give a mean value of 9 mg N m^{-2} day^{-1} (Millis 1981). This is probably much less than in coral reefs and seagrass beds, but it is an important contribution to the nutrient status of mangroves.

4.4. *Mangrove fauna*

The mangal ecosystem is inhabited by a number of strange creatures, of which the fiddler crabs are perhaps best known (Figure 15). Fiddler crabs feed by sifting through the soft mud for bits of decaying organic matter, spitting out the inedible components and swallowing the edible material. Male fiddler crabs are easily recognized by their one greatly enlarged claw, which is used both for displaying to attract females, and in combat with other males.

During times of peak mating, the forest is alive with gaiety as the little males beckon to females with this claw. Sometimes one male will run up to another and begin pounding him on the head, chasing him down into the safety of his burrow. Usually, females seem oblivious to all these frantic attempts to woo them, for most of the time they just wander around stuffing food into their mouths. If a male approaches too closely, she will even dart into her own burrow to hide.

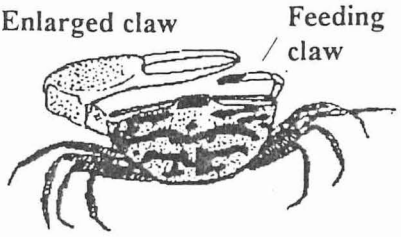

Figure 15. Male fiddler crab, *Uca* sp. Note the enlarged claw, and the smaller feeding claw.

Another group of crabs which are abundant in mangrove forests are the sesarmid crabs, which feed on fallen leaves, algae, and other organic material. One species of sesarmid found commonly along the African coast is especially sensitive to vibrations and can detect a leaf falling on the mud while it is hidden within its burrow. These mangrove leaf crabs can sometimes be seen scurrying out to grab a newly fallen leaf within seconds of its hitting the ground, and then rushing back to their burrows with their nutritious prize. Indeed, great battles often ensue as these crabs fight each other for a scarce morsel. These crabs are easily recognized by their large size, and their equal-sized orange-red claws.

Most sesarmids feed entirely on organic matter found in the upper layer of mangrove mud. Food is rarely in short supply for them, since the whole swamp is covered in rich mud. These crabs are usually dull brown all over, and much smaller than the mangrove leaf crab. Since food is all around them and rarely in short supply, the mud-feeding sesarmids rarely, if ever, engage in **agonistic** behaviour over food.

Of particular significance in Indo-Pacific mangrove areas is the mangrove, or mud crab, *Scylla serrata*, which is harvested for local consumption as well as commercially throughout its range. It may be harvested by hand picking, using a crab hook, nets, crab traps or pots, spearing, or long-handled scoop nets at night in combination with torches. Mud crabs are fairly large, and have a high yield of delicately flavoured meat. They are largely sedentary and have a restricted home range, so they are easily captured and are therefore susceptible to overexploitation (Brown 1993).

Mud crabs may be found on the mud among the mangrove roots, but they usually occupy burrows within the mud. They are especially confined to burrows when they are in the soft-shell stage of their moult cycle. This crab is an opportunistic, nocturnal feeder, scavenging whatever food is available, as well as preying on other crabs, barnacles and molluscs.

Another important crustacean found in Pacific mangrove forests is the mud lobster, *Thalassina anomala*. It is most common among the knee roots of *Bruguiera*, where it constructs conical mounds leading to a burrow system that penetrates to the water line. The mud lobster is not really a lobster at all in the usual sense of the word, but is rather a relative of the ghost shrimps of the genus *Callianasa*. Exactly how the mud lobster feeds is not known with certainty, but it probably strains food particles

from the bottom of its burrow. Mud lobsters are widely harvested throughout the tropical Pacific, and a variety of techniques have been developed for catching them.

Among the more unlikely creatures of the mangal are the mudskippers (Figure 16), once placed in their own family Periopthalmidae, but now known to belong to the goby family (Gobiidae). A number of species occur throughout the tropical Indo-Pacific area, with the most common ones belonging to the genera *Periopthalmus* and *Boleopthalmus*.

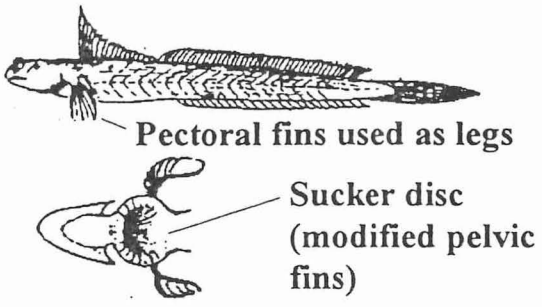

Figure 16. Mudskipper (*Periopthalmus*) showing pectoral fins used as 'legs', and sucker disc derived from pelvic fins.

The genus name *Periopthalmus* (Latin=around eyes) is used because its eyes are perched on the top of its head and they can be moved independently of each other. This gives the fish virtually 360° vision. Mudskippers can often be seen skittering over the mud searching for insects and small crustaceans to eat. Their front, upper (pectoral) fins are quite muscular and function rather like primitive legs, while their front lower (pelvic) fins are modified into a sucker disc. The sucker enables them to cling to the roots and trunks of the mangrove trees, where they can remain motionless and almost invisible for a considerable time. They retreat quickly to water when disturbed, but unlike "normal" fish they do not usually dive below the surface. Rather, they skim over the water in a series of rapid motions that alternate between swimming and flying, and all that can be seen by the human eye is a series of tiny waves on the surface. Once they emerge on a mud bank, they are almost impossible to see because they are perfectly camouflaged.

This fish is able to survive out of water because its gills are housed within an enlarged cavity which contains both water and air. The tissue within the cavity can absorb oxygen from the air as long as it remains moist, so it functions like a kind of primitive lung (which of course it is not). The mudskipper must return periodically to the sea, however, to replenish the water in its gill chamber.

A large number of fish species make use of the mangal, either in their adult or juvenile stages, or both. For example, Collette (1983) collected over 200 species in 58 families by using rotenone (a fish poison used for scientific sampling) in Papua New Guinea. According to Dingwall (1984) at least 30 species of fish use New Zealand mangroves at some stage of their life cycle, including a number of commercially important species.

4.5. *Mangroves and human affairs*

Until recently mangrove forests were thought to be of little importance from a human perspective, either in local areas or worldwide. However, today it is recognized that mangroves serve a number of non-consumptive functions; that is, functions that do not involve the harvesting of the trees themselves, or parts thereof:

- aid soil formation by trapping suspended sediment and debris
- stabilize accreting coastlines, banks and shoals
- filter land runoff and remove terrestrial organic matter
- habitat for many species of birds, fish, invertebrates and epiflora, some of which are harvested on a subsistence or commercial basis
- high primary productivity
- major producers of detritus, which enters nearshore food webs
- act as nursery areas for species which are ecologically important or which are harvested in other ecosystems
- directly and indirectly provide food for harvested species

The root system of mangrove trees, in combination with their attached algae, accumulate and stabilize sediments in areas protected from wave action. While recognizing this rôle of mangroves, it is also important to note that mangroves respond to other accretionary processes, and act as stabilizers of rapidly accreting coastlines, banks and shoals. The latter may be a more important function of mangrove forests.

Since mangroves form a fringe around protected coastlines and are particularly abundant in estuaries, they are well placed to filter runoff from the land and remove terrestrial organic matter. When riverine mangroves are destroyed, terrigenous sediments are able to flow through into adjacent seagrass beds and coral reefs, damaging these ecosystems. This will reduce the productivity of these adjacent ecosystems in terms of food for human consumption.

The importance of mangrove forests as habitat for a variety of organisms is obvious, and we have already looked at some of the creatures of the mangal. A number of birds make use of the mangal for feeding and roosting, and at least one species of kingfisher is exclusive to this ecosystem. Fruit bats (flying foxes) are also well known users of mangrove trees for roosting, as are a variety of birds and mammals from adjacent terrestrial forest. At least one mammal is endemic to mangroves; the proboscis monkey is only found in Borneo mangroves where it feeds on the foliage of *Sonneratia caseolaris* and *Nipa*. In Africa, channels through the mangal are often used by hippopotamus for resting in the daytime, and in some areas the only way to penetrate the forest is through pathways cleared by hippos as they go about their nightly foraging in nearby areas. The salt water crocodile inhabits mangrove forests from Sri Lanka to Australia, and is an endangered species in many areas.

A very significant function of mangroves is that they act as nursery areas for the young of species that are ecologically important, or that are harvested in on a subsistence or commercial basis in other ecosystems. For example, several species of mullets use mangroves during their early development, and are caught by fishers as adult fish in lagoonal areas. Many species of shrimp also use mangroves during their early stages of development. Some species of fish normally associated with coral reefs, such as some angelfishes, also use mangroves extensively during their juvenile phase

The rôle of mangrove trees as primary producers in the inshore areas is substantial. Lugo and Snedaker (1974) estimate net primary productivity values of up

to 7.5 g C m^{-2} day^{-1} for mangrove forests in Florida, USA. The significance of this value becomes evident when one considers that a heavily fertilized and managed sugarcane field has a maximum net productivity of 10 g C m^{-2} day^{-1}. Thus, the productivity of the mangrove ecosystem is high, and a substantial fraction of this represents energy that is available for secondary production by animals and decomposers, or for export from the ecosystem.

One way in which energy fixed by mangrove trees enters the ecosystem is through the fall of leaf litter (Figure 17). Pool *et al.* (1975) estimate litterfall rates of around 2-4 g-dry weight m^{-2} day^{-1}. When this leaf litter falls to the forest floor it begins to decompose, and the organic matter produced by the trees enters the food web through a complex succession of organisms. First micro-organisms, especially bacteria and fungi, colonize the fallen leaves and begin to break down the organic matter. As decomposition procedes, the amount of nitrogen relative to carbon increases (C:N ratio decreases), indicating a higher protein content and greater nutritional value. Decomposing leaves are colonized by an assemblage of **meiofauna**, which feed on the micro-organisms. Eventually, the leaf is eaten by detritivores, which digest mainly the microbiota and meiofauna, and egest small pieces of leaf matter which are again colonized by microbes and further broken down.

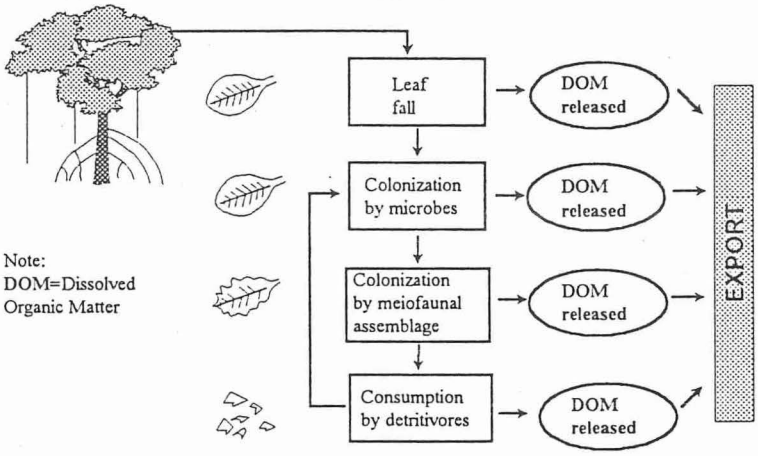

Figure 17. Decomposition of mangrove leaves and the production of detritus and dissolved organic matter (DOM), some of which is exported to other ecosystems.

It is important to note that dissolved organic matter (DOM) is released at all stages of the process, and this DOM enters the water that comes into the mangal at high tide. This DOM promotes the growth of bacteria and other micro-organisms in the water, as well as some planktonic algae, which are then available to support suspension feeding components of the food web (e.g. oysters). Small particles of leaf matter that have been made finer and finer by the repeated passage through the decomposer-detritivore cycle also contribute to supporting the suspension feeders.

DOM is also a major export from the mangrove ecosystem, where it is incorporated into the food webs of adjacent areas. The pathways whereby DOM enters adjacent ecosystems are similar to those which have been noted for seagrass beds. Energy is also exported from the mangal into adjacent ecosystems as DOM, as well as in the form of planktonic organisms supported by DOM, in the currents which flow through the forest.

Being an ecosystem with a high primary productivity, and producing large amounts of detritus, the mangal is also productive in terms of edible species of fish and

invertebrates. Some of these species, such as the mud crab and mud lobster mentioned earlier, are harvested within the mangrove forest itself. Other species, such as mullet and penaeid shrimp, may feed in the mangrove but are usually harvested in areas adjacent to the mangal. In northern New Zealand, some eels, flatfish and grey mullet are caught almost exclusively in, or adjacent to, mangroves (Dingwall 1984). Matthes and Kapetski (1988) produced a worldwide compendium of mangrove associated species of economic significance, which contains a list of hundreds of species across the taxonomic spectrum. It has been estimated that mangals produce 1 million tonnes of molluscs, crabs, shrimps, and finfishes annually, not including species dependent on mangroves but caught elsewhere.

Mangroves also have a number of consumptive uses; that is, the trees themselves, or parts of them, are harvested. These uses must be carefully considered and controlled by managers of the coastal zone. Mangrove trees are harvested as timber, firewood, for pulp, and for making charcoal in many areas. Mangrove trees have also been used as sources of tannins, particularly for preserving fishnets. In the Maldives, the seedlings of some mangroves are cooked and eaten as a delicacy, and in some countries mangrove trees are used in folk medicine.

Many mangrove trees are useful as timber, and some species produce very high quality hardwood. While most of the harder species are used mainly for beams, posts, pit props, and rice mortars, some species are used in furniture and cabinet making. *Lumnitzera littorea* produces a beautiful and fragrant wood, sometimes called 'rose wood', and is used in cabinet manufacture. This species, together with some species of *Sonneratia*, are useful for boat building since they are resistent to ship-worm attacks.

4.6. *Threats to mangrove ecosystems*

Human threats to mangrove ecosystems may be loosely divided into two categories: *consumptive*, in which whole trees, or parts of them, are cut for products such as timber, fuel, or pulp; and *non-consumptive*, in which a forest is threatened by human activity other than direct exploitation of the trees themselves (Figure 18). Adverse effects on mangrove ecosystems as a result of both consumptive and non-consumptive activity are increasing in the tropics as a result of increasing human populations, and attempts to improve or modernize the living standards of coastal peoples.

In areas where trees are cut to supply timber, fuel or pulp, it is important that managers and coastal planners be aware of the need for careful planning to ensure that the forest is not overexploited, or threatened from other sources. On Zanzibar, mangrove trees are exploited to provide building materials and for making charcoal, and cutting is managed with the goal of long-term sustainability in mind. In some areas, such as Malaysia, India, and Bangladesh, mangrove forests are managed silviculturally on a sustainable-yield basis, just as are terrestrial forests. Even where mangroves are used extensively, many countries retain a protective fringe of mangrove trees along shorelines and waterways to reduce erosion and to provide a seed source

Non-consumptive threats to mangrove ecosystems may be further divided into two categories: *pollution* and *land-use conflicts*. One of the more serious forms of

pollution is oil, for this substance can foul gas exchange surfaces of the exposed roots, and lead to death as a result of oxygen starvation. Toxic substances in oil can also poison both the roots and important soil micro-organisms. Cintron *et al.* (1981) documented the effects of an oil spill in a mangal Puerto Rico and noted that in the areas receiving the heaviest impact, 50% of the forest canopy was lost after 43 days, and 95% after 85 days.

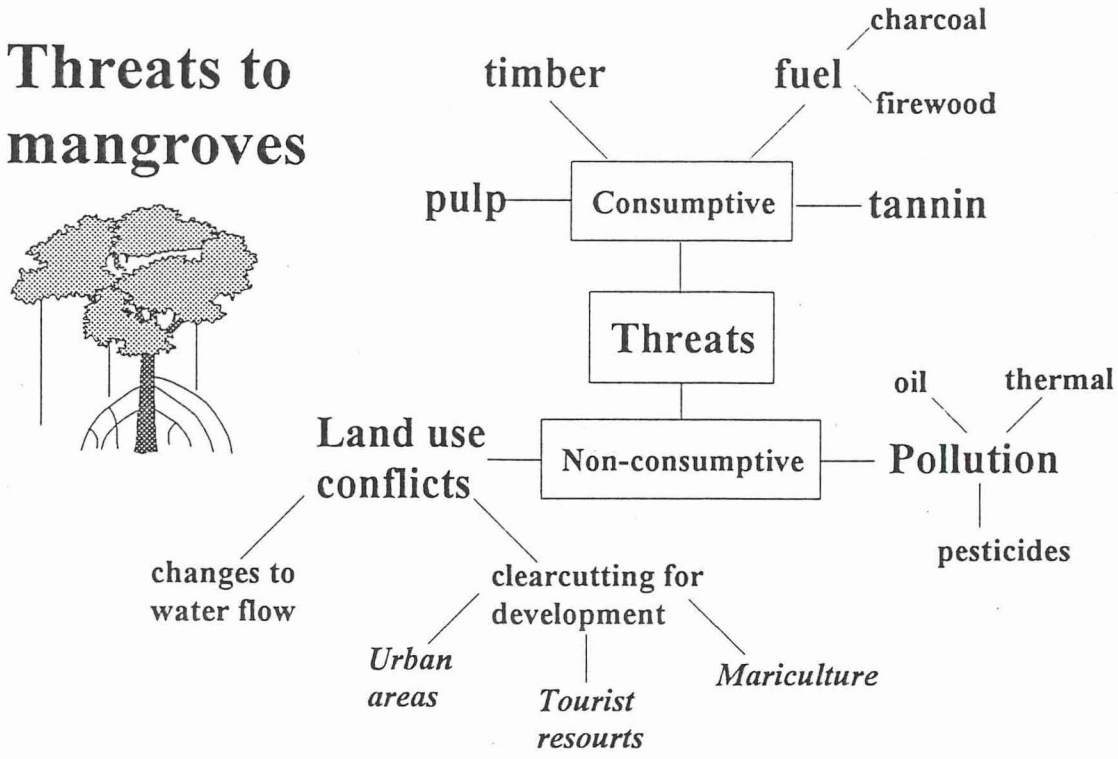

Figure 18. Some of the threats facing mangrove ecosystems worldwide.

Most of the threats to mangrove ecosystems can be placed under the broad heading of *land use conflict*. Changes in land use patterns may critically alter a number of features of the mangrove habitat, which may lead to the deterioration of a local mangal. Alternatively, mangroves are often clear cut and drained to permit certain types of land use to proceed.

Human activities which disrupt water flow patterns through a mangrove can have disastrous consequences. The diversion of fresh water away from river deltas by upstream dams can have serious impacts on riverine mangroves. River water brings in nutrients and particulate material which are necessary for the maintenance of mangroves in estuarine areas. In dry areas, soil salinity can increase rapidly as a result of high evaporation rates if the inflow of fresh water is disrupted, and this can cause the rapid mortality of mangrove trees.

The impoundment of water within mangrove areas can also lead to the degeneration of mangrove forests. Water flow is needed for nutrient provision, but more importantly the air breathing lenticels of the roots need periods of emergence to functinon effectively. If the roots remain continuously covered in water, the trees die as a result of oxygen starvation in the roots. In the 1970's the Natal Parks Board in South Africa built a bridge across a small stream at Sodwana Bay National Park. The

bridge did not permit sufficient drainage, and water was impounded upstream from it. Most of the mangroves in the system were killed as a result of oxygen deprivation, and although the bridge was replaced with one that allowed better drainage, even in 1994 the area has only marginally recovered. A similar case has been documented in Puerto Rico by Cintron and Novelli (1983).

Mining Wastes Alter Coastal Environment

Disposal of mining wastes has produced some dramatic landscape changes in Papua New Guinea (PNG), where wastes are flushed down stream beds and into the sea. On the island of Bougainville, an opencast copper mine, until its recent closure, produced 150 thousand tonnes of rock waste and tailings per day. These were disposed of by stream transport into the Jaba River, and from there to Empress Augusta Bay. In the Jaba Valley, these sediments have spread out across the valley floor, burying the rainforest. After 13 years of mining, the wastes have accumulated to a depth of up to 27 metres. It is predicted that if mining continues this will increase to 65 metres. An expanding delta of 700 ha of copper-rich mining waste now extends 6 km offshore.

Close to PNG's boarder with Indonesia, copper, gold and silver are being mined from another huge open-mine cut at Ok Tedi. The terrain and climate are very difficult. Average annual rainfall at the mine is in excess of 8000 mm and the area is prone to landslips, particularly during frequent earthquakes. There has been a major political controversy over whether or not the government should insist on wastes being contained at the site, and indeed, whether this is possible.After the collapse of a tailings dam, mining has been allowed to continue, but has resulted in some 60 000 tonnes of cyanide-contaminated waste being flushed daily into a tributary of the Fly River System. Fish kills have been reported. Considerable concern has been expressed about the possible adverse effects of these wastes on aquatic life and people who live downstream both directly and through the food chain. This concern has assumed an international dimension since Australian scientists raised the possibility that other mining wastes from the Highlands of PNG could conceivably pass through the Fly River system and into seas under Australian control.

There is little confidence in the will of the mining companies to assume responsibility for these matters. A 1984 incident in which a barge carrying company supplies sank in the lower reaches of the Fly River with 150 000 litres of sodium cyanide reinforces this view. After recovering a mere 7 per cent of the lost cyanide, the search became more difficult and no further recovery attempt was made. Meanwhile the environmental burden of mining sediment and chemicals has increased with the opening of another gold mine in the same catchment, at Porgera.

In July 1989, another small open-cut gold mine was opened on the small island of Misima. The impact on the marine environment is more direct. Tailings are washed to recover an estimated 75 per cent of process chemicals, then mixed with seawater and discharged at a depth of 75 to 100 metres on the outer edge of a fringing coral reef. SOURCE: Anon, 1990. *State of the environment in Asia and the Pacific 1990.* UN Economic and Social Commission for Asia and the Pacific, Bankok, Thailand, 94 pp.

It is a common practice in some areas to convert mangrove forests into fishponds for the aquaculture of prawns and fish. In many areas, mangrove trees are clearcut, the cleared area is surrounded by dykes, and fertilizer applied. It has long been recognized that extensive conversion of mangrove areas to shrimp or fish ponds has decreased yields of other mangrove resources. There are usually coastal villagers who depend on mangrove resources for subsistence or commercial harvests. In many areas the access to village resources is protected by customary law. However, village leaders, managers and planners need to carefully assess the socioeconomic value of natural mangrove stands, before permitting their conversion to aquaculture ponds. Widespread destruction of mangroves for aquaculture can decrease the natural availabiliity of the juvenile stages which form the seed-stock for many aquaculture

operations. Wherever possible, aquaculture schemes which favour the retention of mangroves should be favoured over schemes which call for their removal.

Perhaps one of the biggest threats facing mangroves in certain areas is the clearcutting and drainage of mangals for development purposes. Clearing may be done for urbanization, including housing, industrial areas, and harbour facilities. For example, in Suva, Fiji, much of the low-lying area now occupied by housing, industry and port facilities were once fringed by mangroves that were removed during land reclamation and development.

Although mangroves are dependent on sediment, they are also sensitive to excess sedimentaton, particularly the sudden deposition of large quantities. For example, Cintron and Pool (1976) reported a case in Puerto Rico where sand was extracted from a coastal dune for construction of an airport. Subsequently, storm waves overtopped what was left of the original dune, and carried large amounts of sand into the adjacent mangrove forest. All mangrove trees were killed wherever the sand was deposited to a depth greater than 30 cm. Road construction upstream from riverine mangroves is well known as a source of mortaility to mangroves, and can cause the mortaility of trees over large tracts. Dredging for building materials, or to increase the depth of shipping channels can cause excess sedimentation, particularly when dredge spoils are dumped near mangrove forests.

Since mangroves often have mosquitos, crocodiles, and unpleasant smells, they are not popular with tourists or resort owners. Therefore, when tourist resorts are built, mangrove forests are usually cleared and attempts are sometimes even made to convert the coastline to a sandy beach. When asked to grant permission for a resort developer to clear an area of mangroves, it would be wise for coastal zone managers to consider requiring the developer to incorporate the mangrove fringe into his/her landscape plan, rather than planning for its removal.

4.7. *Summary of management implications (Mangroves)*

1). Mangrove ecosystems are important for a number of ecological and economic reasons, and therefore their conservation (wise use) should be considered in coastal development and land-management planning.

2). Mangroves are sensitive to changes in water flow and drainage patterns. Therefore, any coastal developments which might alter water flow and drainage should be considered carefully by planners, and ways should be sought to minimize the damage of such developments to mangroves.

3). Mangroves are sensitive to certain pollutants, especially excess sediment, oil, and certain industrial effluents. Coastal development should be planned so as to minimize potential damage to mangroves from excess suspended sediment, oil, and industrial effluents.

4). When mangroves must be removed for development because there is no alternative, development plans should be designed to minimize the effect and size of the area cleared. The effects of disrupting fisheries that depend directly or indirectly on mangroves should be carefully considered before granting permission to clear-cut mangroves for development.

5). Any proposal to alter mangrove areas for aquaculture or other purposes should be fully evaluated for potential impact on village-level fisheries. It may be that the socioeconomic value of mangrove resources, such as mud crabs and mud lobsters, may be greater than the socioeconomic value of aquaculture development. Aquaculture schemes which favour the retention of mangroves should be favoured wherever possible.

6). Mangrove areas should be set aside and given reserve status to ensure the long-term conservation of some mangroves in the natural state, and to provide a baseline against which to estimate human inpacts outside of reserved areas. The zoning of mangroves for different purposes in areas of intense use should also be conducted.

CHAPTER 5

Connections among tropical, inshore ecosystems

OBJECTIVES

When you have completed this chapter you should:

- be able to describe and characterize the main ecological connections among coral reefs, seagrass beds and mangrove forests
- be able to state the ecological and socioeconomic importance of the interconnectedness of inshore, tropical marine ecosystems
- be able to state the natural-resource management implications of your knowledge of this interconnectedness.

BACKGROUND REQUIRED

The following background knowledge will greatly facilitate your understanding of the material in this chapter:

- knowledge of coral reefs, seagrass beds, and mangrove forests

STUDY QUESTIONS: Connections among tropical, inshore ecosystems

These study questions are provided to guide your study, and should be answered as you study the readings and other material provided with this course. It is a good idea to write out the answers to these questions in a notebook, and to include illustrations as much as possible. These answers will serve as your study notes for this course.

HINT: Wherever possible, try to organise your answer using a concept map, flow chart or other non-linear format.

1. List 5 areas of interaction among inshore, tropical, marine ecosystems.

2. Under each of the above areas, state the main types of interactions considered in Chapter 5.

3. State the management implications of your knowledge of these interactions.

5. Connections among tropical, inshore ecosystems

Although coral reefs, seagrass beds, and mangrove forests are usually treated as separate ecosystems, it is important to realise that ecosystems never exist in isolation. Nowhere is this more true than in tropical inshore ecosystems. In 1982, a workshop was held at St. Croix in the US Virgin Islands to deal with interactions among coral reefs, seagrass beds and mangroves in the Caribbean (Ogden and Gladfelter 1983). The report from this workshop identified five areas of interaction among tropical marine ecosystems (Figure 19):

- physical linkages;
- interactions involving nutrients and dissolved organic matter (DOM);
- interactions involving particulate organic matter (POM);
- linkages resulting from animal migrations among ecosystems;
- linkages in terms of human impact (these have been dealt with in individual sections and will not be treated again here).

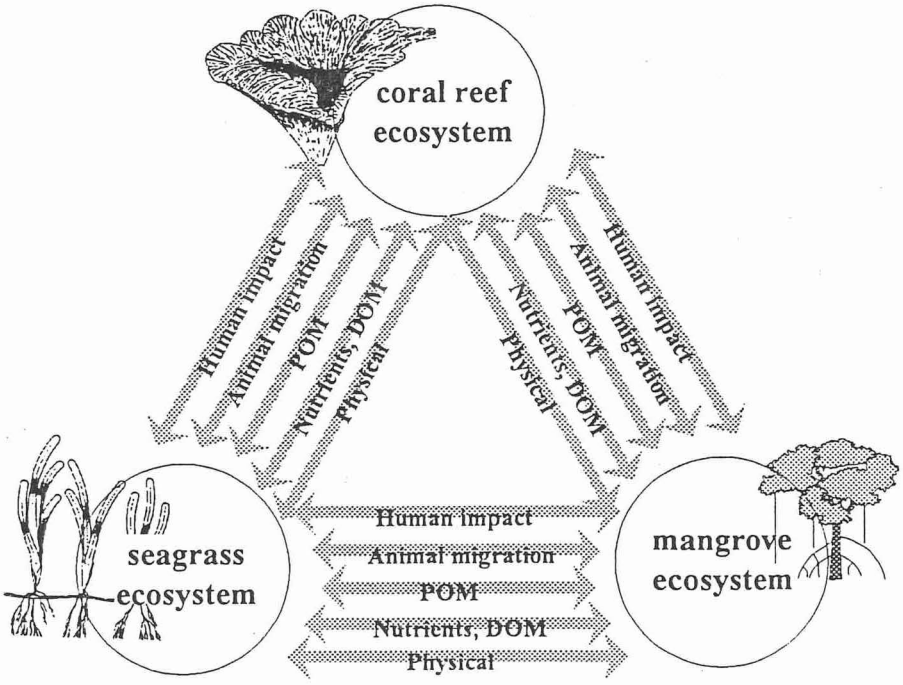

Figure 19. Interactions among tropical inshore marine ecosystems.

5.1. *Physical interactions*

Physical interactions mainly involve effects on other ecosystems as a result of modifications to water motion and sediment transport. Coral reefs reduce wave action, creating a lagoon and shoreline that are sheltered from the impact of large ocean waves. Seagrass beds within lagoons, and mangrove fringes along coastlines depend on these sheltering effects of coral reefs. Since coral reefs grow upward at rates as high as 20-40 cm per century, this offshore protective barrier is maintained through

time. Reefs also reduce the erosive effects of **longshore drift** on coastlines by reducing wave impact. This also contributes the the maintenance of conditions suitable for seagrass beds and mangrove forests.

Longshore drift or longshore currents are currents set up when waves strike a shoreline at an oblique angle. They are responsible for much sediment transport along beaches, and are especially powerful where there are no protective coral reefs. Longshore drift results in coastal erosion only where the sand supply is cut off, as commonly happens as a result of certain types of development, especially the construction of breakwaters and causeways. Longshore drift is not a major factor in erosion of undeveloped areas, since new beach deposits are continually brought in to replace deposits moved along the shore. However, longshore drift does make beach sediments dynamic and unstable, and contributes to their unsuitability for mangrove development where longshore currents are strong.

Mangroves and seagrasses trap sediment, and reduce the amount of sediment reaching the reef area. This sediment trapping is essential to the development and growth of coral reefs in many areas. On the negative side, sediment build-up in the lagoon can smother the back reef, but this is a normal process although it can be greatly accelerated and made damaging by human activities that increase sediment loading. Riverine mangroves can help to regulate freshwater flow into coastal areas, and can therefore help to buffer salinity changes to the benefit of coral reefs and seagrasses in adjacent areas.

Another physical area of interaction is in the provision of sediment. Seagrasses and their epiphytes can contribute considerable amounts of particulate matter that goes into the building of sediments. Coral reefs yield much calcium carbonate material that is broken down into rubble, sand and mud. This accumulates and can create areas suitable for seagrasses and mangroves. For example, the islands that are found on reefs - especially atoll reefs - are created entirely out of calcareous reef material.

5.2. *Nutrients and DOM*

All plants need nutrients, such as nitrogen and phosphorous. However, excess of certain nutrients, especially nitrogen, can upset the balance of organisms in certain ecosystems. Ranking tropical inshore systems on the basis of their tolerance levels of nitrogen would probably produce the order mangroves > seagrass beds > coral reefs. When seawater passes through one of the inshore ecosystems, the concentration of nutrients in the water is reduced as some of them are taken up and used by the primary produces in the system. Since coral reefs are best developed in oligotrophic waters, the removal of nutrients from terrestrial runoff by mangroves and seagrasses may be essential to the survival of coral reefs in some areas.

As noted earlier, both mangroves and seagrass beds export organic matter in the form of dissolved organic matter. Much of this goes into driving food chains that are based on microorganisms in the water column. Some of this DOM and the microorganisms that make use of it enters the food web of adjacent systems, in particular coral reefs. The import of DOM from mangroves and seagrasses represents a significant input of energy into reef systems. Coral reefs also export DOM into the water column, and the combined pool of DOM from mangroves, seagrass beds, and coral reefs represents an important input of energy to nearshore pelagic ecosystems.

5.3. *Particulate organic matter*

Mangroves and seagrass beds export large quantities of particulate organic matter (POM). Coral reefs produce POM to a lesser extent than mangroves and seagrasses, and are probably net importers of POM derrived from the former ecosystems. POM from all three benthic systems also plays a rôle in driving food chains in the nearshore pelagic ecosystem.

5.4. *Animal migration*

Animal migration represents an important link among tropical inshore systems, and a significant means of energy flow among them. Animal migrations are of two main types:

- short feeding migrations;
- life history migrations.

Short-term feeding migrations may take place on a daily, a seasonal, or a sporadic basis. It is not uncommon for some reef fish to make feeding forays into adjacent systems, and a large number of reef fishes feed on nearshore plankton in the water column.

Life history migrations usually involve juveniles using a different system from the adult animal as a nursery area. Many coral reef fishes use mangroves or seagrass beds as nursery areas. Some lagoon fish (e.g. bonefish) migrate to the reef to spawn, a process that may be blocked by causeways, as is the case in Kiribati. A large fraction of reef fishes and invertebrates produce larval stages that are dispersed in the pelagic environment and only settle out as juveniles, often in a nursery area that differs from the adult habitat.

Life history migrations also include spawning agregations. For example, some deep-water groupers move into reef areas to spawn, thus creating links between deep-reef and shallow-reef areas. Fishing these spawning aggregations can pose serious threat to the sustainability such species as fisheries resources, since the reproductive individuals are often removed before they have a chance to spawn. Certain pelagic fish also spawn in coral reef areas.

5.5. *Management implications (connections among tropical systems)*

1. Any attempt to conserve either type of tropical, inshore, marine ecosystem should consider the three main types of system together.

2. Effective management of directed inshore fisheries will require knowledge of the life cycle of the target species, and the rôle of different ecosystems during different stages of the life cycle.

3. Inshore ecosystems are commonly influenced by human impacts as indirect as upland development, and as direct as dynamite fishing. Therefore, management of the coastal zone is most effectively achieved through an integrated management approach, encompassing all aspects of managing both land and sea.

4. The fishing of aggregations of fish that move from one ecosystem to another to spawn should be proheibited.

CHAPTER 6
Coastal fisheries

OBJECTIVES

When you have completed this chapter you should:

- be able to define and examine tropical, coastal fisheries according to scale, from subsistance to industrial
- be able to define and examine tropical, coastal fisheries according to the ecosystem or the environment fished
- be able to define and examine tropical, coastal fisheries according to target species
- be able to characterize some of the management problems highlighted by each of the above perspectives on tropical, coastal fisheries
- be aware of the complex nature of tropical, inshore fisheries, and the limitations that this complexity places on fisheries management

BACKGROUND REQUIRED

The following background knowledge will greatly facilitate your understanding of the material in this chapter:

- basic knowledge of the nature and structure of coral reefs, seagrass beds, and mangroves, and the relationships among them
- some familiarity with fisheries in your own region

STUDY QUESTIONS: Coastal fisheries

These study questions are provided to guide your study, and should be answered as you study the readings and other material provided with this course. It is a good idea to write out the answers to these questions in a notebook, and to include illustrations as much as possible. These answers will serve as your study notes for this course.

> **HINT:** Wherever possible, try to organise your answer using a concept map, flow chart or other non-linear format.

1. Explain what aspects of fisheries change in moving along the scale from subsistence to industrial fisheries.

2. Discuss the management implications of the changes in fisheries in moving along the scale from subsistence to industrial fisheries.

3. What are the main ecosystems in which fish are caught in tropical inshore areas?

4. Identify what you consider to be the most important difficulty in managing coral reef fisheries. What are the implications of this in terms of fisheries management in developing countries?

5. What problems exist in the management of targeted fisheries in tropical, inshore areas? What are the implications of this in terms of fisheries management in developing countries?

6.0. Coastal fisheries

6.1. *Definition of coastal fisheries*

Tropical **coastal fisheries** are those fisheries taking place in estuaries, lagoons, on reefs and their outer slopes, and extending offshore to the distance over which it is practical for small craft to operate, usually a few kilometres (modified after Munro & Fakahau 1993). While coastal fishing may take place to depths of 300m, roughly the boundary between the lower limit of the **deep reef zone** or **outer slope** and the upper limit of the **bathyl zone** (Munro & Fakahau 1993), most is carried out in shallower water for practical reasons. The words **inshore** and **nearshore** are often used in the same context, and are taken here as being synonymous with **coastal** as applied to fisheries.

While there are offshore fisheries resources such as tuna that have considerable potential to contribute to national economies in tropical areas, the impact of fisheries development on coastal communities is greatest for nearshore fisheries. This is so because the majority of coastal inhabitants in tropical areas live in relatively small villages, prosecute small scale fisheries, and lack the capital to venture into the offshore fishing arena. In addition, considerable indigenous knowledge of coastal fishing exists among coastal peoples, and this knowledge can be put to good use in the development and management of coastal fisheries for long-term sustainability.

A small capital influx into a community based largely on a subsistence economy can have a tremendous socioeconomic benefit if accompanied by appropriate education. This is an important consideration in fisheries development, yet it is often ignored by fisheries planners in favour of large-scale commercial or industrial fisheries. This often results in conflicts between coastal communities and commercial fishing interests regarding a resource that cannot support both village-based and larger-scale commercial fishing. Such conflicts can only be solved by a critical examination of our social values.

It is crucial for fisheries managers and policy makers to consider fisheries from a number of different perspectives. Three different criteria for defining tropical inshore fisheries that are used here are: scale, ecosystem or habitat fished, and target species. Each of these criteria offers a different perspective on fisheries, and produces different information that is essential in making correct management decisions. In this chapter we define inshore fisheries according to each of these three criteria, and explore some of the management implications of each perspective offered.

6.2. *Types of coastal fishery based on scale*

To understand the nature of coastal fisheries, and how their prosecution can affect fish and other marine natural resources, it is useful to distinguish three types of fisheries based on the degree of mechanisation of the vessels used, the degree of capitalisation of the fishery, and the degree of harvest in excess of local consumption. These are subsistence fisheries, artisanal fisheries, and commercial fisheries. A **subsistence fishery** is a fishery in which fish or other living marine resources are harvested for the sole purpose of home consumption. An **artisanal fishery** is a fishery

with a low degree of capitalisation in which fish or other living marine resources are harvested on a small scale, usually for local markets. The degree of mechanisation of artisanal fisheries is usually low, and the financial return derived from them is usually small relative to commercial fisheries. The amount of harvest is greater than the amount of fish consumed by the fishers and other local villagers, but this excess is still relatively small. It is important to note that, in most cases, subsistence and artisanal fisheries are not distinct from one another; rather, an artisanal fishery uses the same methods as a subsistence fishery, but a substantial fraction of the catch is sold for money. Most references to subsistence fisheries actually make little distinction between subsistance and artisanal fisheries.

A **commercial fishery** is a fishery involving substantial capitalisation and in which fisheries resources are harvested on a fairly large scale, for local, urban or export markets. The degree of mechanisation of commercial fisheries is usually high, and the financial return derrived from them is usually large relative to artisanal fisheries. The harvest in excess of local consumption is large as is demand for the product. At the one extreme of commercial fisheries are **industrial fisheries**, in which fishing takes place on a large scale, fish are processed industrially, and value-added products are brought to market.

It is important to emphasize that these fisheries do not represent discrete fishing systems, but are arbitrary divisions of a continuum of fishing types ranging from a single shore-based fisher with a hand line, through artisanal fishers in small boats, through small scale commercial fishers in mechanised boats, to large fishing vessels employing a number of crew and going after a high-profit commercial catch for industrial processing. Fisheries are classified in these categories here only because it gives us a basis from which to discuss the role of fishing in coastal societies, and the impact of fishing on the fish and other marine natural resources that are harvested.

True subsistence fisheries exist today in a relatively few places, mainly in isolated island areas which lack an urban market in close enough proximity to allow the convenient sale of catch. For example, the island of Rotuma is located 460 km from the nearest land. There are c. 14 villages on the island, with a total population of c. 3000 people, and no accessible urban markets within reach of island fishers. Fish and other marine resources harvested in Rotuma are entirely for local consumption, although it is possible that a substantial quantity of marine resources leave Rotuma in the luggage of 'expatriot' Rotumans living in other parts of Fiji and the Pacific.

Most village fisheries throughout the tropics today are of the combined subsistence and artisanal type. For example, even in fairly isolated Rotuma, traditional fishing practices are being abandoned. More-and-more families consume tinned and packaged foods purchased using money earned through the sale of copra, or gained from relatives living elsewhere. There is thus a small artisanal fishery, in which fish are sold to other Rotumans who no longer fish for subsistence.

In other areas, where there are urban markets within reach, artisanal fisheries predominate, with far more of the village catch being sold than is consumed locally. For example, on Viti Levu, Fiji it is a common practice for villagers to consume fish only when there are too few fish to make a marketable bundle, or when there are a few

fish in excess of such a bundle. As is commonly ocurring throughout Pacific island countries, the money gained from marketing the day's catch is often used to purchase processed foods of low nutritional quality.

Light commercial fisheries also exist in the coastal zones of most tropical countries. Again taking Fiji as an example, customary marine tenure regulations place the direct control of reefs, lagoons and mangroves in the hands of village chiefs. Most villages issue fishing licences to commercial fishers, who are then allowed to fish commercially within the marine area under village control.

Such light commercial fisheries may harvest the same resources that are harvested by villagers in the subsistence / artisanal sector, but they are often not prosecuted by the villagers themselves. For example, in the Fijian village of Ucunivanua, there are no commercial fishers, although artisanal fishing and gleaning from the reef, mangroves and mudflats for sale in Suva markets is common. Several commercial licences have been issued by the Chief, via the Fiji Fisheries Division, to commercial fishers living around the Suva area.

There are relatively few heavily commercialized or industrialized fisheries in tropical areas based on inshore resources. An exception is the deep snapper and grouper fishery described on pages 64-66. This fishery is particularly heavily developed and industrialized in places such as Hawaii.

A significant feature of the continuum from subsistence through to industrial fisheries is that it represents an increase in mechanization, capitalization, short-term profit potential, harvest in excess of local consumption, and - most importantly from a management perspective - potential impact on the resource (Figure 20). Subsistence fisheries have a low potential impact on the resource because a wide variety of species are caught and only a sufficient amount of the resource to supply local consumption needs is taken. As soon as subsistence fishers begin to market catch, then the quantity of resource harvested exceeds local consumption, and the potential impact on the resource increases proportionately.

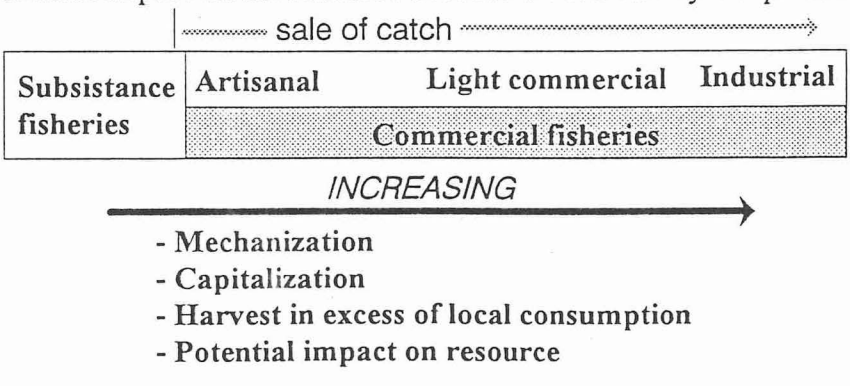

Figure 20. A diagrammatic representation of the continuum of types of fisheries according to degree of mechanization, capitalization, harvest in excess of local consumption, and potential impact on the resource.

One way to express this potential impact is as **risk of overfishing**. Overfishing may be defined as fishing a resource or resources at levels which substantially reduce productivity and yield to the fishery to levels very much below levels experienced in a pristine resource, or which brings about major changes in the ecosystem. If it is

extreme, overfishing can lead to the **commercial extinction** of a resource; that is, a point is reached where the resource can no longer be harvested at a commercial profit, and the fishery collapses. When subsistence fishers begin to market catch, this risk is still acceptably low, except for high-priced species that are easily targeted (e.g. giant clams, bêche-de-mer). Except for such susceptible species, fisheries management practices are probably unnecessary for subsistence-artisanal fisheries. Population density within coastal villages, however, is a critical factor as well.

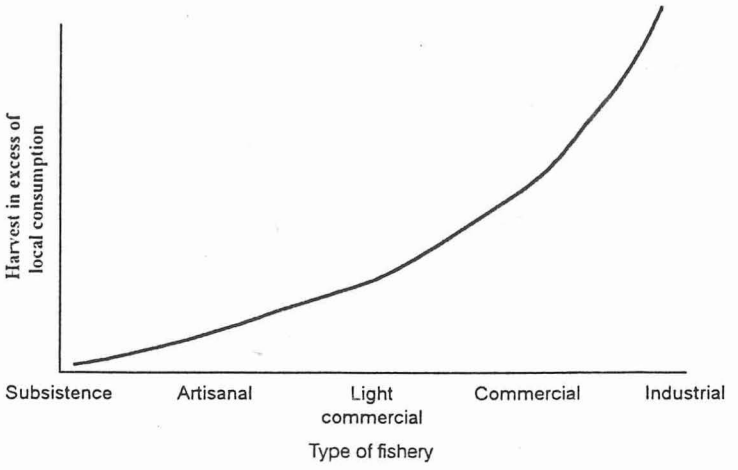

Figure 21. The relationship between fishery type and the degree of harvest in excess of local consumption.

As soon as we cross into commercial fisheries, however, the harvest in excess of local consumption begins to increase exponentially (Figure 21). Going hand in hand with this increase is an increase in the risk of overfishing (Figure 22). As long as the commercial fishery remains relatively unindustrialized, capitalization is kept to relatively low levels, and **government incentives** do not produce an overdevelopment of this sector, then the risk of overfishing can probably be contained by the appropriate management practices. It is within this area that fisheries management is necessary and can be effective at controlling the risk of overfishing (Figure 22).

Once fisheries become industrialized, or even a light commercial fishery becomes overcapitalized as a result of government incentives, there is an almost certain risk of overfishing, even when fisheries management practices are in place. There are almost no industrialized fisheries in the world that have not been overexploited. The consequences of commercial overfishing may be lowered production of the resource, but the result is often the commercial extinction of the resource and the complete collapse of the industry, with resulting increases in unemployment and dependence on external aid.

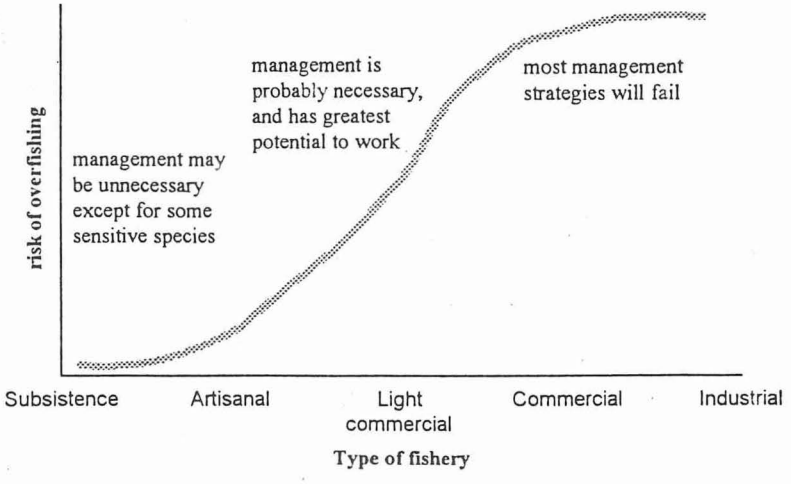

Figure 22. The relationship between type of fishery and the risk of overfishing.

The stock of codfish on the northern banks off Newfoundland, Canada, provides a good example of what can happen to a fishery when it becomes overcapitalized and overdeveloped. This stock of fish spawns on the banks offshore, but migrates inshore in spring following bait fish. While they are offshore the northern cod are targeted by trawler fleets, and while they are inshore they are caught by smaller-scale commercial fishers using relatively small boats.

Historically, northern cod stocks were fished mainly by an inshore sector using small boats, and cod traps that are attached to the shore. This stock was fished heavily offshore by European trawlers during the 1960's, with the result that the fishery collapsed in the early 1970's as a result of overfishing. During this time, many of the inshore fishers left the fishery and migrated to cities in other Canadian provinces to seek employment. In 1977, Canada declared a 200-mile exclusive economic zone, and set about rebuilding the northern cod stock. So optimistic were the predictions about stock rebuilding, that the Canadian government implemented a series of loans and grants to encourage fishers back into the fishery, and to encourage the development of a strong Canadia trawler fleet and a heavily capitalized industrial processing sector.

The government incentives were effective at promoting the development of the Canadian fishery for northern cod, and many inshore fishers returned to the fishery. A large trawler fleet was also developed, with most of those fishing for northern cod being controlled by two different fishing companies. By 1985 it was evident that something was amiss, and that catches by the inshore fishers was beginning to decline. In 1986, a group of inshore fishers hired me to investigate the accuracy of stock assessments and other management practices for northern cod. It was blatently obvious at the time that the inshore fishery was declining, and that fisheries biologists had grossly over-estimated the size of the stock. The minister of fisheries was approached with the information, but refused to believe it. Overfishing by the trawlers continued until in 1993 it was recognized that the northern cod had reached commercial extinction, and the then new minister was forced to close the fishery altogether.

The result of the closure of the main fishery in Newfoundland was widespread unemployment, and large scale financial aid packages from the Canadian government to the Newfoundland fishers who had lost their livelihood as a result of the mismanagement of the fishery. To some extent, the hardships were mitigated by this aid from central government. What had happened was the over capitalization and over development of the industrial fishing sector. Because of the heavy capitalization of this sector, decisions were made to allow heavy fishing by trawlers to continue even after it was recognized that severe overfishing was taking place.

In tropical inshore fisheries, the risk of overfishing may become unacceptably large at a relatively low degree of commercialization, not at the level of heavy industrialization that characterised the northern cod fishery. This is so because most tropical fisheries are concentrated around coral reefs and related ecosystems, which occupy a relatively narrow zone. This concentration of fishing effort in a narrow region makes reef-based fisheries very susceptible to overexploitation, even by a quite small commercial fishing fleet of small craft.

Tropical fisheries operate at a different scale from large bank fisheries, such as that for the northern cod, but there is a lesson in the northern cod story for tropical fisheries as well. The subsistence/artisanal and the commercial sectors are competing for the same resources. Commercial overfishing will result in a decrease in the productivity of the subsistance/artisanal sector, and consequent hardships that will be felt at the village level. In most tropical countries there will be no rich central government to step in with financial aid.

There are many examples in tropical fisheries where financial incentives have accelerated the overharvesting of resources and other forms of degradation of the coastal region. For example, in the Philippines, a 1975 fisheries decree made the incorrect assumption that most marine resources of that country were underexploited. In retrospect, it is now known that most fisheries were already overexploited at that time. Policies based on the assumption of underutilized resources included subsidies, incentive schemes, and lower tariffs on fishing gear and other inputs to the fishing sector. These directed economic policies served to worsen the overexploitation of fisheries in the Philippines.

The single most important management conclusion to draw from the above analysis is that the capitalization and commercialization of tropical inshore fisheries should be kept to minimal levels, and industrial processing of inshore catch should be avoided altogether. Indeed, the commercialization of inshore fisheries may not always be a viable option (see also page 74). Government incentives should not be used to develop or expand commercial inshore fisheries, as there is a high probability that they will increase the risk of overexploitation to unacceptable levels.

6.3. *Type of fishery based on ecosystem*

Coastal fisheries can also be defined according to other criteria. For example, fisheries are often defined on the basis of the ecosystem within which fish are caught. Using these criteria, coastal fisheries in the tropics can be grouped into estuarine and mangrove, coral reef, and slope fisheries. Slope fisheries may be further divided into **demersal** and **pelagic** fisheries, depending on whether fish reside and are caught near the bottom (demersal) or in the water column (pelagic). This provides an entirely different perspective on the nature of coastal fisheries than the division according to scale and, although this approach largely ignores the important human factors, it is an important point of view to present to fisheries managers, policy makers and planners.

Mangrove fisheries are generally almost exclusively the domain of subsistence and artisanal fishers, although commercial fisheries exist in mangroves in some countries. The main resources harvested in and adjacent to mangrove forests are:

- mullets
- various sea perch
- clams and mussels
- mud crabs
- mud lobster
- shrimps
- oysters

It is absolutely crucial in managing mangrove fisheries to consider the needs and rights of the subsistence / artisanal sector. The temptation to overdevelop the commercial potential of mangroves and adjacent habitat should be avoided. In addition, the harvest of timber from mangrove forests where there are subsistence or artisanal fisheries should be carefully controlled so that any effect on mangrove fisheries is minimized.

Coral reef fisheries are also the historical preserve of subsistence and artisanal fishers. Today, light commercial fisheries also exist in most reef areas. A wide variety of fish and other marine resources are taken using a variety of methods. It is the tremendous variety of resources that are harvested from coral reefs, and indeed all tropical, inshore ecosystems, that contributes substantially to the difficulty of managing reef-based fisheries.

We will use the village fishery of Dravuni Island, located within the lagoon of a large, nearly circular barrier reef, the Great Astrolabe Reef, Fiji as an example of a typical coral reef fishery. On a representative day spearfishing, men from the village took 13 species of reef fish. At night, a further 9 species were speared. About 15 species were taken by 5 women and 1 man using handlines on another average day. These figures are normal for reef fisheries, where numerous species contribute to each day's catch.

Considering the fishery as a whole for a region, the extremely high number of species taken in tropical fisheries becomes even more obvious (Table 2). The high number of species, combined with the high diversity of landing sites, makes even the gathering of statistical information all but impossible. Clearly, conducting stock assessments for 175-396 species would be an impossible task, and other techniques have to be used in managing reef-based fisheries. Very few, if any, reef-based fisheries are effectively managed at present.

Table 2. Catches of fish in reef-based fisheries in various areas in the tropical Pacific (SOURCE: data from Wright 1993).

Area/country	# of spp.
Tigak Islands, northern PNG	253
Arno Atoll, Marsall Islands	175
Onotoa, Kiribati	396
Solomon Is., fishing competition	183

Slope fisheries for demersal species take place in the deeper areas adjacent to reefs (100-500 m), or along the edges of continental shelves. Most tropical countries have relatively narrow continental shelves, the domain of the most productive industrial fisheries. Most island nations have no shelf at all, and coral reefs tend to slope rapidly to abyssal depths. For islands, therefore, the zone suitable for demersal slope fisheries is very narrow.

Of particular significance on slope areas between 100 and 500 m are snappers (Lutjanidae) and groupers (Serranidae). Because of the depths involved, such demersal species have not generally been targeted by subsistence fishers in most areas. Nevertheless, snappers and groupers from the deep reef-slope have rapidly become targets for commercial fisheries because of their high value to tourist and export markets.

The diets of most slope species of commercial interest is only rather poorly known. Some species feed near the bottom on smaller fish and bottom invertebrates, while others feed up in the water column on small pelagic fish and planktonic invertebrates such as salps. The primary production which drives food chains leading up to deep-water snappers and groupers most probably originates in shallow water, since these fish occur in a zone well below that in which efficient photosynthesis can occur. Food webs at those depths are probably driven largely by organic matter exported from mangrove forests, seagrass beds, and coral reefs.

Environmental engineers and other mining specialists charged with the disposal of large quantities of mine tailings are fond of citing reports of the low biological productivity of deep slope areas. This is done as a means of justifiying the disposal of mine tailings at sea in the same slope areas where commercial snapper and grouper fisheries are prosecuted. The existence of these fisheries negates the assumption that such areas are of low biological productivity. Indeed, the figures cited by those in favour of marine disposal are usually taken from deep-sea areas that are located away from highly productive, shallow-water ecosystems such as coral reefs, seagrass beds and mangrove forests. The export of energy and materials from those ecosystems to adjacent deep-sea areas is probably substantial. Any proposals to develop sites for the disposal of marine tailings into reef slope areas should include assessments of biological and economic productivity based on local studies, not just blind acceptance of biological productivity figures taken from other types of deep sea areas. While there may well be other grounds for justifying marine disposal, it seems unlikely that the often-cited 'low biological productivity' is justified for the reef slope environment.

In general, slope fisheries are prosecuted by boats that are less than 15 m long, and in most countries less than 10 m long. They may be powered by either inboard or outboard engines. A few vessels use echo-sounding equipment to locate fishing grounds, particularly in well developed fisheries such as that of Hawaii, but most small vessels use land bearings to locate suitable sites for fishing. Multi-hooked, baited, hand lines are the main fishing gear in use.

The narrow width of the reef-slope zone means that a relatively small area is available to support fish resources. This makes reef-slope fisheries particularly susceptible to overfishing. A further factor contributing to the susceptibility of reef-slope snappers and groupers to overfishing is the fact that they tend to form aggregations around promentories, rather than being evenly distributed across the slope. This further reduces the productive area, and changes the expected relationship between catch per unit of effort (CPUE) and population size. In species which form such aggregations, CPUE data are unlikely to be reliable, since as long as there are enough fish to saturate catches, the CPUE will be unrelated to population size. Thus, changes in CPUE may not occur until stocks are in serious decline.

Although tropical deep-water demersal fisheries are in the early stages of development in many countries, the potential for serious overfishing should not be ignored. For example, there are five main species in the well developed deep-slope fishery of Hawaii. Of these, three are known to be overfished, while one is near optimum level of harvest, and the other is thought to be underutilized. Controlling

such a multispecies, hook-and-line fishery so all species are equally exploited is impossible, since it is not possible to select what species are caught.

The sensitivity of deep-slope fisheries to overfishing is often exacerbated through government incentives to develop the fishery. These have included financing the construction of fishing boats, the construction of support facilities such as ice houses (e.g. see Figure 29), and assistance with marketing. These are the same incentives that have led to the overcapitalization and overdevelopment of other fisheries, and could have the same disastrous consequences to deep-slope fisheries that they have had elsewhere.

A further aspect of this fishery makes it sensitive to overfishing. Since this is a hook-and-line fishery, there is no equivalent of mesh-size limitation that can control the size of fish caught. Once fish are brought to the surface, they are generally dead or dying as a result of expanded and burst gas bladders. Thus, undersized fish cannot be released, for they would not generally survive. This makes the fishery susceptible to **growth overfishing**; that is, fish may be harvested at a less than optimal size and this can reduce overall yield to the fishery.

6.4. *Types of fishery according to target species*

Another way to categorise fisheries is according to the target species, such as lobsters, giant clams, groupers (rock cods), barracuda and so on. This approach ignores complex interactions among species, ecosystem effects, and critical human factors, but may provide valuable insight into the management of targeted resources. It is particularly important for managers to think about fisheries according to target species because some species are more susceptible to overfishing than others. Also, looking at fairly simple targeted fisheries highlights some of the complexities of managing tropical marine resources.

A number of species, or groups of related species, are the targets of directed inshore fisheries in tropical areas. Most of these directed fisheries are carried out for commercial purposes by either artisanal or commercial fishers. Such directed fisheries include trochus, sea cucumbers for bêche-de-mer, pearl oysters, snappers, groupers, mud crabs, and mud lobsters, as well as many other species too numerous to mention (see Wright and Hill, 1993 for examples).

As an example of a directed commercial fishery, we can examine the bêche-de-mer fishery. The harvesting of sea cucumbers for processing into bêche-de-mer — also called *trepang* — is an industry that began in the tropical Pacific as early as the the late 18th century. Strictly speaking, the term bêche-de-mer refers to a dried product manufactured from sea cucumbers, rather than the animals themselves. The principal producers of bêche-de-mer in the Pacific are Papua New Guinea, the Solomon Islands, New Caledonia, Vanuatu, and Fiji, with a mean annual harvest in the South Pacific of 1717 tonnes valued at just over US$ 12 million (Table 3). On a world scale, Indonesia and Philippines are also major producers, each with an annual harvest roughly equal to the rest of the Pacific combined.

Table 3. Annual bêche-de-mer production in the South Pacific, 1989-1992 **(Source: extracted from SPC 1994)**.

Country	Tonnes harvested	US$ Value
Papua New Guinea	546	4 776 708
Solomon Islands	622	2 594 864
New Caledonia	123	1 33 560
Vanuatu	24	86 268
Fiji	402	3 579 840
Total	1717	12 371 240

The product is prepared by boiling sea cucumbers, cleaning, and drying them to a hard, rubbery consistency. They may also be smoke cured. The traditional market for this product is vast, including China and South-east Asia where it is considered a delicacy and an aphrodisiac, but markets also exist in Asian communities in many western countries.

Sea cucumbers belong to the class Holothuroidea of the animal phylum Echinodermata, the phylum which also includes sea urchins, starfish (seastars), brittle stars, and sea lilies. There are about 1200 species of sea cucumber that have been described worldwide, with about 300 species in shallow water within the Indo-Pacific region. Of these, about 17 species in five genera are harvested for the production of bêche-de-mer. The multi-species nature of the bêche-de-mer fishery is typical of tropical fisheries, and provides a good example of the difficulties of managing such fisheries.

Holothurians are either deposit feeders or suspension feeders. Deposit feeders feed by using flat, branched tentacles to collect deposits of bottom sediments, which are then forced into the mouth through the action of the tentacles. Suspension feeders use highly branched, tree-like tentacles, which are covered in mucus, to trap particles suspended in the water. Food is removed and digested when the tentacles are inserted into the mouth and 'swallowed' together with trapped food particles and mucus. Nearly all commercial sea cucumbers are deposit feeders, although precise feeding relationships for most species remain unknown. We know almost nothing about the rôle of sea cucumbers in the ecosystems in which they occur, but their high abundance in those areas where they are not harvested suggests that this rôle is probably not trivial.

Sea cucumbers are essentially sedentary animals, although many species move over short distances, especially those which feed on bottom deposits. Their low mobility makes them particularly susceptible to overharvesting because they are easily seen by divers and shallow-water gleaners. Sea cucumbers are harvested by gleaning from shallow reef and mud-flat areas, by free diving, SCUBA diving, and diving using surface-supplied air (hookah).

As shallow water areas become depleted, there is a trend of increasing use of hookah to exploit deeper water. For example, over 100 hookah units were sold in Fiji in 1991. These units give harvesters of sea cucumbers access to substantial subtidal populations. The increasing use of hookah places increasing pressure on the resource, and many areas are already overfished. It also places the lives of collectors at risk, as many accidents occur with the use of this equipment.

The trade in bêche-de-mer is as complex as the assortment of species which make up the resource, and it is difficult to obtain accurate statistics on the industry. Two major centres in the bêche-de-mer trade are Singapore and Hong Kong. In 1988, Fiji reported a total production for export of 717 metric tonnes of bêche-de-mer, but Hong Kong alone reported total imports of 1000 metric tonnes from Fiji in the same year. Thus such statistics as are available are of dubious reliability.

Possibly, part of the reason for the discrepancies in statistics is that there is a considerable amount of illegal fishing for bêche-de-mer taking place in Fiji. Much of the production of bêche-de-mer through illegal fishing is also exported illegally and would not be recorded in the export statistics. Such illegal fishing also creates its own problems in the management of the fishery as it goes completely undocumented.

There are very few tropical sea cucumber fisheries that are under any form of management regime. In all of the tropical Pacific Islands, as of 1992, there were only two countries with any formal management practices at the national level for sea cucumber fisheries:

- minimum legal size limit on dried sea cucumbers (Fiji);
- export limit of 40 tonnes of dried bêche-de-mer (Vanuatu).

As stocks are becoming severely depleted through the use of diving equipment in many areas, and are already overexploited in most areas, the need for some form of management of bêche-de-mer fisheries is obvious. The form that this management will take, if any, in financially-limited tropical countries remains to be seen. Possible management techniques include:

- closed areas (reserves);
- closed seasons;
- quotas;
- gear restrictions.

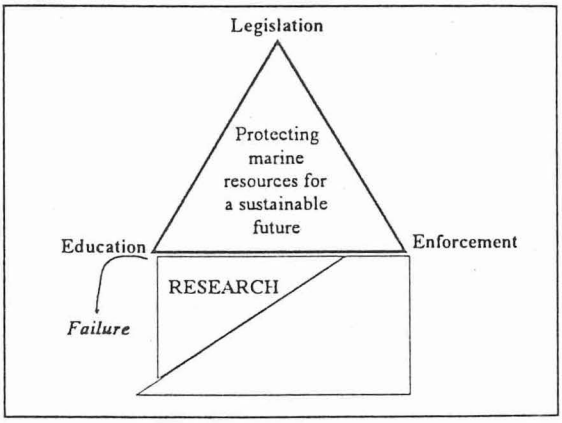

Figure 23. The protection of marine resources to provide for a sustainable harvest for the future requires appropriate legislation, education and enforcement. All of these must be balanced on a firm foundation of research into the biology, sociology and economics of fishing systems.

The biggest problem facing most tropical nations, however, is not the development of appropriate legislation, but rather developing the capacity to enforce such regulations as may be developed to protect bêche-de-mer fisheries. Legislation is useless without its two counterparts, education and enforcement (Figure 23), but education and enforcement are expensive.

The management conclusion to be drawn from this analysis of bêche-de-mer fisheries is that even directed tropical fisheries are based on complex, multispecies assemblages. Such statistics as are kept are not available for individual species, and indeed, gathering fisheries data for individual species in most cases would be impossible. The usefulness of even the statistics that are available is questionable because an unknown fraction of the catch goes unreported, and may even be taken and marketed through illegal means. For this reason, the usual fisheries management techniques of stock assessment and quota setting are impossible. The absence of sound management strategies, but the development of techniques that can increase total catch as well as catch rates, places these fisheries resources in great danger of being overharvested. Since little is known of the rôle of sea cucumbers, or indeed most commercially harvested species, in the ecosystem in which they occur, the development of fisheries without this knowledge is dangerous in terms of maintaining stable ecosystem properties.

Discussion questions

1. Which do you consider more valuable to society; a strong village system based on small scale-fisheries, or a strong national economy based in part on large-scale commercial fisheries? Are these two mutually exclusive? Explain your answer to both of the above questions.

2. What would you expect the socioeconomic consequences to be of a collapse of inshore fisheries in your area?

3. How do you think the collapse of inshore fisheries can be prevented in your area?

4. Can you think of multispecies directed fisheries in your area? Discuss one, and the problems that it presents to fisheries managers.

5. Do you see any problems with the approach to fisheries management implicit in the approach suggested by the quotation below? Suggest alternative approaches to sea cucumber management.

> "*At present, we do not have the information needed to manage holothurian fisheries in order to produce maximum or optimum sustainable yields. For this, more detailed studies of the processes of recruitment, growth and mortality are needed.* We do nevertheless have the basic biological information needed, and the research techniques available, at least to develop management systems that will protect the resources of most commercially important holothurians from the worst effects of overfishing, and to ensure that the resource is harvested in a sustainable way." (SOURCE: Preston 1993: 403 — *italics* added)

CHAPTER 7

The changing nature of fishing communities

OBJECTIVES

When you have completed this chapter you should:

- be aware of the dependence of coastal communities on marine resources
- understand the nature of subsistence fisheries, and be able to state some of the features of traditional fishing societies that have conservation effects
- understand changes taking place in the way coastal communities use marine resources, and the impact of such changes on those resources
- be able to describe some of the effects of population growth on marine resources. and on patterns of resource use
- be able to describe, using an example, some of the effects of the mismanagement of inland resources, and of poor economic opportunities or policies, on patterns of marine resource use
- be able to describe some of the effects of these changing patterns of resource use on the inshore environment and on its fisheries resources

BACKGROUND REQUIRED

The following background knowledge will greatly facilitate your understanding of the material in this chapter:

- an understanding of tropical inshore ecosystems, the interactions among them, and some of the threats which they are facing
- knowledge of inshore fisheries according to scale, ecosystem fished, and target species
- some knowledge of changing patterns of fishing and marine resource utilization in your own society

STUDY QUESTIONS: The changing nature of fishing communities

These study questions are provided to guide your study, and should be answered as you study the readings and other material provided with this course. It is a good idea to write out the answers to these questions in a notebook, and to include illustrations as much as possible. These answers will serve as your study notes for this course.

> **HINT:** Wherever possible, try to organise your answer using a concept map, flow chart or other non-linear format.

1. To what extent are coastal communities in the tropics dependent on inshore marine resources. Can you cite examples from your own country?

2. List as many aspects as you can of traditional fishing practices and societies that have conservation effects. Add any information that you can from your own country. Do you think the conservation aspects of traditional fishing societies were intended to conserve resources? Explain.

3. Explain briefly how island size and reef area affect the susceptibility of coastal resources to overharvesting.

4. Document the changes that are taking place, or that have taken place in the recent past, in the fishing practices of coastal communities in the tropics. How do these changes affect the pressure on coastal marine resources? What are the long-term consequences of this?

5. How does population growth affect patterns of inshore fishing? What are the consequences of this for marine resources?

6. Describe, using an example, some of the effects of the mismanagement of inland resources and of poor economic opportunities and policies on patterns of marine resource use. What are the consequences of this for the coastal environment and its fisheries resources?

7. The changing nature of fishing communities

7.1. *Dependence of coastal communities on marine natural resources*

It has been estimated that 60% of the world's populaton, or 5.5 billion people, lived in the coastal zone in 1990. As the world's population grows, this figure is expected to increase to 75%, or 11 billion people, by 2100. Clearly, this places considerable pressure on coastal resources, and on the sea as a source of protein. We need to consider the dependence of coastal peoples on the sea, how the changes in patterns of coastal resource-use that are currently underway throughout the tropics affect these resources, and the management implications of this knowledge if we are to manage coastal resources for a sustainable future.

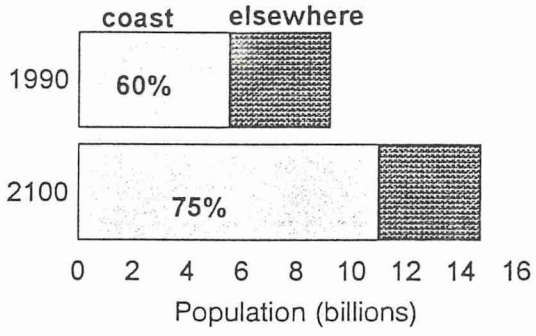

Figure 24. World population in the coastal zone in 1990 and projected for 2100 (Source: **UNEP 1992, *The World Environment*).**

Coastal communities throughout the tropics have traditionally been dependent on subsistence fishing for a substantial part of their protein. Taking the South Pacific region as an example of the importance of subsistence fishing, it has been estimated that 80% of a total inshore catch of 104 658 metric tonnes worth US$ 243 677 346 annually between 1989 and 1992 was taken by the subsistence sector (SPC 1994). While it is likely that this represents an over-estimate as it is evident that SPC (1994) uses 'subsistence' in the sense of 'subsistence/artisanal', nearly all of the artisanal catch of finfish goes to local markets, so this figure represents local consumption. Most of the commercial, inshore catch of finfish is also sold in local markets, so clearly marine protein is important within the South Pacific region.

Although the advent of modern technology and the availability of processed and packaged foods have changed some patterns of food consumption among coastal peoples of the tropics, most coastal communities still depend heavily on seafood to meet their protein needs. Indeed, it has been estimated that more than 60% of the population of developing countries derrive at least 40% of their annual protein from fish. For example, in Vanuatu, village-level fishing provides 61-65% of the total protein consumed in the country.

The present dependence of coastal communities on fishing to meet their immediate nutritional requirements places a responsibility on fisheries managers and planners to ensure the sustained access by coastal communities to critical resources. Indeed, it can be argued that ensuring the long-term access by coastal inhabitants to healthy stocks of marine resources is far more important than developing commercial fisheries towards some idea of maximum or optimum commercial yields (Figure 25).

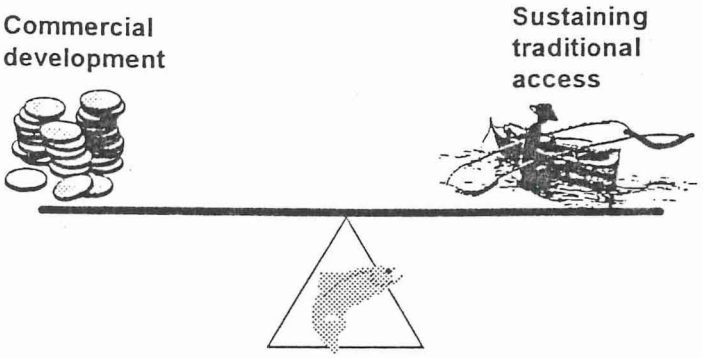

Figure 25. Balancing different objectives of fisheries management.

7.2. *Traditional, subsistence fishing communities*

Prior to the arrival of the market economy in tropical village societies, fishing formed part of a self-sufficient economic unit consisting of village, land, and sea (Figure 26).. The land provided vegetable staples through subsistence agriculture and the gathering of wild foods. Hunting and keeping domestic animals. such as pigs and chickens, provided for some protein needs. For the majority of coastal communities, however, most protein requirements were met through fishing and gleaning other marine resources.

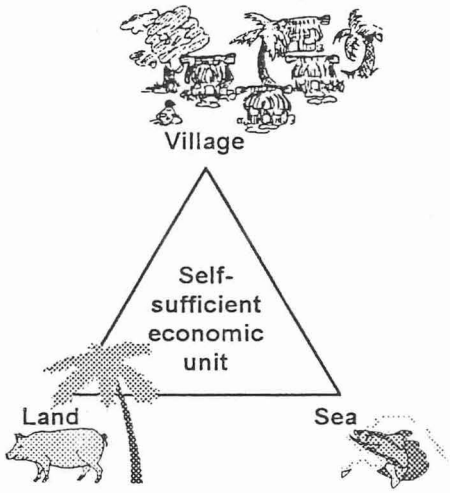

Figure 26. The self-sufficient economic unit of traditional societies before the advent of the market economy.

Within traditional subsistence fishing societies, a variety of ingeneous fishing methods were employed using intricately constructed fishing gear made and deployed by highly skilled fishers. Johannes (1981) described the traditional fishing technology and methods employed by Palauan subsistence fishers. Traditional Palauan fishing technology included throwing spears, natural poisons, parts of other marine organisms, leaf sweeps, shark nooses, gorges, weirs and fish traps.

Four aspects of traditional fishing technology and methods meant that the impact of the fishery on target populations and on the ecosystem in general was relatively small. Firstly, the fishers were also the manufacturers of the gear used, and this meant that a substantial fraction of their time was spent making fishing gear, so they were not fishing at such times. Secondly, the fishers were not as mobile as they can be with modern, engine-powered fishing boats, so there were always areas that were not fished. These "protected" areas could act as natural reserves, supplying fish to outside areas if local depletion did occur. Thirdly, the subsistence nature of the fishery meant that only small quantities of seafood were needed to supply local need. Therefore, there was no need to catch excess fish, so fishing was generally a part-time operation. Fourthly, until this century, most tropical coastal areas had low human population densities.

Another important consideration here is the relationship between island size, reef area, and the size of human populations. Large islands, with a large reef tract, and a relatively small human population can be expected to have a relatively low

susceptibility to overexploitation by subsistence fisheries. Small islands, with small reef tracts and relatively large human populations may be susceptible to overfishing even by subsistence fisheries. Similarly, islands with narrow fringing reefs are more likely to be overexploited by subsistence fisheries than are islands with broader barrier reefs enclosing fairly deep lagoons.

In addition to the low impact of traditional subsistence fisheries due to aspects of the technology and the nature of the fishery, many traditional fishing societies had various traditions and taboos that had benefits in terms of conservation. Johannes (1981) noted a number of features of traditional Palauan society that promoted conservation:

- *lagoon tenure* - the right to fish in an area resides with the village, and no outsiders are allowed to fish without permission. This reduces the probability of overfishing a resource as a result of non-ownership;
- *avoid waste* - in many societies, an ethic of catching only the fish that were needed was present;
- *restricted species* - some villages restricted the catching of some easily obtained species, or restricted fishing in nearby sheltered areas, to periods of stormy weather when other species or areas were not accessible;
- *reduced fishing on spawning aggregations* - some villages had total bans on fishing the spawning aggregations of some species, while others had a policy of allowing some spawning to occur (e.g. 1 day) before fishing was allowed;
- *religious protection* - some species were protected by virtue of their religious significance, or the religious significance of the area where they occurred.

7.3. *Coastal fishing communities in a modern context*

There are still a few areas where traditional culture has been largely unaffected by contact with market economies, so traditional fishing technology and methods are still used and traditional ethics with conservation benefits are still in place. However, in most areas throughout the tropics societies have been influenced by modern economics, technology, fishing methods, commercialization, and ethics.

Among the changes taking place at village level throughout the tropics are:

- increasing adoption of a market economy
- more widespread use of outboard motors
- increasing use of monofilament nets and lines
- better storage, handling and marketing facilities

Even at the village level, and even in remote regions, societies are increasingly adopting a market-oriented economy. However, for most rural villagers, the only marketable products are agricultural and marine resources. These are the same resources that sustained villagers prior to the advent of a market economy. Therefore, the increasing acceptance of market economics means the gradual erosion and

disappearance of the self-sufficient economic units represented by the interaction of village, land, and sea (Figure 26).

We will examine some of these changes in village level fishing, using Fiji as a case study. The increasing change from subsistence fisheries to artisanal and small-scale commercial fisheries is evident in the number of small-boat commercial licenses issued by the Fiji Fisheries Division (Figure 27). The number of licenses increased exponentially until 1986, but stabilized after that, and even decreased in 1993.

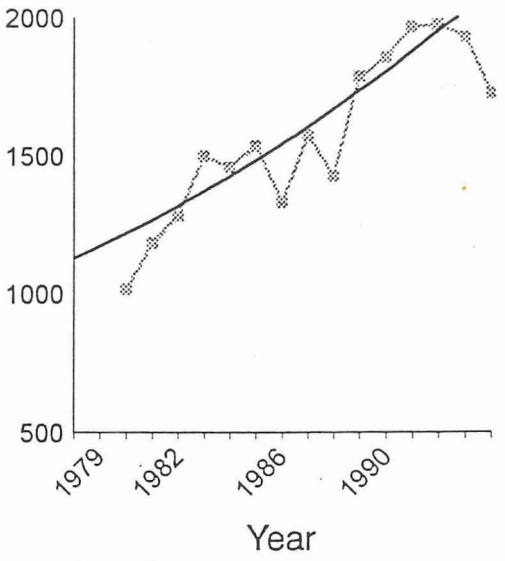

Figure 27. Commercial fishing licenses issued by Fiji Fisheries Division 1978-1991.

The increasing use of motorized boats is well illustrated by vessel registration figures for Fiji up to 1990 (Figure 28). Clearly, the increasing registration of fishing vessels is a trend that could not continue without placing coastal resources under serious threat, if indeed the threat level has not already become serious in most areas. Fortunately, the registration of commercial vessels has decreased in Fiji since 1990.

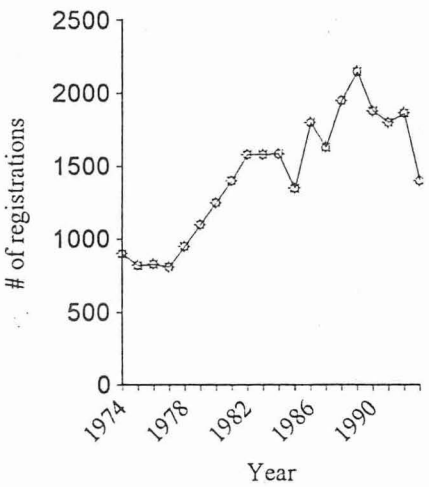

Figure 28. Vessel registrations in Fiji 1974-1990.

Changes in the patterns of use of nets and monofilament lines are difficult to document, although it is a well known trend. In Fiji, much of the gear sold to fishers is marketed through the Fisheries Division, and amounts to c. FJ$ 47 000 annually. Much of this consists of monofilament nets and lines.

One of the most significant developments that is giving coastal villages increasing access to commercial markets is the availability of ice and freezing facilities. As an example of the impact of ice we can examine trends in Fiji, where ice is sold to fishers by the department of fisheries. Ice production has increased exponentially since 1978 (Figure 29). The apparent decrease in ice production in 1993 was a result of operational problems

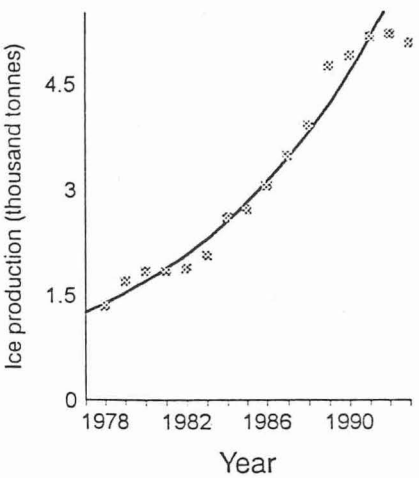

Figure 29. Ice production by Fiji fisheries, 1979-1991.

in two ice plants, and does not represent a change in the overall trend. This is a dangerous exponential trend, which cannot continue indefinitely without contributing to the risk of overfishing.

As societies move from subsistence to artisanal and commercial fishing (see Chapter 6), the pressure on the resources increases substantially (Figure 30). It is also the case that as villagers move away from subsistence fishing, with few exceptions, their dependence on processed foods of low nutritional quality also increases. This increasing dependence on processed foods and other aspects of 'western' lifestyle means that money is needed to acquire such commodities. The need to pay school fees for children also creates a demand for money, and the only way to acquire it in most rural settings is to harvest more natural resources. This creates further pressure on those resources, and increases the likelihood of overharvesting, and the danger of creating a cycle of increasing demand for natural resource harvesting (Figure 31).

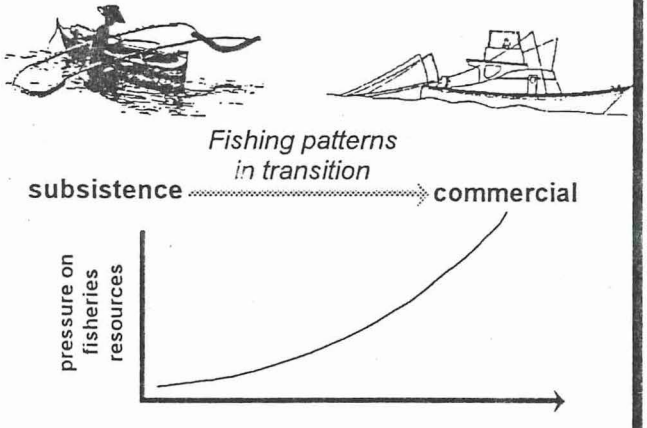

Figure 30. Changes in village-level fisheries.

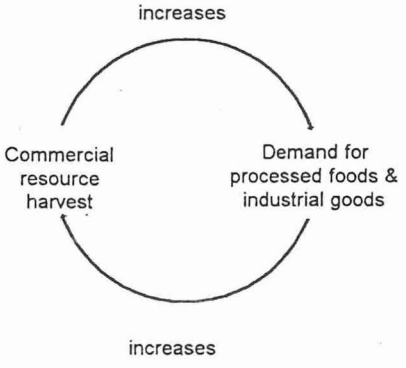

Figure 31. The circular relationship between commercial resource harvest and demand for commercial goods.

Improvements in fishing power, population growth, and increasing commercialization of fisheries have already resulted in declines in stocks, catch rates, and even total landed volume of fish in many areas (Table 4). There is probably no greater challenge facing fisheries managers than the challenge of maintaining sustainable fisheries in the face of the changes taking place in village-level fishing as a result of increasing fishing power, increasing populations, increasing market demand for fish, the cyclical relationship between increasing demand for manufactured goods and the increasing need to harvest marine natural resources to pay for them.

Many of the cultural traditions that helped to protect marine resources in pre-market societies are being eroded away as village economies become increasingly market-oriented. In many cases, such cultural traditions were either deliberately or unintentionally weakened or eliminated by past colonial administrations. However, in many areas, especially in the Pacific, the exploitation of nearshore resources has continued to be regulated by customary marine tenure.

Table 4. Evidence of overfishing in tropical Pacific countries (from SPC 1994).

Area	Type of resource & effect
Palau	Declines in stocks of reef and lagoon fishes
Kiribati	Declines in stocks of reef and lagoon fishes
Cook Islands	Declines in bonefish, milkfish, and parrotfish
Fiji	Declines in Serranids (groupers) and Lutjanids (snappers)
Western Samoa	Declines in reef and small pelagic fishes

Such tenure relationships are a mixed blessing for those charged with managing marine resources. On the positive side, customary tenure has restricted entry into fisheries, thus solving one of the problems of fisheries managers. It has also prevented the authoritarian management of fisheries by central government, and forced government fisheries departments into a more advisory rôle. In places where marine tenure relationahips exist, there is a good basis for the establishment of community-based management schemes. On the negative side, customary tenure can prevent the development of large marine reserves as a management tool for fisheries.

Whatever the effects of customary tenure relationships on fisheries, it is crucial for fisheries managers to work together with the holders of such customary rights towards shared management of resources. It is equally crucial for fisheries managers to work with coastal villagers in developing management plans, and to incorporate local knowledge of marine resources into management plans. The effective management of the diversity of marine natural resources in the tropics, as well as the diversity of people dependent upon them, is necessary to ensure a sustainable future is surely the greatest challenge facing all countries that are blessed with an abundance of warm water, coral reefs, seagrass beds, and mangrove forests.

7.4. *Population growth and integrated mismanagement*

All other immediate threats to the management of neashore marine resources for sustainability are relatively inconsequential when compared to the threat from **exponential human population growth**. The populations of most tropical countries are growing at dangerously high rates, and an increasing fraction of people are projected to inhabit the coastal zone (Figure 24). This means more people in fishing families, and an escalating demand for marine resources to feed increasing numbers of people. Population growth has consequences for the management of coastal resources that go far beyond the simple need to feed more mouths.

One of the consequences of high population growth, particularly when there is a general lack of economic opportunities, is that many people become involved in marginal fisheries. When the industrial and agricultural sectors of the economy cannot absorb surplus labour, the consequence for most countries is severe unemployment and poverty. Many people who make up the surplus labour pool turn to small-scale fisheries as a means of providing food and ensuring at least a small income. Often such small-scale fishers are also small-scale farmers as well, with neither fishing nor farming meeting their needs adequately. As populations grow, the pressure on marine

resources increases, but overfishing greatly reduces yields to individual fishers, thus increasing hardships.

This phenomenon has been documented in a number of places, but was recently highlighted for the Samar Sea area of the Philippines by Jürge Saeger (1993). For the Philippines as a whole, the number of marginal fishers has increased by 7.5% every year since the early 1960s, a rate which has doubled marginal fishing every decade. All of these fishers and their families live below the poverty line. In the Samar Sea, 40% of all fishers only fish on a part-time basis. Seventy-five percent of fishers have **seven** or more children (see box below).

Population growth has not been the only factor leading to an increase in marginal fishers, for some of the increase has been due to a phenomenon that I will call **integrated mismanagement**. In this case, the increase in marginal fishing involves the combined effects of population growth, unfavourable economic conditions and policies, and poor management practices in upland forest and agricultural land (Figure 32).

Poor upland land management practices, most notably afforestation, have resulted in severe soil erosion of up to 10 cm per year. This amounts to as much as 2000 tonnes per hectare of soil eroded from the land each year, and it has caused most of the marginal agricultural land in the are to become unproductive. As a result, small-scale farmers and their families were forced to move to the coast to partake in the fishery. The net result has been severe overfishing, with many of the fish that were once common no longer being part of the catch, indicating that they have been fished out.

Many religions have a belief that the deity or deities which they worship commanded them to procreate and increase population levels. Taking Christianity as an example, the *Bible* commands Christians to '*multiply and fill up the earth*'. This has been interpreted by some Christian sects as an admonishment against birth control and family planning. However, the *Bible* does not say 'multiply and *overflow* the earth, destroy her resources, create poverty and disease, and eventually make the earth uninhabitable'. It only says '*fill* up the earth'. How do we know when the earth is full? What must we do when it is full? The answers are all around us. The earth is already more than full, and we are destroying the environment that sustains us. We must control our own population, but this can only be achieved through economic and educational upliftment together with an acceptance of its necessity.

The poor upland management practices have further complicated the effects on fisheries, as the heavy sediment load in coastal waters from the afforested mountain slopes has killed off most of the coral reefs around Samar Island. Only 5% of the coral reefs in the area are considered to be in reasonable condition. The loss of a productive ecosystem such as a coral reef further reduces fisheries productivity, and contributes further to coastal degradation. The relationship among these factors, and how they contribute to the degradation of the coastal marine environment is presented in Figure 32.

The interaction of population growth, poor economic opportunities or policies, and the mismanagement of inland resources clearly have major direct implications for the management of marine resources (Figure 32). All of these factors, however, are beyond the control of fisheries managers acting alone. Nevertheless, managing fisheries resources will inevitably require the control of all of these potential problem areas. The only way to achieve this is to adopt a programme of integrated management in which all aspects of the environment and its resources are managed as a single integrated system.

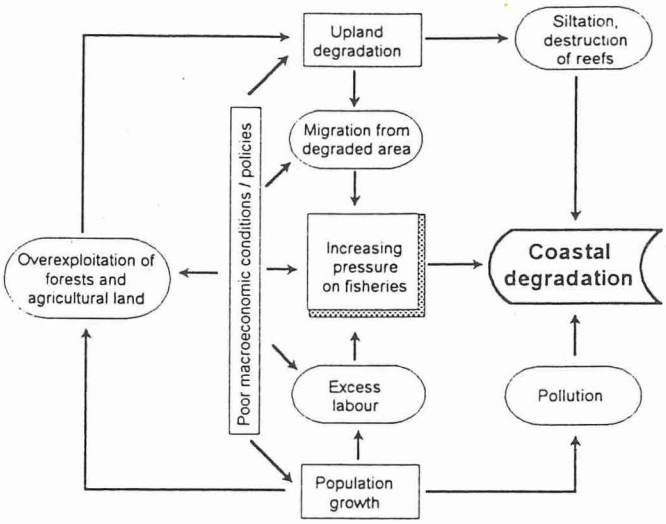

Figure 32. Interaction of some of the factors producing degradation of coastal marine ecosystems.

One of the problems with achieving integrated management is that environmental degradation is often a slow and subtle process, that results from an accumulation of relatively imperceptible impacts. We are only able to notice environmental changes by making comparisons, but we are rarely able to make comparisons with a healthy state of the environment. Rather we compare the current state of the environment with that state which we have observed most recently. Looking at extinctions of a once abundant species such as the passenger pigeon as an example of this phenomenon, we see that each generation remembers a different situation. Once, the birds were so abundant that it was difficult to believe that hunting them could diminish their numbers in any way. However, gradually, through time, their numbers declined. Hunters continued to hunt, having only recent abundances with which to compare perceived current abundance. Each hunter contributed a little to their decline, and eventually passenger pigeons were hunted into extinction, almost without anyone taking notice.

Similarly, managers and developers are generally reluctant to believe that the process or development under their management contributes seriously to environmental degradation. It is essential to convince governments of the need to treat the environment as an integrated whole, involving people, land and water, and that therefore it should be managed in an integrated manner. It is hoped that all students of this course will be better able to understand the nature of fisheries in relation to the total environment, and apply that understanding by implementing integrated laws and policies that reduce overfishing, and prevent other forms of environmental degradation.

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Glossary

$^{o}/_{oo}$ - parts per thousand, usually used to express salinity values (*see also* salinity)

> - mathematical symbol for 'greater than'

< - mathematical symbol for 'less than'

abiotic - non-living; not pertaining to living systems

adaptation - a genetically inherited trait, or a related set of genetically inherited traits, that convey selective advantage under certain environmental conditions (e.g. the elongated mouth of the longnose butterfly fish is an **adaptation** for obtaining food within holes and crevices in the reef)

ahermatypic corals - corals which do not form coral reefs (e.g. some stony corals, soft corals, black corals)

alga (plural **algae**) - general name with no taxonomic status for fairly simply structured plants characterised by naked reproductive structures, and including seaweeds and phytoplankton, as well as freshwater, terrestrial and subaerial forms

algal ridge - low, jaged coralline algal ridge especially common on the windward side of coral reefs, and often dominated by *Hydrolithon onkodes* in the Indo-Pacific region.

aphotic zone - the deep portion of the oceans where light levels are too low to support photosynthesis (*see also* euphotic zone)

aragonite - one of two forms of calcium carbonate deposited by living organisms on coral reefs

artisanal fishery - a fishery in which fish or other living marine resources are harvested on a small scale, usually for local markets

atoll - a roughly circular reef that encircles a central lagoon, often with small islands on the reef top formed by accumulated calcareous sand derrived from reef organisms

barrier reef - a coral reef which is located some distance from the shore (usually > 1 km) and separated from it by a relatively deep lagoon

benthic - pertaining to the sea bottom and to the organisms that inhabit the sea bottom

benthic algae - those algae living attached to rocks and other substrata on the ocean floor

biomass - the total mass of all living organic matter, usually expressed on a per area basis

bioerosion - the erosion of rock and skeletons of reef organisms through the activities of living organisms, such as boring algae, sponges, and animals that comsume calcified food

biotic - biological, living

blade - the flattened, usually broad, leafy structure of seaweeds and seagrasses

bleaching - the loss of endosymbiotic algae by corals and other invertebrates, usually considered a stress response to a variety of environmental perturbations such as extremes of light, temperature and salinity.

bloom - the occurrence of extremely dense populations of one or more species of algae, often used in the context of phytoplankton, but also applied to blooms of benthic algae that may occur in association with eutrophication

blue-green algae - photosynthetic bacteria (Cyanobacteria) that are usually treated as algae

borer - an organism which penetrates, and lives within living or dead calcareous material, or within rock

bryozoan - an organism belonging to the phylum Bryozoa (moss animals); phylum of small, aquatic, usually attached and colonial animals superficially resembling hydroid coelenterates but considerably more complex; have ciliated tentacles with which they feed and a through digestive system with an anum; some have thorny or calcareous skeletons

buoyancy - the ability of an object or organism to float or rise upwards as a result of the forces exerted by the water

calcification - the living process by which calcium carbonate and related salts are laid down by corals, calcareous algae and other organisms to form hardened skeletons; the physical precipitation of calcium carbonate and related salts

calcite - one of two forms of calcium carbonate deposited by living organisms on coral reefs

calcium carbonate - carbonate salts of calcium, and other cations such as magnesium and strontium that substitute easily for calcium (limestone)

carnivore - an animal which feeds on other animals

catastrophe - the relatively sudden large scale mortality of most organisms within an ecosystem, usually resulting from a major environmental perturbation such as a severe storm

cementers, reef - those calcified organisms which bind together reef material into a stable and solid structure; mainly coralline algae

colony - a group of individual organisms of the same species that live together in a mutually interdependent way (e.g. a coral colony)

commensalism - a symbiotic relationship in which the symbiont benefits without seriously affecting the host either positively or negatively (*see also* mutualism)

commercial extinction - the point in overfishing a resource when the resource can no longer be harvested at a commercial profit, and the fishery collapses

commercial fishery - a fishery in which fish or other living marine resources are harvested on a fairly large scale, for local, urban or export markets

community - all the organisms (plants, micro-organisms, animals) that occur in a given area or habitat; the biotic component of an ecosystem (*see also* ecosystem)

competition - the result of two or more individuals, populations or species using a common resource (e.g. space, food, light) within an ecosystem; one or more individual, population or species is negatively affected by the interaction in terms of growth or reproductive success

convergent evolution - evolution which produces an increasing similarity in some charagteristic(s) between two or more different species of organism which initially differed in this characteristic(s) (e.g. root structure in mangrove trees)

coral - a usually colonial animal belonging to the animal phylum Cnidaria, Class Anthozoa

coral reef - biotic structures comprising compacted and cemented assemblages of skeletons and skeletal segments of sedentary organisms living in clear, warm, oligotrophic, marine waters within the depth range of substantial light penetration

coralline alga (plural **coralline algae**) - calcified red alga belonging to the order Corallinales laying down calcium carbonate as calcite

crustose - in algae, flattened and closely appressed to a substratum

cryptocrystallization - precipitation of calcium carbonate within small spaces and chambers that contain organic material and are cut off from the surrounding seawater

cuticle - waxy, resistant covering on the outer surface of plant leaves

cyanobacteria - photosynthetic bacteria that are usually treated as algae (blue-green algae)

detritus - decaying excrement and other solid waste products of all types of organisms including their remains after death; usually rich in micro-organisms such as bacteria, fungi, and protozoa

dinoflagellate - a microscopic, single-celled or chain-forming, usually photosynthetic alga belonging to the Class Dinophyceae and characterised by a theca made up of cellulose plates, and two flagella, one trailing and one encircling the cell along a middle line

disturbance - any relatively discrete event in time that disrupts ecosystem, community or population structure and changes resources, substrate availability, or the physical environment

diversity - in ecology, the number of species (species richness) inhabiting an area, together with an analysis of their relative abundances (equitability); often used for number of species, although this is more correctly called species richness

economic overfishing - fishing at a level above which profits begin to decline decline and reach a point at which the cost of operating the fishery is more than the revenue it generates; can occur rapidly in an open-access situation

ecosystem - all the organisms (plants, micro-organisms, animals) that occur in a given area or habitat together with the non-living (abiotic) features of the environment

ecosystem overfishing - fishing critically affects the relationships among species within an ecosystem

endolithic - living within rock, or calcareous material such as coral skeletons

epiphyte - a plant which attaches itself to other plants without parasitizing them

euphotic zone - the shallow portion of the oceans where light levels are sufficient to support photosynthesis (*see also* aphotic zone)

euryhaline - an organism capable of withstanding a wide range of salinities (*see also* stenohaline)

eutrophication - the addition of unnaturally high nutrient levels to an ecosystem, and the resulting unnaturally heavy growth by a few species of algae that can tolerate high nutrient levels

fillers, reef - those calcified marine organisms which contribute calcified material that fills in the spaces among the framework builders of the reef, or which contribute to rubble that is eventually stabilized by reef cementers

food chain - a diagrammatic representation of a set of trophic relationships arranged in a linear order. A food chain can be thought of as a linear subset of feeding relationships taken from a food web (*see also* food web)

food web - a diagrammatic representation of the complete set of trophic (feeding) relationships of an organism or ecosystem.

foraminiferans - single celled animals belonging to the order Foraminifera of the phylum Protozoa, having calcareous tests that form some calcareous sedimentary deposits

framework builders, reef - those calcified marine organisms which contribute to the three dimensional frame which forms the basis of a coral reef (mainly stony corals)

fringing reef - a large coral reef formation which closely borders the shoreline, and is not usually separated from it by a wide, deep lagoon

$gCm^{-2}year^{-1}$ - grammes of carbon per square metre per year

gross primary productivity - the total amount of organic matter produced through photosynthesis by plants within an ecosystem

growth overfishing - the larger individuals in a population are progressively removed, so that the average size in the catch gradually decreases over time, and eventually, fish are harvested at a less than optimal size, thus reducing overall yield to the fishery

herbivore - an animal which feeds mainly on plant material

hermatypic corals - stony corals which form coral reefs (*see also* ahermatypic corals)

industrial fisheries - a fishery in which fishing takes place on a large scale, fish are processed industrially, to produce value-added products

isotherm - line joining points of equal temperature (often based on annual or long-term mean temperatures)

limestone - calcium carbonate rock

longshore drift - (longshore currents) currents that are set up when waves strike a shoreline at an oblique angle; responsible for much sediment transport along beaches, and are especially powerful where there are no protective coral reefs

mangal - the name given to mangrove ecosystems (*see also* **mangrove**)

mangrove - An association of trees or high shrubs which develops under sheltered conditions in the intertidal zone of tropical and sub-tropical areas; mangrove can be applied to the ecosystem, in which case it becomes synonymous with mangal, or it can be applied to the trees which inhabit the mangal; the context should enable the reader to determine in which sense the word is being used (*see also* mangal)

medusa - the free-swimming life stage of a cnidarian, commonly called a jellyfish

meiofauna - small animals between 63 μm and 1 mm in length; often important components of the diets of juvenile fish, and other fish with small mouths

mollusc - large phylum of animals including limpets, mussels, snails, octopuses, sea slugs, etc.; mostly aquatic; soft-bodied, often with a hard shell; unsegmented; with a head an muscular foot

mortality - the rate at which individuals are lost from a population through death

mutualism - a symbiotic relationship in which both the symbiont and the host benefit (*see also* commensalism)

nematocyst - a microscopic stinging cell used by cnidarians to capture prey

net primary productivity - the excess organic matter produced after some of the energy produced by plants during photosynthesis has been used for their own respiration; may be used for growth, reproduction, or storage, and is therefore available to drive food chains

nitrogen fixation - the conversion of atmospheric nitrogen into organic nitrogen compounds, a process that can be carried out only be certain bacteria and blue-green algae; the process by which the biosphere is enriched in biologically useable nitrogen

nursery habitat - habitat used by the juveniles of a species that is different from the habitat used by adults; may provide food or shelter or both

nutrients - dissolved inorganic ions found in seawater and sediment that are needed for metabolic processes by plants

oligotrophic - low in concentration of the dissolved inorganic nutrients needed by algae and other plants

omnivore - an organism which consumes a variety of animal and plant material

overfishing - fishing a resource or resources at levels which substantially reduce productivity and yield to the fishery to levels very much below levels experienced in a pristine resource, or which brings about major changes in the ecosystem; if extreme, overfishing can lead to the commercial extinction of a resource (*see also* economic overfishing, ecosystem overfishing, growth overfishing, recruitment overfishing)

parasitism - a type of highly evolved symbiotic relationship in which the parasite lives onnor in the host and benefits at the expense of the host, which may be killed as a result of being parasitized

pelagic - pertaining to the waters of the ocean and the organisms which inhabit the water column

phytoplankton - microscopic plants (algae and cyanobacteria) which are free floating in the sea

piscivore - an organism which consumes fish as its main food source

plankton - free-floating organisms in the water column of the sea

polyp - the sessile, benthic form of cnidarians such as corals and sea anemones

primary productivity - the amount of organic matter synthesized by photosynthesis in plants; usually expressed as grammes of carbon synthesized per square metre per day ($g\ C\ m^{-2}\ d^{-1}$)

recruitment overfishing - the biomass of fish capable of reproduction (the spawning stock) is reduced to a level that substantially reduces the recruitment of new individuals to the population

reef flat - the portion of a coral reef that extends behind the algal ridge or reef crest to the shore in the absence of a deep lagoon

rhizome - a horizontal, undersediment stem in seagrasses

rubble - in coral reefs, broken up pieces of coral, coralline algae and other calcified organisms that collects in certain areas of the reef

salinity - a measure of the total amount of dissolved salts in seawater, usually expressed in parts per thousand ($^{o}/_{oo}$) (*see also* $^{o}/_{oo}$)

sand - sediment with particle sizes in the range 0.06 to 2 mm

seaweeds - marine algae that are large enough to sea with the naked eye

sediment loading - an indication of the sediment content of water. Water with a high sediment load carries a large quantity of sediment and is usually very turbid, while water with a low sediment load carries very little sediment and is very clear (*see also* **turbidity**).

silt - very fine sediment with particle sizes in the range 0.004 to 0.06 mm

sponge - non-mobile animals consisting of many cells with little organization, lacking a nervous system, and which feed and respire through currents that are drawn into the body through small pores and passed out through larger pores; sponge bodies are supported by a skeleton which may be of calcium carbonate, silica, or a silk-like protein called spongin

stony coral - corals which produce a calcium carbonate skeleton (corallite)

subsidence theory - a theory first proposed by Charles Darwin for the origin of coral atolls, in which atolls begin as fringing reefs around volcanic islands. The island then subsides, and the reef grows upward at approximately the same rate, to produce a barrier reef. With the eventual disappearence of the volcanoe, the reef becomes an atoll

subsistence fishery - a fishery in which fish or other living marine resources are harvested for home consumption

sustainable - the ability of a resource to sustain human populations at present or projected levels; the ability of a resource to sustain income levels derrived from resource harvesting at present or projected levels; capable of maintaining long-term yields at a relatively constant level without substantially reducing productivity very much below levels experienced in a pristine resource

symbiosis - an intimate and prolonged relationship between two or more organisms in which at least one partner obtains some benefit from the relationship (*see also* commensalism, mutualism, parasitism)

stenohaline - an organism that tolerates only slight variations in salinity (see also euryhaline)

tide - the periodic rise and fall in the surface water of the ocean in response to gravitational and centrifugal effects of the moon and sun

tide pool - a pool of water left on the seashore or the top of a coral reef as the tide goes out

threat - any purturbation, caused directly or indirectly by human activities, which can alter the structure and function of an ecosystem, change patterns of species abundance and diversity, or reduce the productivity of the natural resources harvested from the ecosystem

tropical - of or pertaining to the region of the earth lying near or between about 23°N and 23°S

turbidity - a measure of the transparency of water. Hight turbidity is usually a result of high sediment loading (see also **sediment loading**)

turf - fine, threadlike or small statured marine algae (seaweeds), often perenating from a creeping, rhizome-like or crustose base

vivipary - a type of development in which a young plant develops while it is still attached to the parent plant, and is later released as a partially formed plant

xeromorphic - characters which are adaptations to a shortage of fresh water

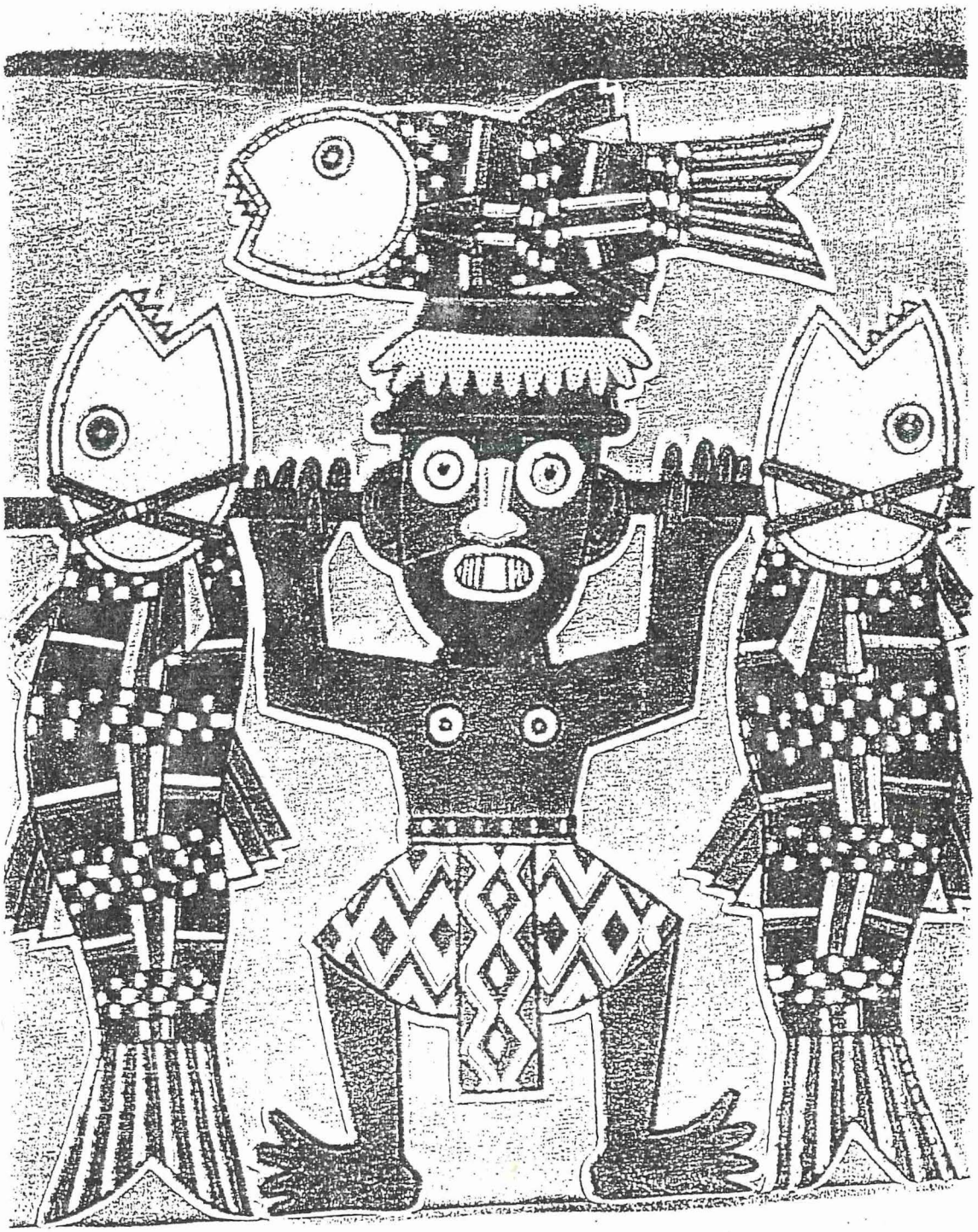
zooplankton - free-floating animals in the water column of the sea

zooxanthellae - symbiotic, unicellular dinoflagellates found within the tissues of corals, sea anemones, molluscs and several other types of marine animals

PARTICIPANTS GUIDE

MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

MODULE 2: NATURE OF FISHING OPERATIONS



CONTENTS

MODULE 2: NATURE OF FISHING OPERATIONS

Performance objective:

To describe the institutional factors that influence the nature of fishing operations

Intermediate objectives:

(1) Compare the types of fishing technologies and their influence on resource use

(2) Determine the factors influencing the organisation of production and distribution

3) Examine management approaches and the infrastructure factors influencing marketing and distribution of catch

4) Outline possible futures for development

Focus points

THE SOCIAL AND PHYSICAL SETTING

THE ROLE OF THE STATE

Activity: Group discussion
Let's therefore list the principal functions of the State. Can you think of others?

OHP Principal functions of the State.

1. It maintains law and order.
2. It is an arbitrator and mediator in industrial disputes.
3. It is a developer and planner of social and economic programmes and infrastructures.
4. It is a financial broker, controlling and disbursing funds from its own revenue.
5. It is an initiator of capitalist development, offering incentives to encourage investment.
6. It is itself a capitalist actor, controlling huge sums of money in Para-State bodies and joint ventures.
7. It is the channel for bilateral and multilaterat contacts with nations and interrgovernmental bodies.

TYPES OF FISHING

Subsistence fishing

Traditional fishing

Fishing Methods

SHOW SLIDES WITH DESCRIPTIONS BASED ON FOLLOWING TEXT

Handlining; Noosing; Net fishing; Spearfishing; Weirs and traps; Fish drives
Fish poisons and stupefacients

Influence of the market economy

Artisanal (small-scale commercial) fishing

Reading 2:3
W. C. Clarke." Learning from the past: traditional knowledge and sustainable development." *Contemporary Pacific*, 2(2)1990:233-253

Reading 2:9
E. Hviding. " Customary marine tenure and fisheries management; some challenges, prospects and experiences." from G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 (pp.89-101)

Reading 2:12
M. Pulea. " An overview of constitutional and legal provisions relevant to customary marine tenure and management systems in the South Pacific." *Forum Fisheries Agency Report* 93/23(1993):61p

Reading 2:13
K. Ruddle. "Traditional marine tenure in the 90s." from G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 (pp. 6-45)

Activity: individual country presentations and group discussions
Participants give examples of practices in their own countries, and discuss reasons for /effects of these practices — if possible using photos, slides, video or audio tapes.

Recreational fishing

Activity: group discussion

What kinds of control might be introduced? Who will be the key players? Who will monitor the controls?

Industrial fishing

Reading 2:4
ESCAP. "National and regional maritime policies." from its *The Law of the Sea in the South Pacific: a study on the integration of marine affairs activities within government concerns*. NY: UN, 1991 (pp.5-14)

Activity: OHP and group discussion

Show and discuss overhead of Keats Mod 1 figs 18,19,20 graphs about fishery types, consumption etc

c&p

Show and discuss overhead of Keats Mod 1 figs 18,19,20 graphs about fishery types, consumption

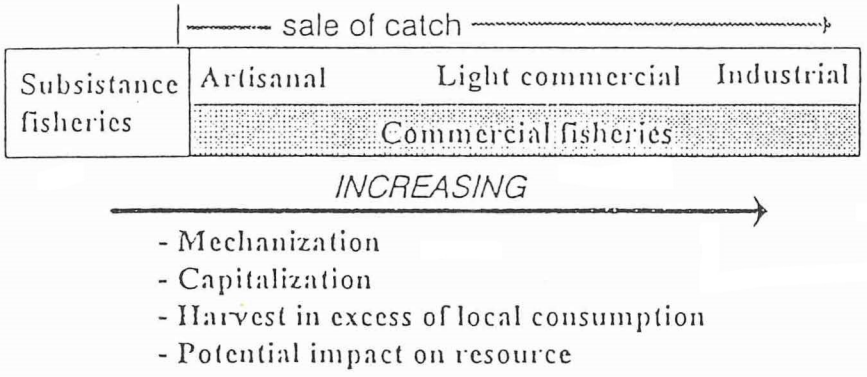


Figure 18. A diagrammatic representation of the continuum of types of fisheries according to degree of capitalization, mechanization, harvest in excess of local consumption, and potential impact on the resource.

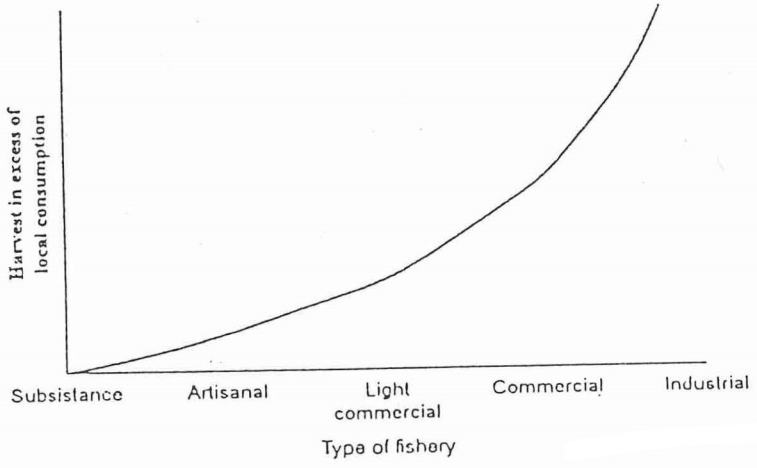
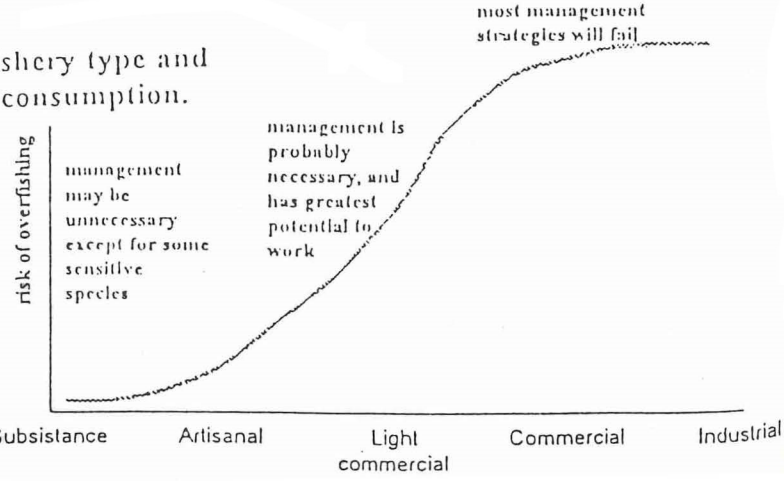


Figure 19. The relationship between fishery type and the degree of harvest in excess of local consumption.



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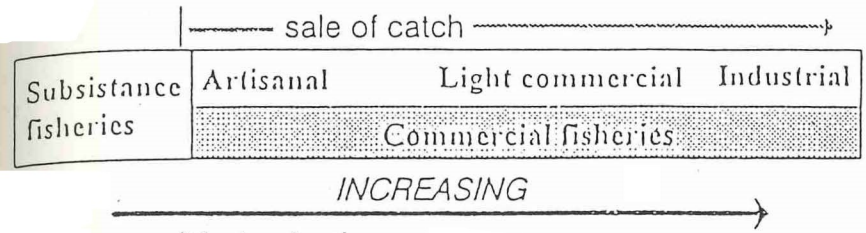
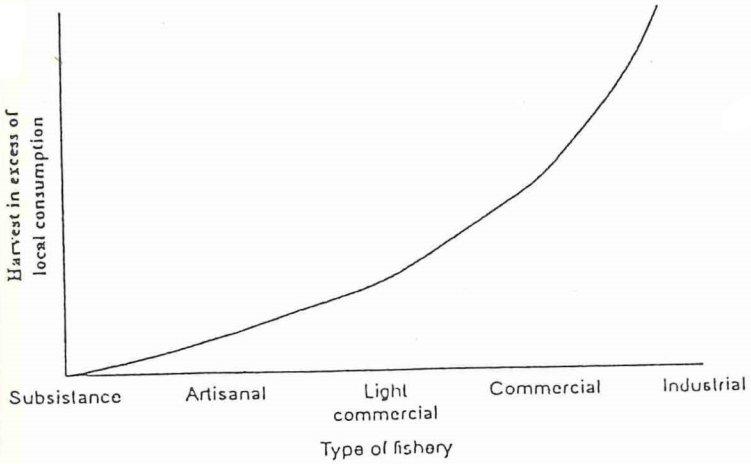


INCREASING

- Mechanization
- Capitalization
- Harvest in excess of local consumption
- Potential impact on resource

Figure 18. A diagrammatic representation of the continuum of types of fisheries according to degree of capitalization, mechanization, harvest in excess of local consumption, and potential impact on the resource.



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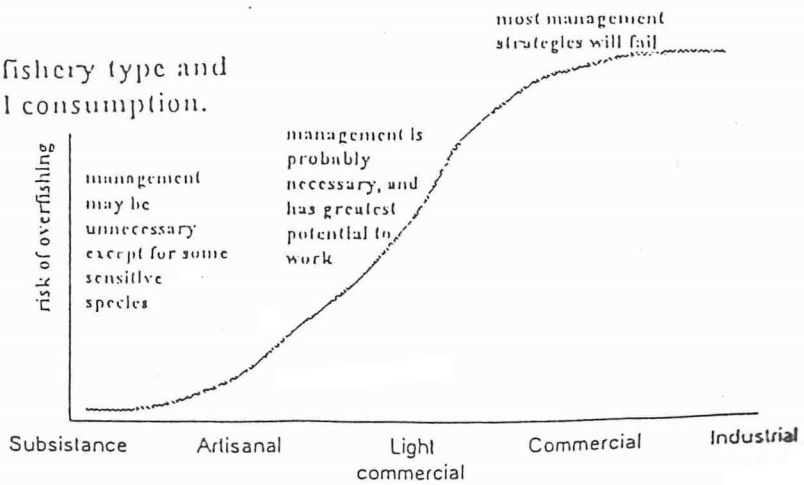

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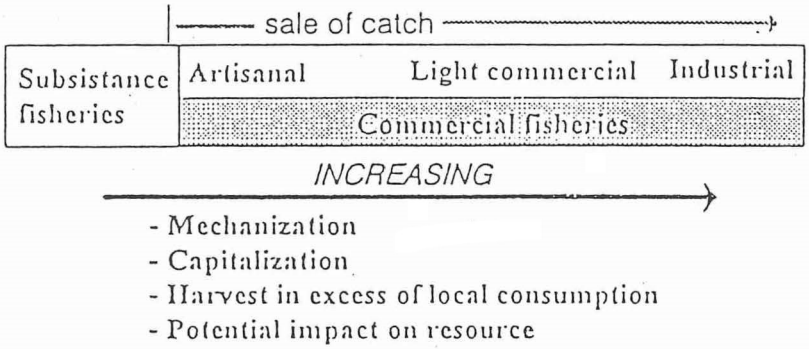

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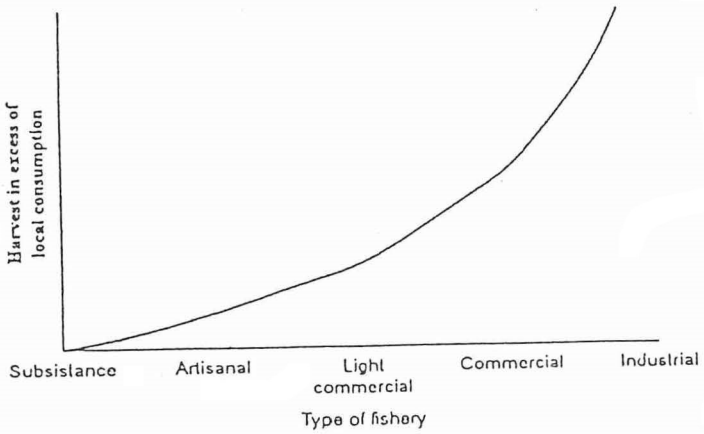


Figure 19. The relationship between fishery type and the degree of harvest in excess of local consumption.

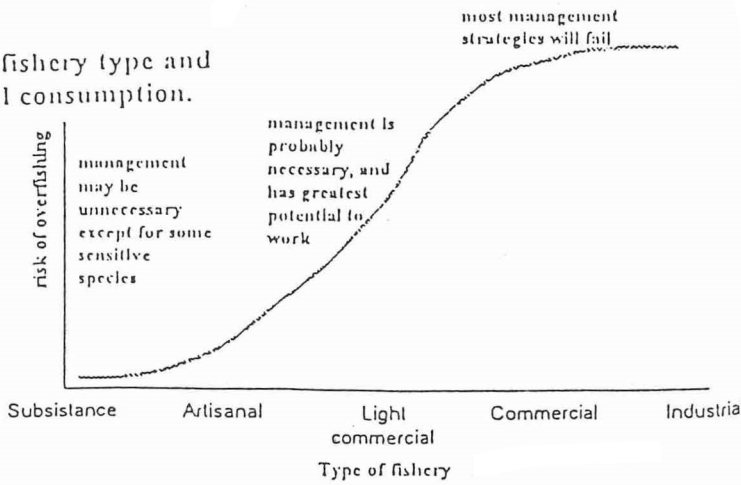


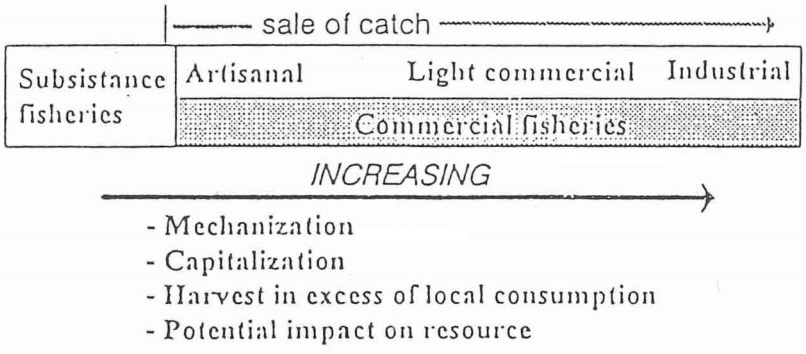
Figure 20. The relationship between type of fishery and

Activity: OHP and group discussion

Show and discuss overhead of Keats Mod 1 figs 18,19,20 graphs about fishery types, consumption etc

c&p

Show and discuss overhead of Keats Mod 1 figs 18,19,20 graphs about fishery types, consumption



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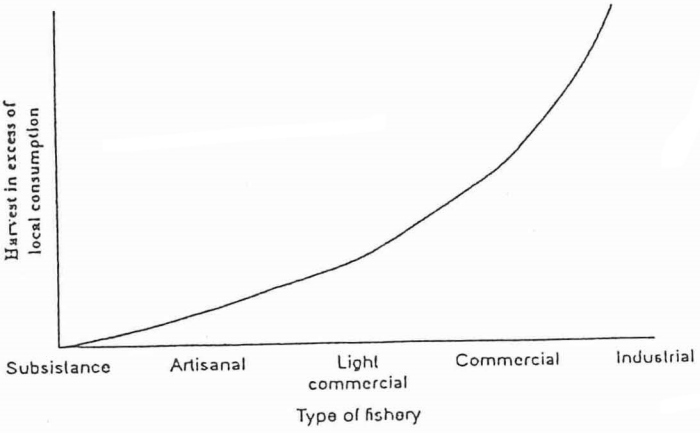
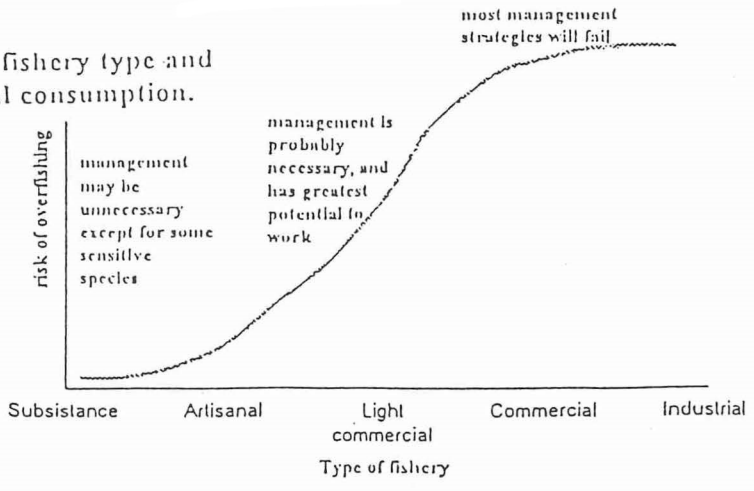


Figure 19. The relationship between fishery type and the degree of harvest in excess of local consumption.



Aquaculture: case study

OHP

Country	Project
Cook Islands	pearl.
Fiji and French Polynesia	have the best developed fish farming operations : *Spirulina;* mussel; oyster; pearl; shrimp; clam; cockle; trochus.
Guam	eel; milkfish; prawns; tilapia hybrid.
Kiribati	*Eucheuma;* milkfish.
Marshall Islands	shrimp.
New Caledonia	clam; milkfish; trochus; turtle
Papua New Guinea	carp; mullet; trout.
Tonga	oyster; pearl; tilapia.
Tuvalu	crab; milkfish; pearl.
Western Samoa	mussel; prawn.

Reading 2:1
M. Beem. "Getting started in aquaculture." *Oklahoma State University OSU Extension Facts*, 9201 (nd. 6p)

Reading 2:8
E. Hviding. *The rural context of giant clam mariculture in Solomon Islands: an anthropological study*. Manila: ICLARM/University of Bergen, Norway, 1993 (ICLARM Contribution 953, Tech.Rpt. 39. 93p.)

Reading 2:17
World Bank/UNDP/CEC/FAO. "Tropical aquaculture development research needs." *World Bank Technical Paper 151: fisheries series*(1991): x,52p

Activity: Group discussion

Participants will draw on the lecture, the Readings and their own experience to:
discuss experiences with projects that failed, and with projects that succeeded; identify and list elements in failure and in success;
identify country-specific or culture-specific elements;
prepare lists of country-specific or culture-specific elements;
prepare lists of common elements.

OHP

Checklist of questions for evaluating aquaculture projects.

1. Does the proposed species meet the following criteria?
   - It feeds low on the food chain.
   - It can tolerate wide temperature differences.
   - It has limited breeding problems, high growth rate and high disease resistance.
   - It is well researched.

2. Does the species meet these additional criteria?
   - It is established and profitable elsewhere.
   - It is widely used as a protein source.
   - It is acceptable to consumers.
   - It can be adapted to small-farming.
   - Farming is labour intensive.

3. Does the species have potential as an export commodity?
4. What can we learn from similar projects in the Pacific and Southeast Asia?
5. Has an Environment Impact Assessment been made?
6. Who benefits?
7. Are local people and governments motivated and capable of sustaining the project?
8. Who invests the capital?
9. What project components are required?
10. Where will they come from?
11. Who will be the consultants?
12. What technology transfer components are included?
13. What protective clauses are included?
14. Are estimates realistic?
15. If the project has external funding, what happens when the funding runs out?
16. Do the answers to these questions show that the project is likely to succeed?
17. Where do we go from here?

THE STATUS OF COASTAL FISHERIES

General status

OHP

Mean Annual Coastal Fisheries Production in the South Pacific 1989-1992.

Catch	Weight (t)	Value (US $)
Commercial reef and deep slope fish	10,476	26,034,723
Commercial coastal pelagics	4,419	14,708,216
Commercial estuarine fish	1,586	4,280,170
Commercial crustaceans	1,903	15,343,502
Commercial beche-de-mer	1,717	12,371,240
Commercial trochus, greensnail, pearl-shell	2,147	8,688,686
Total Commercial Catch	24,609	83,353,790
Total Subsistence Catch	80,049	160,323,747
Total Coastal Fisheries Catch	104,658	243,677,346

Shallow water fisheries

OHP Mean annual subsistence and commercial production from coastal fisheries for the countries and territories of the South Pacific between 1989 and 1992.

Country	Subsistence fisheries production (t)	Nominal Value (US$)	Commercial fisheries production (t)	Value (US$)	Total fisheries production (t)	Nominal Value (US$)
American Samoa	215	814,238	52	178,762	267	993,000
Cook Is.	858	3,047,863	124	314,491	982	3,362,174
F.S. M.	6,243	11,237,400	646	1,502,296	6,889	12,739,696
Fiji	16,200	40,117,924	6,506	18,979,880	22,706	59,097,804
French Polynesia	3,108	12,432,000	2,891	15,573,555	5,999	28,005,555
Guam	472	1,935,632	114	433,894	586	2,369,526
Kiribati	9,084	13,373,667	3,240	4,770,000	12,324	18,143,667
Marshall Islands	2,000	3,103,213	369	714,504	2,369	3,817,717
Nauru	98	219,600	279	628,605	377	848,205
New Caledonia	2,000	7,344,417	1,032	4,833,410	3,032	12,177.827
Niue	103	471,504	12	54,720	115	526,224
Northern	202	826,685	120	493,601	322	1,320,095
Marianas						
Palau	750	1,805,192	736	2,412,071	1,486	4,217,263
Papua New Guinea	20,588	41,176,000	4,966	22,096,908	25,554	63,272,908
Pitcairn Is.	8	16,000	0	0	8	16,000
Solomon Is.	10,000	8,405,660	1,150	4,343,811	11,150	12,749,471
Tokelau	191	104,509	0	0	191	104,509
Tonga	933	1,901,208	1,429	2,806,641	2,362	4,707,849
Tuvalu	807	657,781	120	97,811	927	755,592
Vanuatu	2,045	1,953,360	467	1,514,364	2,512	3,467,724
Wallis & Futuna	862	4,310,000	138	1,285,400	1,000	5,595,400
Western Samoa	3,281	5,070,074	219	319,066	3,500	5,389,140
Total	**80,048**	**160,323,927**	**24,610**	**83,353,790**	**104,658**	**243,677,346**

Deep slope fisheries

Nearshore pelagic fisheries

Beche-de-mer

Trochus

Pearl oysters

Crustaceans

Activity: Group discussion of the paper so far, and of the status of coastal fisheries in general.

Summary and conclusions

Activity: group discussion

OHP: prophecies and suggestions for management strategies

Present fin-fishery development initiatives in the region are likely to continue to run towards pelagic rather than demersal fisheries, because of the larger unexploited resource base.

Beche-de-mer and mother-of-pearl shell fisheries offer potential for increased income but shallow water invertebrate fisheries are easily over-exploited and any such income must be considered mainly as "windfall" cash for village fishers rather than as a basis for permanent investment

Countries with developing pelagic fisheries will have to find some way of accessing these overseas markets and to take advantage of the better returns on the landings

More and more attention will be devoted to the consolidation and management of reef fisheries

If a large part of the population expects to share in the revenues from the resources such as trochus then limited seasons with short pulses of intensive effort may be the only form of effective management. It has been suggested beche-de-mer producers form a cartel and rotate harvests between islands each year, giving depleted stocks the chance to recover in those islands not participating in an annual harvest. Another alternative is for the harvest periods for trochus and beche-de-mer to be opened alternatively to provide a similar recovery period.

Pure research may be outside the manpower and financial resource priorities of most Pacific Island fisheries departments and be more appropriately carried out by the universities.

There is no magic cure for over-fishing. Management and stock conservation research in the Pacific Islands perhaps should continue to focus on mechanisms of limiting total harvest volume in socially and economically feasible ways

There should be constant information interchange between national governments and the main regional organisations involved in fisheries development and management.

Are there any with which you disagree? If so, which and why?

THE CONTRIBUTION OF THE FISHERIES SECTOR TO DEVELOPMENT

Employment and income

Food and nutrition

OHP

Per Capita Consumption of Fish For Some South Pacific Islands	
	Kg/Per Capita
Fiji	46.9
Solomon Islands	59.9
W. Samoa	42.9
Vanuatu	30.0
Tonga	21.1

Source : ICOD, World Fisheries, 1991.

Rural development

Other social benefits

Reading 2:2
S. T. Cavuilati. "Managing fisheries resources: the Fiji experience." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 (pp. 37-63)

Reading 2:6
E. Hempel. "Seafood marketing: prospects and challenges". from M. N. Kusairi; M. A. Fatimah; A. B. Abdullah (eds.) *Fish industry: prospects and challenges.* Serdang: Malaysian Fisheries Society, 1992 (Malaysian Fisheries Society Occasional Publication 5:1-21)

Reading 2:7
E. Hempel." Fish import requirements of the EEC countries." from M. N. Kusairi; M. A. Fatimah; A. B. Abdullah (eds.) *Fish industry: prospects and challenges.* Serdang: Malaysian Fisheries Society, 1992 (Malaysian Fisheries Society Occasional Publication 5:42-54)

Reading 2:15
J. Veitayaki. "Village level fishing in the Pacific." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 (pp. 73-96)

APPROACHES TO MANAGEMENT

Reading 2:2
S. T. Cavuilati. "Managing fisheries resources: the Fiji experience." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 (pp. 37-63)

Reading 2:5
FAO. *Strategy for fisheries management and development.* Rome: FAO, 1986 (pp.[5],1-26)

Reading 2:10
M. King; A.McIlgorm. " Objectives of fisheries management." from their *Fisheries biology and management for Pacific Island students, prepared for... the University of the South Pacific 1988.* Launceston: Australian Maritime College/AIDAB, 1988 (pp. 41-55)

Reading 2:16
World Bank Group/Private Sector Fisheries Development Working Party, Washington, DC, September 4-5, 1991: *Report.* [Washington: World Bank/DANIDA/Amsterdam-Rotterdam Bank, 1991?] (pp.1-12)

Activity: group discussion of management approaches illustrated in Readings 2.2; 2.5; 2.10 and 2.16

Case study: planning and managing marketing in the artisanal sector

OHP Four points in the approach to development:

(1) To achieve success one must minimise the risk of failure.

(2) Preparation for development cannot be undertaken until detailed development objectives have been formulated.

(3) Fisheries development cannot be approached successfully in isolation, but must be seen as part of a much larger system or systems.

(4) Development must incorporate planning and practice.

OHP Fisheries development must be approached as a part of larger systems.

Fish consumption cannot be totally isolated from eating meat or indeed other forms of protein, from local methods of cooking,
from standards of living,
levels of income,
sources of income,
sources of supply,
or from the cultural traditions of the locality and region.

Nor can it be divorced from
the role of government,
budget allocations,
sources of public and private sector finance,

industrial development,
size and location of markets,
location of labour
and managerial resources.

Objectives

OHP

they should be allowed access to and be skilled in the use of, the tools of their trade;

that they should have access to one or more markets for their product;

that the price paid for their product should allow them to continue to produce more products;

and that should they get their produce to market as far as possible when they wish.

OHP To support the commercial objective:

1 Every effort should be made to embark only on developments likely to show a positive financial return.

2 Per capita consumption of fish and fish products should be increased from its present level in the next 5 years; the main effort to be directed towards the urban communities.

3 As far as practicable, increases in the supply of fish should be presented in the same form and species mix as at present

4 Fish should be supplied at average prices equivalent to or lower than the present price

5 Preference should be given to the provision of low value species and fish products

To support the welfare objective:

1 Every effort should be made to embark only on development showing positive economic (rather than financial) returns

2 Every effort should be made to provide communities with a system of transport suitable for taking produce to market and designed to ensure viable financial returns to the communities

3 Assistance should be given in the form of training, equipment and management to better take advantage of the scarce resources available, taking care not to unduly disturb the communities's traditional strength but through better organisation, build on and utilise these strengths

4 Special assistance should given to most disadvantaged communities, and to communities temporarily suffering the effects of natural catastrophe (hurricane damage, drought)

Data

OHP: Questions: What if:

(1) More fish were given away to friends and relatives?

(2) Fish were always available at the central market?

3) Surplus fish were landed at the village jetties every day of the week

4) The price of fish was to increase by 10%?

(5) The price of fish was to decrease by 10%?

(6) Fish were made available in frozen, filleted, steaked and smoked form in addition to the currently available fresh form?

(7) Conditions of glut and scarcity were prevented or minimised?

8) The price of substitute products was to rise by 10%?

(9) The price of substitute products was to fall by 10%?

10) Fresh fish could be preserved for an extra two days while maintaining the same quality?

Infrastructure

Product type

OHP Typical questions to be considered in this analysis.

1 What is the average time it will get the product from the point of production to consumption?

2 Could this time be reduced?

3 Could the costs of shortening the time taken to get to the product to the market be absorbed by the resultant revenues?

4 Can production schedules be met with handling, processing, distribution, transportation and marketing schedules?

5 What wastage can be expected?

6 Is short, medium or long term preservation required?

OHP: misconceptions

1) High and new technologies are superior to old or simple technologies.

2) Cured fish is unhygienic and difficult to cook.

3) Cured fish is a poor person's food.

4) As long as a frozen product is solid to the touch, it can be preserved almost indefinitely.

(5) Ice melts quickly and is a waste of money when used to chill fish, .

Management

OHP: Organisational systems

government department;

statutory body, authority, corporation;

public, limited company;

private, limited company;

co-operative;

association;

sole trader.

Financial controls

OHP Management accounting questions.

1) What proportion of costs are represented by the price of raw materials, electricity, labour?

2) If product throughput were increased by 20% what effect would this have on the allocation of fixed, operating and variable costs?

3) At ruling market prices and current production levels, what mark-up is required to break even, and to show a 10 and a 20% profit on turnover?

4) In running a public cold store, if one wished to change the fee structure from a fee per unit day stored to a constant fee, what would be the minimum fee and the throughput under which existing financial targets could be met?

5) If ice were provided to fishers at a subsidised price in return for products, by how much could one raise or lower fish prices over those paid when ice is not

subsidised and still meet financial targets?

6) What is the average time that the product rests in a particular cold store? As a result what is the coast per unit of product stored?

Human management

Technical control

Activity: group discussion of the Carleton case study

OHP: Outline

Four points in the desired approach to development

- minimise the risk of failure.
- formulate detailed development objectives.
- see fisheries development as part of a much larger system or systems.
- incorporate planning and practice.

Objectives: dual

- commercial objective
- welfare objective

Data

Infrastructure

Product type

- Two important and distinct factors:
  - intermediate and final market.
  - structure of the transportation and distribution system.
- Common constraints, misconceptions and prejudices.

Management

- Organisational systems
- Financial controls
- Human management
- Technical control
  - Appropriate technology.

APPROACHES TO SUSTAINABLE DEVELOPMENT

READINGS and Activity

Reading 2:11
G. Lebel; H. Kane. " Towards sustainable development; Food production and food security; Species: living natural resources; Managing the commons." from their *Sustainable development: a guide to [the Brundlant report] **Our common future: report of the World Commission on Environment and Development.*** Geneva: Centre For Our Common Future, 1990. (Chapters 1;4;5;9)

Reading 2:14
G. R. South. "Marine resources and development: a view of the future." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 (pp. 123-149)

LIST OF READINGS

Reading 2:1
M. Beem. "Getting started in aquaculture." *Oklahoma State University OSU Extension Facts*, 9201 (nd. 6p.)

Reading 2:2
S. T. Cavuilati. "Managing fisheries resources: the Fiji experience." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 (pp.37-63)

Reading 2:3
W. C. Clarke. "Learning from the past: traditional knowledge and sustainable development." *Contemporary Pacific*, 2(2)1990:233-253

Reading 2:4
ESCAP. "National and regional maritime policies" from its *The Law of the Sea in the South Pacific: a study on the integration of marine affairs activities within government concerns.* NY: UN, 1991 (pp.5-14)

Reading 2:5
FAO. *Strategy for fisheries management and development.* Rome: FAO, 1986 (pp.[5],1-26)

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E. Hempel. "Seafood marketing: prospects and challenges". from M. N. Kusairi; M. A. Fatimah; A. B. Abdullah (eds.) *Fish industry: prospects and challenges.* Serdang: Malaysian Fisheries Society, 1992 (Malaysian Fisheries Society Occasional Publication 5:1-21)

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E. Hempel. "Fish import requirements of the EEC countries." from M. N. Kusairi; M. A. Fatimah; A. B. Abdullah (eds.) *Fish industry: prospects and challenges.* Serdang: Malaysian Fisheries Society, 1992 (Malaysian Fisneries Society Occasional Publication 5:42-54)

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G. Lebel; H. Kane. "Towards sustainable development; Food production and food security; Species: living natural resources; Managing the commons." from their *Sustainable development: a guide to [the Brundlant report] Our common future: report of the World Commission on Environment and Development.* Geneva:Centre For Our Common Future, 1990. (Chapters 1;4;5;9)

Reading 2:12
M. Pulea. "An overview of constitutional and legal provisions relevant to customary marine tenure and management systems in the South Pacific." *Forum Fisheries Agency Report* 93/23(1993):61p.

Reading 2:13
K. Ruddle. "Traditional marine tenure in the 90s." from G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific.* Suva: International Ocean Institute, 1994 (pp. 6-45)

Reading 2:14
G. R. South. "Marine resources and development: a view of the future." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 (pp. 123-149)

Reading 2:15
J. Veitayaki. "Village level fishing in the Pacific." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 (pp.73-96)

Reading 2:16
World Bank Group/Private Sector Fisheries Development Working Party, Washington, DC, September 4-5, 1991: *Report.* [Washington: World Bank/DANIDA/Amsterdam-Rotterdam Bank, 1991?] (pp.1-12)

Reading 2:17
World Bank/UNDP/CEC/FAO. "Tropical aquaculture development research needs." *World Bank Technical Paper 151: fisheries series.*(1991): x,52p

Additional Readings

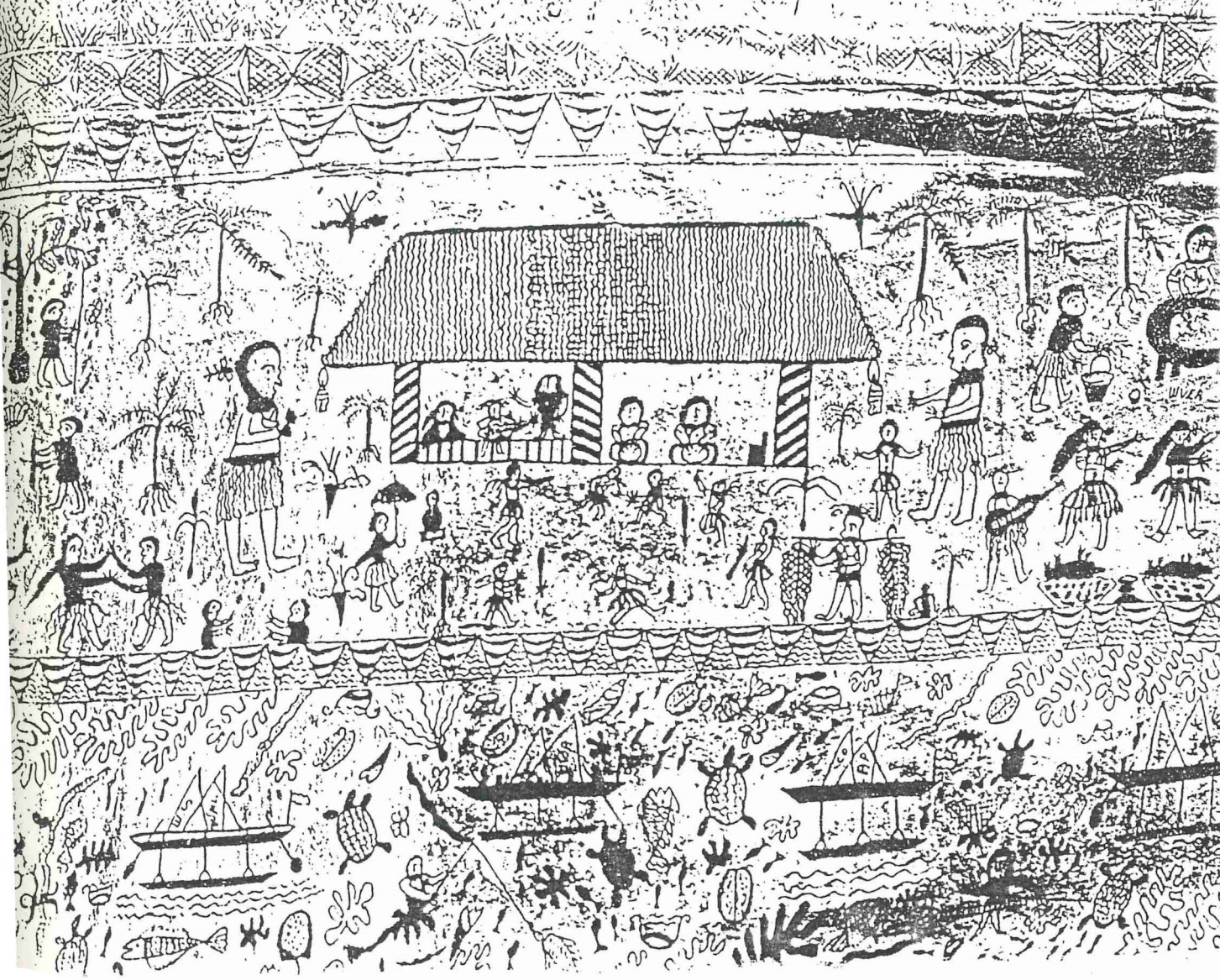
Reading 2.18
J. L. Munro and S. Fakahau. "Appraisal, assessment and monitoring of small-scale coastal fisheries in the South Pacific region." from A. Wright and L. Hill (eds.) *Nearshore marine resources of the South Pacific: information for fisheries development and management.* Honiara: FFA; Suva: IPS,USP, 1993 (Chapter 2, pp. 15-53)

Reading 2.19
J. L. Munro and S. Fakahau. "Management of coastal fisheries." from A. Wright and L. Hill (eds.) *Nearshore marine resources of the South Pacific: information for fisheries development and management.* Honiara: FFA; Suva: IPS,USP, 1993 (Chapter 3, pp. 55-72)

MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

MODULE 3: OBSTACLES TO SUSTAINABLE COASTAL FISHERIES DEVELOPMENT

PARTICIPANTS GUIDE



CONTENTS

MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

MODULE 3: OBSTACLES TO SUSTAINABLE COASTAL FISHERIES DEVELOPMENT: PARTICIPANTS GUIDE

Performance objective:

Identify the main obstacles to sustainable fisheries development.

Intermediate objectives

1. Identify and examine the major human impacts on the coastal environment.
2. Identify and examine policy objectives that conflict with the aims of sustainable development.

OBSTACLES TO SUSTAINABLE COASTAL FISHERIES DEVELOPMENT

Focus points

CHANGING FISH ABUNDANCE AND MARINE RESOURCE SUSTENANCE

READINGS and Activity

Identify and note:

1. Any problems that are common to South East Asia and our region.
2. Any problems that are unique to our region.
3. Any solutions that may be applied to both regions.
4. Any solutions that may be unique to our region.

Keep your notes for future reference, so that you can use them in discussions.

Reading 3:1

P. Chansnoh. "Community management of coastal resources, Southern Thailand." *Naga,* (Oct.1993): 10-12

Reading 3:2

S. A. Diraputra. "An overview of fishery management practices and issues in Indonesia." from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers.* [np. nd. np] pp. 21-51

Reading 3:6

D. M. Johnston. "A postscript." from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers.* [np. nd. np] pp. 147-158

Reading 3:19

J. Veitayaki. *Coastal fisheries in the tropical South Pacific: a question of sustainability?* Suva: ORMP,USP, 1994 9p.

LAND-BASED POLLUTION IN THE PACIFIC: A MAJOR THREAT TO THE SUSTAINABILITY OF OCEAN RESOURCES

Introduction
Land-based sources of marine pollution

OHP: pesticides imported.

Agriquat (21,710 litres)
Gramoxone (88,120 litres)
Bentazon (100 litres)
Glyphosate (7,040 litres)
Pirimiphos-methyl (625 kg.)
Pirimiphos-methyl Permethrin (390 litres)
Bendiocarb (1,425 kg.)
Carbofuran (200 litres)
Benomyl (223 kg.)
Tridemorph (890 litres)
Propiosonazole (220 litres)
Oxyamyl (1000 litres)
Brodifacoum (590 kg.)
Flocoumaffen (2,357 kg.

OHP Urbanisation

100 %	Nauru
7O%	New Caledonia
69%	Palau
65%	Marshall Islands
59%	Cook Islands
57%	French Polynesia
53%	Commonwealth of Northern Mariana Islands
48%	American Samoa,
42%	Tuvalu
39%	Fiji

Effects on the marine environment
Managing ocean resources

Slide and video session

Activity: Observation followed by discussion
Participants walk for about 10 minutes around campus, identifying potential on-campus sources of marine pollution. On return, discuss findings and recommend action.

READINGS

Reading 3:5
D. Hinrichsen. "The South Pacific." from *Our common seas: coasts in crisis.* London: Earthscan Publications/UNEP.[nd] pp. 62-82
Reading 3:7
G. Kullenberg. *The vital seas: questions and answers about the health of the oceans.* Geneva: UNEP, 1984
Reading 3:13
J. Saeger. "The Samar Sea, Philippines: a decade of devastation." *Naga,* (Oct.1993):4-6
Reading 3:17
J. Van Dyke; K. R. Smith; S. Siwatibau. "Nuclear activities and the Pacific Islanders." *Energy,* (1984): 733-750 (East-West Environment and Policy Institute Reprint 77)
Reading 3:21
S. Venkatesh; S. Va'ai; M. Pulea. "An overview of environmental protection legislation in the South Pacific countries." *South Pacific Regional Environmental Programme Topic Review,* 13(1983) 62p.

LOSS OF TRADITIONAL KNOWLEDGE

Activity: Group discussions

eg

The loss of traditional knowledge should be addressed and effort should be taken to use traditional knowledge as the basis for the adoption of appropriate technology.Is it already too late? What steps are being taken in individual countries?

READINGS from Module 2
Reading 2:3
W. C. Clarke." Learning from the past: traditional knowledge and sustainable development." *Contemporary Pacific,* 2(2)1990:233-253
Reading 2:9
E. Hviding. "Customary marine tenure and fisheries management; some challenges, prospects and experiences." from G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific.* Suva: International Ocean Institute, 1994 (pp.89-101)
Reading 2:12
M. Pulea. "An overview of constitutional and legal provisions relevant to customary marine tenure and management systems in the South Pacific." *Forum Fisheries Agency*

Report 93/23(1993):61p.

Reading 2:13

K. Ruddle. "Traditional marine tenure in the 90s." from G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 (pp. 6-45)

Fishing ground ownership, tenure disputes and conflicting uses

Reading 3:9

[Market competition; competition between private and public fishing segments; competition between the fishing sector and local community.] from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers.* [np. nd. np] pp. 102-109 (Chapter 6: Domestic fishery conflicts)

OVERFISHING

The basic problem

READINGS

Reading 3:4

Greenpeace. *It can't go on for ever: the implications of the global grab for declining fish stocks*. Amsterdam: Greenpeace International, 1993. 20p

Reading 3:10

M. Momoivalu. "Fisheries facing problems." *Fiji Times*, (24/09/94):4

Responses by Governments, IGOs and industry

Reading 3:12

C. Pachusanond et al."Trade measures, the GATT and fish: a new pressure." from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers*. [np. nd. np] pp. 67-75

Video

Reading 3:15

J. M. Vakily. "Dynamite fishing in Sierra Leone." *Naga*, (Oct.1993): 7-9

Planning hampered by lack of accurate data
Need for research, education, training and information exchange
Activity: Identify urgent research and training needs
Each participant writes down on a piece of paper
a). A topic requiring urgent research
b). An area or skill in which s/he needs special training
Collect papers, list and discuss results.

Reading 3:14
UNDP.DGIP/UN.DOALOS. *Consultative Meeting on Training in Integrated Management of Coastal and Marine Areas for Sustainable Development ...Sardinia, Italy, 21-23 June 1993: Draft report* and *Draft action plan for human resources development and capacity building for the planning and management of coastal and marine areas.* NY: UN, 1993 ii,62p

Reading 3:18
J. Veitayaki. "Geographers at sea: an old approach to integrated ocean resources management." from E. Waddell and P. D. Nunn (eds.) *The margin fades: geographical itineraries in a world of islands.* Suva: IPS,USP,1993 pp.215-230

Reading 3:20
J. Veitayaki. *Training in marine resources management in the South Pacific: role of the University of the South Pacific's Ocean Resources Management Programme.* Suva: ORMP,USP, 1994 19p.

Reading 3:22
World Bank/UNDP/CEC/FAO. "Small pelagic fish utilization research needs." *World Bank Technical Paper 153: fisheries series.* (199?) 3-8

Failure of management systems
Effects on the industry and beyond it.

OHP: Summary: points dealt with in the module so far

Changing fish abundance and marine resource sustenance
due to

- environmental change and pollution
- increasing population.
- increasing urbanisation
- increasing mobility
- commercialisation of fishing
- loss of traditional knowledge
- fishing ground ownership, tenure and conflicting uses
- overfishing
- governments & ROs encourage exploitation
- greed and lack of foresight
- deficiencies in research, education, training, information exchange
- management failures

Decline affects all sectors of community/economy
Why sustainable development?

Activity: Group discussion and summary of causes:

Divide into groups; each group to produce a list of major causes and effects of decline. Then compare lists. Emphasise interrelationship of causes and effect but see if there is any agreement on any one major cause.

POLICY OBJECTIVES THAT CONFLICT WITH THE AIMS OF SUSTAINABLE DEVELOPMENT.

OHP: Commonly stated aims of the fisheries sector

To generate future employment opportunities through the exploitation and processing of marine products.

To increase production to satisfy local fish and marine products demands;

To increase the value of fish for export.

To regulate and control the exploitation of finfish and non-finfish products.

OHP: Policy and planning defects

a) Existence of socio-economic dualism: intensive technological modernisation undertaken without adequate recognition of the worth of the existing artisanal technological diversity.

b) Absence of early government-sponsored initiatives to generate and disseminate intermediate technologies in fish harvesting, processing and distribution.

c) Regular failure of fishers' organisations because of the lack of clear and stable organisational direction and control.

d) Excessive emphasis on export oriented trade based on very few species and markets with little emphasis on value addition. This resulted in lopsided development of public sector infrastructures, which now remain unused.

e) Failure to appreciate the intricate link between bodies of water and the lack of integrated planning for fisheries development and management.

f) Absence of early measures to manage the entry and use of coastal fishing zones and estuarine areas. Results include unbridled private investment in capture activities, taking advantage of the open access nature of bodies of water, and ignoring norms of fishing methods or amount of fish caught.

g) Fishers' reluctance to expand their area of fishing operations to the deeper and comparatively less exploited fishing areas while economically important species are present in coastal waters.

h) Inadequacy of earlier efforts to develop aquaculture in inland water areas.

i) Inability to coordinate reduction of inland water pollution by other sectors.

j) Lack of emphasis on the proper treatment of fish as a source of inexpensive, nutritious food.

k) Absence of any sound long-term credit and subsidy policy or funds to steer investments in the right direction.

l) Inability to use available fishery and academic information to foster the sustainable development of fisheries resources.

m) Lack of coordination and clear-cut roles in related government agencies.

Activities

Panel discussion.

READINGS

Reading 3:3
L. Gibson. "International aid in the Pacific: what is in it for us?" from E. Waddell and P. D. Nunn (eds.) *The margin fades: geographical itineraries in a world of islands.* Suva: IPS,USP, 1993 pp.141-150
Reading 3:8
R. M. Lawson. "Development and growth constraints in the artisanal fisheries sector in island states." Paper presented for the 1979 *Development Studies Centre seminar series: the Island states of the Pacific and Indian Oceans - anatomy of development.* [np; 1979] 31p
Reading 3:11
G. L. Munro. "Fishery diplomacy in the 1990s: the challenges and constraints." from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers.* [np. nd. np] pp. 3-17
Reading 3:16
S. M. A. Vallejo. "Integrated marine policies: goals and constraints." pp.153-167 from ?

Research project. Study development plans for individual countries or work programmes for regional organisations and identify areas of potential conflict with the aims of sustainable development.

Suggested procedure.

1. Organisers arrange via PIMRIS with USP Library (and if necessary Forum Secretariat, SOPAC, SPC Nabua, UNDP) for participants to have access to recent national development plans and regional organisation work programmes.

2. Participants divide into small groups and identify the country or organisation whose plan or programme they will study. Each group should study a different country or organisation.

3. Each group works through the entire plan/programme and produce:

   a list of specific fisheries objectives
   a list of other sector objectives that have or may have an effect on fisheries
   a list of objectives that may support sustainable development of fisheries
   a list of objectives that may conflict with sustainable development of fisheries

4. Participants reconvene, present and discuss findings in order to identify areas that might be dealt with nationally, and areas that might require regional actions.

LIST OF READINGS

Reading 3:1
P. Chansnoh. "Community management of coastal resources, Southern Thailand." *Naga,* (Oct.1993): 10-12

Reading 3:2
S. A. Diraputra. "An overview of fishery management practices and issues in Indonesia." from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers.* [np. nd. np] pp. 21-51

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Reading 3:10
M. Momoivalu. "Fisheries facing problems." *Fiji Times,* (24/09/94):4

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G. L. Munro. "Fishery diplomacy in the 1990s: the challenges and constraints." from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers.* [np. nd. np] pp. 3-17

Reading 3:12
C. Pachusanond et al."Trade measures, the GATT and fish: a new pressure." from K. I. Matics and T. L. McDorman (eds). *SEAPOL International Workshop on Challenges to Fishery Policy and Diplomacy in South-East Asia, Rayong, Thailand, 6-9 December 1992: selected papers.* [np. nd. np] pp. 67-75

Reading 3:13
J. Saeger. "The Samar Sea, Philippines: a decade of devastation." *Naga,* (Oct.1993):4-6

Reading 3:14
UNDP.DGIP/UN.DOALOS. *Consultative Meeting on Training in Integrated Management of Coastal and Marine Areas for Sustainable Development ...Sardinia, Italy, 21-23 June 1993: Draft report* and *Draft action plan for human resources development and capacity building for the planning and management of coastal and marine areas.* NY: UN, 1993 ii,62p

Reading 3:15
J. M. Vakily. "Dynamite fishing in Sierra Leone." *Naga,* (Oct.1993): 7-9

Reading 3:16
S. M. A. Vallejo. "Integrated marine policies: goals and constraints." pp.153-167 from ?

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J. Van Dyke; K. R. Smith; S. Siwatibau. "Nuclear activities and the Pacific Islanders." *Energy,* (1984): 733-750 (East-West Environment and Policy Institute Reprint 77)

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J. Veitayaki. "Geographers at sea: an old approach to integrated ocean resources management." from E. Waddell and P. D. Nunn (eds.) *The margin fades: geographical itineraries in a world of islands.* Suva: IPS,USP,1993 pp.215-230

Reading 3:19
J. Veitayaki. *Coastal fisheries in the tropical South Pacific: a question of sustainability?* Suva: ORMP,USP, 1994 9p.

Reading 3:20
J. Veitayaki. *Training in marine resources management in the South Pacific: role of the University of the South Pacific's Ocean Resources Management Programme.* Suva: ORMP,USP, 1994 19p.

Reading 3:21
S. Venkatesh; S. Va'ai; M. Pulea. "An overview of environmental protection legislation in the South Pacific countries." *South Pacific Regional Environmental Programme Topic Review,* 13(1983) 62p.

Reading 3:22
World Bank/UNDP/CEC/FAO. "Small pelagic fish utilization research needs." *World Bank Technical Paper 153: fisheries series.* (199?) 3-8

COASTAL FISHERIES DEVELOPMENT AND MANAGEMENT MODULE FOUR: WOMEN IN COASTAL FISHERIES MANAGEMENT AND DEVELOPMENT.

Participants' guide.

COASTAL FISHERIES MANAGEMENT AND DEVELOPMENT

Module Four

WOMEN IN COASTAL FISHERIES MANAGEMENT AND DEVELOPMENT

COASTAL FISHERIES DEVELOPMENT AND MANAGEMENT MODULE FOUR: WOMEN IN COASTAL FISHERIES MANAGEMENT AND DEVELOPMENT.

CONTENTS

4. WOMENS' CONTRIBUTION TO FISHERIES PRODUCTION AND RELATED ECONOMIC ACTIVITIES

Purpose:
Objectives:

Fishing
- Observations and studies in the Pacific
- Observations and studies in other coastal areas

Related activities

5. POLICIES AND STRATEGIES FOR FISHERIES DEVELOPMENT

Purpose:
Objectives:

Changing policies on women in development
FAO and development
FAO initiatives
Case study: Fiji

6. HOW CAN WOMEN BE INCORPORATED IN FISHERIES DEVELOPMENT PLANS AND POLICIES ?

Purpose:
Objectives:

Constraints
What can we do to overcome these constraints ?
What strategies do we need to formulate ?
- Education, Training & Extension
  - Strategies
- Research Information and Database
  - Strategies
- Project Development
  - Strategies

7. CASE STUDIES AND EXERCISES IN PROJECT FORMULATION

8. LIST OF READINGS AND RESOURCE MATERIALS REQUIRED

COASTAL FISHERIES DEVELOPMENT AND MANAGEMENT

MODULE FOUR: WOMEN IN COASTAL FISHERIES MANAGEMENT AND DEVELOPMENT

Purpose: To create an awareness among planners, policy makers, and fisheries managers of the crucial role of women in coastal fisheries. This will enable them to be more gender-sensitive when designing and evaluating coastal fisheries projects and will also assist them in identifying ways to incorporate women in fisheries development programmes.

Performance Objectives (Terminal)

(a) To define the fishing activities of women and analyse their contribution towards self-reliant and sustainable fisheries.

(b) To recognise the contribution of women towards household food security and income for the social and economic well-being of the coastal communities.

(c) To realise that the betterment of the coastal communities depends upon the recognition of the important role of women.

(d) To find ways and means of incorporating women in fisheries development plans and policies.

Introduction and overview

OHP. Crucial strategies directly involving women

Improvements in post-harvest handling and processing technology

Better marketing conditions

Aquaculture

Development and use of community-based activities, especially those related to informal production systems such as subsistence activities.

1. PARTICIPATION OF WOMEN IN THE DEVELOPMENT PROCESS

Purpose: To outline the roles played by women in the development process

Objectives: On completion of this section, participants should be able to identify women as a productive economic and social resource, and to describe their role as agents for sustainable coastal development.

Women as resources

In every community, women represent a significant proportion of the total population.

OHP Figure 1. The World survey of women and men

Data do not necessarily include women's part-time, seasonal or domestic food crop labour.

Source: *Women in agricultural development: FAO's plan of action.* Rome: FAO, 1990

Women as agents in sustainable coastal fisheries development

OHP: possible consequences of commercialisation.

Depletion of stocks

Overcapitalisation of the fishery

Since improved gear and technology are usually associated with male-dominated fisheries, men would benefit and progress. This would leave women in subordinate positions, and reduce their opportunities for the necessary training, education, and other means necessary to be fully productive members of their communities.

Disappearance of subsistence fishery aiming to meet the nutritional needs of coastal communities. As the industry modernises, women are gradually displaced by mechanisation and/or cannot participate because of the long periods of absence from home.

Resources are not likely to survive to support the rural fishing communities. Without these resources, the fishing communities who at present rely on them and future generations would have few alternative local means of support. This would result in increased urban drift and rural depopulation, with all the social and economic problems that these entail.

Exercise: Before examining these options in more detail, we will view and discuss a video programme on Women in Development.

2. THE NATURE OF WOMEN'S FISHING

Purpose: The purpose of this section is to give an overview of the fishing activities of women..

Objective: On completion of this section, participants should be able to identify and describe the nature of women's traditional and subsistence fishing activities.

Women's fishing activities

OHP Some fisheries-related activities of women:

Catching fish in deep water from boats or without boats in shallow lagoons

Collecting shellfish, molluscs and seaweeds

Marketing fish and fisheries products caught by other household members or by themselves

Post-harvesting processing (smoking, salting and drying)

Making and repairing nets, traps, gear and equipment

Traditional aquaculture: catching fry, fingerlings, juveniles; preparing feed, feeding fish; harvesting of catch; maintaining ponds and cages.

Taking care of animals on integrated farms

Cultivating crops such as taro, yams and vegetables close to ponds

Studies of fishing activities of Pacific Island women

OHP: Table 1. Fiji Fisheries Production (1988-1992)

Year	1988	1989	1990	1991	1992
i) Subsistence fishery	15600	15800	16000	16200	16400
ii) Artisanal-Fish	4748.23	4767.87	4747.35	3958.56	3965.14
-nonfish	2119.58	1608.98	1865.39	2051.3	2550.3
iii)Industrial Tuna	9175	9598	7351.2	8578	9418
iv) Other Exports	1897.19	1251.6	1602.32	1518.66	1270.59
Total domestic Prod.	33540	33026.45	31466.26	32306.5	31055.7
Subsistence as% of Total Domestic Prod.	46%	48%	51%	50%	53%

Note: a.Other exports-shark-fin, trochus, beche-de-mer, dried seaweeds, crustaceans & molluscs
b.Industrial Tuna-landings by domestic and foreign vessels at PAFCO.
Source: Fiji Fisheries Division *Annual Reports*

Studies of fishing activities of women in other coastal areas

Exercise: Group discussion

Suggested topics:

What conclusions can we draw from this brief comparison of women's fishing activities in the Pacific and in other coastal areas?

Have we omitted or underestimated any notable activity?

Have we over-emphasised the importance of any activity?

Is it fair to assume that because women are using traditional technology and skills they are exploiting fisheries resources rationally?

Are women's fishing activities more adapted to the aims of sustainable fisheries development than are the activities of men?

3. WOMEN AS AGENTS FOR FOOD SELF-RELIANCE

Purpose : The purpose of this section is to outline the contribution of women towards household food security in coastal fishing communities

Objectives: On completion of this section, participants should be able to :

recognise the contribution of women in providing a reliable source of protein and food

recognise and analyse the influence of women on household health and nutrition

apply these to the concepts of food dependency and food self-reliance.

Protein and food consumption patterns
Reading 4:6
G. David; E. Cillauren. *Traditional village fishing, food security and development of fisheries in Vanuatu.* Port Vila: ORSTOM, 1992 27p.

Reading 4:10
FAO. "Small-scale fishermen:: fishing for food." *Fighting Hunger: Information Bulletin of the World Food Day Secretariat,* 1(1986). 3p

Nutritional status in other coastal areas

Women as nutritional mediators
Exercise: Group discussion

Are there any regular or current assessments of the role of women in providing a reliable source of protein and food in your country?

How does this assessment take place? Is it an effective means of assessment or could it be improved? How is the assessment information used?

If not, why is there no assessment? Could a means of assessment be introduced? How would you do this and how would this information be used?

Importance of food self-reliance

OHP

Food dependence occurs when a country becomes dependent on imported food. The greater the proportion of food consumption from imported food, the greater is the extent of food dependence.

Food dependency, much like famine or malnutrition is one of the components of nutritional vulnerability [defined as] the lack or inadequacy of adaptation responses and regulatory mechanisms of any food production system to the constraints and unbalances occasionally generated by its environment.

Nutritional security is defined as

> The presence in a food production system of adaptation responses to constraints and external unbalances, through which the population's nutritional need can be guaranteed in a durable manner.

Food self-reliance is defined as

> The durable satisfying of the population's nutritional needs through a rational exploitation of the country's natural resources.

OHPThe following diagrams show the dominance of female labour in traditional fisheries as compared to division of labour in fisheries where there is increased mechanisation.

Diagram 1. An Example of Typical Division of Labor by Gender in Traditional Fishing Communities

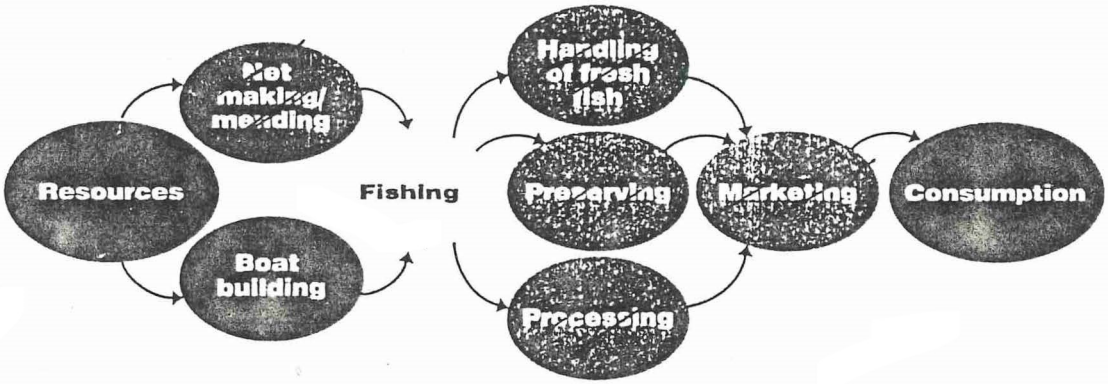
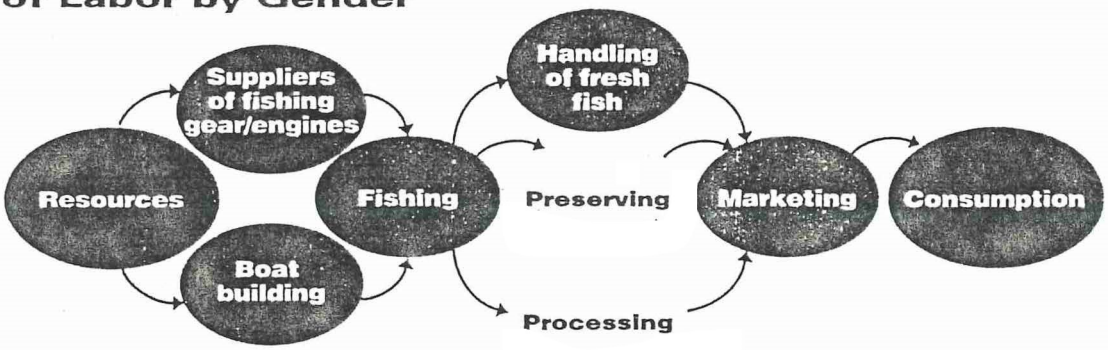


Diagram 2. Effect of Modernization on the Division of Labor by Gender



Mainly Men Mainly Women Both Men and Women

Source: CIDA. 1993. *Women in Fisheries Development.* Ministry of Supply and Services - Canada. p3

Exercise: Group discussions
Suggested topics:

Why does a subsistence production system provide a more balanced food system as opposed to the new or acquired food system?

What type of food dependency occurs in your country?

What contribution do women's fishing activities make towards self-reliance and self-sufficiency in your country?

Are these activities helped or hindered by commercial fisheries operations?

4. WOMENS' CONTRIBUTION TO FISHERIES PRODUCTION AND RELATED ECONOMIC ACTIVITIES

Purpose: The purpose of this section is to help participants recognise the contribution of women towards the social and economic well-being of their family in coastal communities.

Objective: At the end of this section, participants should be able to describe and analyse the role of women as income earners in supporting their families and local communities.

OHP Why women may be active in the market economy

To support the family's livelihood as major income earners for the household.
To supplement the family income.
To sell the catch of husbands and other family members, especially if they are full-time fishers.
To raise funds for church or community projects.
To operate as market mediators or entrepreneurs.

Reading 4:11
FAO. *Women in fishing communities: a special target group of development projects; guidelines.* Rome: FAO,1988 iii,63p.

Observations and studies in the Pacific :

Exercise: observation of fish marketing

Time permitting, participants individually or in small groups visit the Suva fish market, the Naboukalou Creek market and other areas where fish products are sold informally (eg, Vatuwaqa Creek, sometimes Brown St.)

If possible without causing embarrassment, participants observe fish selling activities and find answers to questions such as the following:

What product is sold?
Who sells the product? [Man or woman]
Is the seller a 'catcher" or a 'mediator'?
Who buys the product?
Is there any haggling over price?
If there is, who is more successful, seller or buyer?
If the seller refuses to lower the price, what reason does s/he give?

Participants record the results of their observations, and of any discussions that they may have had with sellers. The observation activity will be followed by a group discussion in which participants will report their findings and see what common conclusions (if any) may be reached.

Note: butchers' paper and/or whiteboards may be needed for this.

Observations in other coastal areas

Exercise: Discussion based on slides on the following:

- women's fishing
- type of gear & technology
- nature of marketing
- processing of marine products
- living and working conditions of women
- general livelihood

Why should women be encouraged to participate further in income-generating activities in the fisheries sector?

Reading 4:9

FAO. "The role of women in small-scale fisheries." [Press Release] *World Food Day,* (16 October 1986) 8p.

Reading 4:17

V. Ram. " Women in commercial fisheries in the South Pacific: a focus on the situation in Fiji." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 pp.105-120

Additional Readings

Reading 4:7

E. Demby. "The role of women in the artisanal fishing sector of Sierra Leone." *EC Fisheries Cooperation Bulletin,* 6(Sept.1993): 13-14

Reading 4:8

T. Endres et al. "Women's activities in fishing in Burkina Faso." *EC Fisheries Cooperation Bulletin,* 6(Sept.1993): 18

Reading 4:9
FAO. "The role of women in small-scale fisheries." [Press Release] *World Food Day*, (16 October 1986) 8p.
Reading 4:15
E. Matthews. "Women in fishing in traditional Pacific Island cultures." *SPC Regional Technical Meeting on Fisheries*, 23 (Information Paper 14). 7p.
Reading 4:16
C. H. J. Palin. " Women in fisheries, Ethiopia." *EC Fisheries Cooperation Bulletin*, 6(Sept.1993): 9-10

Exercise: reading and group discussion
Suggested topics:
What issues relating to the economic role of women do these articles raise? .
Is further research needed in order to analyse the role of women as income earners in the fisheries sector?
If so, what kinds of research projects are needed ?
What are individual countries currently doing?
Are there any regional initiatives in this field?
If so what are they?

Exercise: research for debate on the proposition: that subsistence activities and food security would be hampered if women were encouraged to participate in income-generating fisheries.

Individual participants try to find points for both sides, in the context of their own countries, and considering the further questions:

a) Is it possible to encourage both activities at the same time?
b) If it is, what are the likely consequences?

Group debate
Participants form two teams, and appoint a moderator, time keeper and adjudicator etc from within the group to organise a debate.

Public debate
Following the group debate, the Lecturer may organise a debate on the same subject for relevant USP staff and other persons with interest and expertise in the topic.

5. POLICIES AND STRATEGIES FOR FISHERIES DEVELOPMENT

Purpose: The purpose of this section is to find ways and means of incorporating women in fisheries development plans and policies

Objectives: By the end of this section, participants should be able to:

analyse the objective of fisheries plans and policies

identify the priority areas in fisheries management & development

further appreciate the role of women in the development process

promote the betterment of women in order to promote the betterment of the wider community.

Introduction: changing policies on women in development

Exercise: Group reflection and discussion on WID policies.
Participants divide into 3 groups to reflect on one of the following topics:

1. From a development point of view, is it important to identify how labour is divided in households? Why or why not?

2. What are the likely effects on the sector if present policies on fisheries development in your island countries continue as at present? What impact on subsistence fishery?

3. To what extent is it true that the betterment of coastal communities depends on recognising and enhancing the social and economic roles of women?

After a mutually agreed time, each group presents its conclusions (if any) for discussion by the full group.

FAO and development

OHP 3p a summary of FAO's WID initiatives and activities, and a summary of the provisions of Agenda 21 on women.

c&P & OHP 2p a summary of FAO's WID initiatives and activities.

1984
- ☆ Resolution of the FAO World Conference on Fisheries Management and Development including women specifically in the Programme of Action for the Development of Small Scale Fisheries
- ☆ FAO Government Consultation on the Role of Women in Food Production and Food Security in Africa, Harare
- ☆ FAO Regional Conference for Africa includes discussion on rural women
- ☆ FAO National Workshops on "The Role of Women in Agriculture and Food Security" held in Egypt, Sudan and Tunisia

1985
- ○ World Conference to Review and Appraise the Achievements of the UN Decade for Women: Equality, Development and Peace, Nairobi, Kenya. Adoption of the Nairobi Forward-Looking Strategies for the Advancement of Women (NFLS)
- □ FAO Conference Resolution 12/85 relating to rural women's problems, especially in the areas of training and access to inputs and technology

1986
- ☆ FAO Regional Conferences are held in Asia and the Pacific, the Near East and Latin America and the Caribbean. Include discussions on rural women and agriculture
- ☆ FAO begins coding projects according to women in development concerns
- ☆ FAO prepares the chapter "Women in Agriculture" for the UN World Survey on the Role of Women in Development

○ United Nations events - □ FAO events - ☆ FAO activities

1987
- ○ Formulation of the UN System-Wide Medium-Term Plan for Women in Development (SWMTP) 1990-1995 for implementation of the NFLS, designating FAO as the agency responsible for all food and agricultural components of the Plan
- ☆ FAO prepares the Second Progress Report on WCARRD Programme of Action Including The Role of Women in Rural Development
- ☆ FAO policy paper "Women in Agriculture and Rural Development: FAO's Programme Directions" is presented to the FAO Conference
- □ FAO Conference Resolution 3/87 requesting a plan of action for the integration of women in development encompassing strategies to ensure that all relevant programmes of FAO incorporate the recommendations of the Nairobi Forward-Looking Strategies and the System-Wide Medium-Term Plan
- □ FAO Conference Resolution 4/87 requesting a meeting of experts to discuss how to integrate women into the process of rural development

1988
- ☆ FAO Expert Consultation on Experiences of Institutional Changes Concerning Women in Development, Rome
- □ FAO Council Resolution 1/94 adopting the Plan of Action for the Integration of Women in Development

1989
- ☆ FAO prepares the chapter "Women, Food Systems and Agriculture" for the update of the UN World Survey on the Role of Women in Development
- □ The FAO Plan of Action for the Integration of Women in Development is adopted by the FAO Conference

15a

A TIMELINE OF FAO's MANDATE AND ACTIVITIES ON WOMEN IN DEVELOPMENT

1945
❒ Establishment of FAO
1948
○ Universal Declaration of Human Rights
1949
☆ Establishment of the Home Economics and Social Programme Service in FAO
1966
○ International Covenant on Civil and Political Rights
○ International Covenant on Economic, Social and Cultural Rights
1967
○ UN Declaration on the Elimination of Discrimination Against Women
1969
○ UN Declaration on Social Progress and Development
1975
○ International Women's Year and World Conference in Mexico
❒ FAO Council Resolution 2/66 "Integration of Women in Agricultural and Rural Development and Nutrition Policies"
❒ FAO Conference Resolution 10/75 "The Role of Women in Rural Development"

○ United Nations events · ❒ FAO events · ☆ FAO activities

1976
○ Start of the UN Decade for Women 1976-1985
☆ Establishment of the FAO Inter-Divisional Working Group on Women in Development
1979
❒ World Conference on Agrarian Reform and Rural Development, Adoption of Declaration of Principles and Programme of Action
○ UN Convention on the Elimination of All Forms of Discrimination against Women
1983
☆ FAO's Home Economics and Social Programme Service is converted into Women in Agricultural Production and Rural Development Service
☆ FAO Committee on Agriculture discusses the "Role of Women in Agricultural Production"
☆ FAO's Report on the State of Food and Agriculture dedicates a special chapter to "Women's Participation in Agriculture"
☆ FAO Near East Regional Experts Meeting on Women in Food Production, Amman
❒ FAO Conference Resolution 4/83 requests FAO to monitor programmes that benefit rural women
☆ FAO Expert Consultation on Women in Food Production, Rome

AGENDA 21

REQUIRES:

- STRONGER ROLE OF WOMEN IN SUSTAINABLE DEVELOPMENT

- AGENDA 21 IMPLEMENTATION - ALL UN BODIES "SHOULD ENSURE GENDER CONSIDERATIONS ARE FULLY INTEGRATED INTO ALL POLICIES, PROGRAMMES AND ACTIVITIES.

- <u>CHAPTER 24</u> - SEPARATE CHAPTER ON WOMEN : ENTITLED

  "*GLOBAL ACTION FOR WOMEN TOWARDS SUSTAINABLE AND EQUITABLE DEVELOPMENT*"

- CHAPTER 24 RECOMMENDS:

  - STRONGER ROLE OF WOMEN IN SUSTAINABLE DEVELOPMENT
  - RIDDING OF ALL OBSTACLES TO WOMEN'S EQUAL AND BENEFICIAL PARTICIPATION, ESPECIALLY IN:
    - DECISION MAKING ON ENVIRONMENT AND SUSTAINABLE DEVELOPMENT ISSUES

FAO initiatives

OHP The Group was set up to undertake these tasks:

Review ongoing and pipeline projects to determine the possibility of including women in project activities.

Identify any negative impact of development initiatives on women's economic activities.

Organise or promote workshops.

Identify new pilot activities.

Help counterpart experts and decision makers in recipient countries to become more sensitive to gender issues.

Reading 4:12

FAO; SIDA. "Review of selected fisheries development projects." from their *Gender issues in fisheries and aquaculture, including proceedings of the workshop on enhanced women's participation in fisheries development. Zimbabwe, 4-7 December 1990.* pp. 68-82

Case study

Reading 4:13.

Fiji. Central Planning Office."Women in development." [and] "Fisheries." from its *Opportunities for growth: policies/ strategies for Fiji in the medium term.* Suva: the Office, 1993 pp.71-74; 88-90

OHPExercise, part 1: women in fisheries-related projects

The table provided has three columns.

In column 1, list the major fisheries projects in your country for the past year.

In column 2, use the letter C to show that your government was the chief funder; G to show that an IGO was the chief funder; and N to denote an NGO.

In column 3, write the letter A to denote a high direct involvement of women: or the letter B to denote a significant direct involvement: or the letter C to denote little or no direct involvement of women.

FISHERIES PROJECTS INVOLVING WOMEN

COUNTRY

Fisheries Project	Funding	Women Involved?

OHP Exercise, part 2: participation of women in fisheries training programmes

In Column 1 of the table, list any practical fisheries-related training courses in which participants from your country have taken part in the past year.

In Column 2, use the letter N to show that the course was national; or the letter S to denote a regional course; the letter I to denote an international course.

In Column 3, use the letter G to show that your government was the chief funder of the course; G to show that an IGO was the chief funder; H to denote an NGO.

In Column 4, place a tick in the last column for each course in which at least one woman from your country participated.

Again, you may have to depend on memory for some of these details, but fill in as many as you can. If there are several participants from the same country, it will be easier to work together.

OHP Exercise, part 3.
Individuals or country groups attempt to find answers to these questions.

Approximately how many students from your country have completed fisheries related formal education programmes at tertiary institutions ?

How many of these are women ?

Approximately how many students from your country are undertaking fisheries related formal education programmes at tertiary institutions ?

How many of these are women ?

OHP Exercise, part 4: Individual analysis followed by group discussion

1. Individuals or country groups attempt to analyse and draw conclusions from their own project list.

Some relevant questions:

Which projects seem most relevant to women?
How many of these did in fact involve women?
To what extent did these involve women?
What reasons can you give for the involvement or lack thereof?
Are Governments or IGOs or NGOs more likely to support projects involving women?
Why?

2. Individual or country groups attempt to analyse and draw conclusions from their own training course list.

Some relevant questions:

Which courses seem most relevant to women?
How many of these did in fact involve women?
What reasons can you give for the involvement or lack thereof?
Do women participate more in national, regional or international courses?
Why?
Are Governments or IGOs or NGOs more likely to support the inclusion of women in training courses.?
Why?

3. What proportion of women have undertaken or are undertaking formal tertiary education in fisheries-related subjects?

4. Group discussion: participants report their conclusions and attempt to identify the possible causes, and the implications for coastal fisheries management. They may also identify regional trends and note any areas where regional action might be appropriate.

6. HOW CAN WOMEN BE INCORPORATED IN FISHERIES DEVELOPMENT PLANS AND POLICIES?

Purpose: The purpose of this section is to identify strategies that might be used to incorporate women in fisheries development plans and policies.

Objectives: On completion of this section, participants should be able to do the following:

1) Identify constraints to the development and enhancement of women's activities in the fisheries sector.

2) Identify possible strategies to overcome the above constraints.

Constraints

OHP: practical and strategic constraints
General socio-economic conditions

1. Women and rural coastal communities generally are faced with poor infrastructure and marketing facilities; in some areas they lack the basic health services. All these lead to increased inefficiency, hardships and heavy workloads.

2. Over-fishing, pollution, coastal development activities and destructive fishing practices are causing degradation of the coastal environment and creating serious threats to the major source of protein and food and to the livelihood of coastal communities who depend on these resources.

Attitudes

3. Deep-rooted social and cultural attitudes ensure that women are in subordinate positions within households and are given low priority in education and training opportunities. This leads to a high percentage of illiteracy among women.

Access to resources

4. Increased demand for cash puts pressure on women in rural fishing communities are faced to increase incomes without neglecting household activities.

5. Domestic responsibilities mean that most women cannot spend long periods away from home. Activities requiring additional time must be economically and socially justified.

6. Training and extension courses may be held in places or at times that may make regular attendance by women difficult.

7. As women often lack collateral or control over the income they earn, they may have more difficulties than do men in securing credit from Development Banks and financial institutions,

8. Women are often under-represented in Cooperatives, and therefore lack support and economic power that such collective institutions may offer.

9. Women have limited access to modern fisheries knowledge, technology, credit and other government support systems. This has placed significant constraints on their ability to expand into commercial operations. Most of the benefits are directed at male-dominated fisheries.

Planning and decision-making processes

10. Women are involved in a wide range of fishing activities, but their traditional roles are considered non-economic. The inadequacy of specific data and statistics limits assessment of their economic worth and potential, and affects economic planning and development. Considering the history of women's active involvement and the diverse cultural background, ethnographic and theoretical research on women in fishing communities is almost non-existent.

11. Women have been excluded from decision-making processes dealing with coastal environment such as in aquaculture and coastal development and management.

12. Fisheries policies often emphasise development of export and industrial fisheries to increase foreign exchange and create economic growth by directing major portion of its resources and funds. Low priority is placed on policies promoting self-reliance, such as subsistence activities and others involving women. Often such projects are not self-sustaining; there is no follow-up because of limited funds available for women's projects. The disappearance of such systems in small island countries can lead to malnutrition and famine.

13. Women involved in land-based fisheries activities such as processing and marketing are excluded from decisions on resource management because they are not seen as direct users of the resources. However, increased effort and over-exploitation would reduce their access to fish and therefore have a direct impact on their income levels.

Exercise: group discussion.

Can we identify any one single constraint that underlies all or most of the others? In other words,

What can we do to overcome these constraints ?

One very important problem that we have identified [or have failed to identify?] is that of attitudes. We may suggest both practical and strategic solutions, but unless we are able to change attitudes, the suggestions may not work.

Exercise : small group reflection and group discussion

Participants divide into small groups to look individually at the following list of possible solutions, and identify those aimed at general socio-economic conditions; those aimed at attitude change; those aimed at access to resources; and those aimed at attitude change access to decision-making and planning processes. Then identify the solutions that seem most likely to work in the context of the participants' societies, and assign priorities to each solution — A= top priority; B = second priority; C= low or no priority.

After a mutually agreed time, the whole group reconvenes; individual groups report on findings and the whole group assigns priorities to each solution.

OHP General guidelines and strategies

1. Provide education and training on gender issues to sensitise the public on the importance of gender differentiation because of the different roles of men and women in fishing economies.

2. Encourage women to take up education and training opportunities on aspects of the fisheries industry such as fishing and harvesting techniques, post-harvest technology, resource use and management, financial management and administration and the sciences.

3. Carry out more quantitative, qualitative research and information on women's fishing activities and contributions. Social and economic indicators should give gender specific data in order to address the particular needs and assess the situation of both men and women. More empirical data, case studies, ethnographical, historical and specific details on women's activities in fishing communities are also needed.

4. To balance household domestic responsibilities and income earning opportunities vital for their survival, improve the socio-economic and living conditions for women and rural communities: access to medical facilities, water, fuel, and health, nutrition and hygiene extension services.

5. Support environmental public education both formal and informal means to the public at large. Environmental legislation and regulations are essential to give guidelines in sustainable resource use and management.

6. Facilitate women's access to modern fishing knowledge technology and credit through extension, technical assistance and training. Communication and leadership skills training must be provided for women.

7. Include women at all decision making levels. Representatives from groups or individuals on women's issues must be included in any decision-making affecting their livelihood.

8. Improve marketing and post-harvest infrastructural facilities by providing adequate storage facilities, ice, shelter and regular transportation or collection services.

9. Incorporate in development plans policies for self-reliant economic systems. Artisanal and subsistence fisheries are vital to the protein and food supply for the coastal communities.

10. There must be two-way communication from the decision makers to the users at the operational level to users and vice versa. Because of the various user groups, there is need for an integrated system of management and development of coastal areas. The planning process must incorporate the interests and concerns of all affected directly or indirectly.

What strategies do we need to ensure that participation of women and the role of gender issues are adequately addressed ?

Education, training & extension:
Exercise: Group discussion
OHP Strategies: How to put these strategies into practice?

1. Include gender issues into formal curricula in schools to sensitise the general community

2. Increase public awareness on marine-related issues by providing simple and appropriate educational materials such as audiovisual materials, pamphlets, seminars, group discussions, field days.

3. Provide compulsory basic education to all, as well as nonformal courses to increase literacy levels of women.

4. Secure secondary and tertiary level scholarships for girls and women.

5. Facilitate women's access to training programmes at national, regional, and international level.

6. When designing, conducting and evaluating fisheries training programmes, take into account the existing knowledge, expertise, attitudes and values of the target group so that trainees can relate to the programme and recognise its benefits. Programmes should be on-going, and have proper monitoring, evaluation and follow-up components.

7. Focus extension activities on harvesting technologies, marketing and processing. This will help in overall coastal fisheries development, and will also involve greater women's participation in the process.

8. Employ female extension officers and trainers in areas where a man may be culturally unacceptable or where advice or training by women may be more acceptable. Trainers and educators should be sensitive to women's interests and concerns.

9. Improve the communications skills and technical knowledge of extension officer or trainers. Use adult education techniques that take into account different literacy levels within the fishing community especially where those of women may be lower.

10. Target extension advice on health, nutrition and other community matters at the whole community, not just at women. Training community members may be an effective way of conveying the extension message.

Research, information and database management

Women's contribution is too often ignored because of the lack of adequate evaluation techniques and methodologies.

The extent of participation of women in fisheries activities varies from country to country and even within the country, depending on the availability of fisheries resources, social custom and tradition, alternative economic opportunities, and so on. Therefore there is a need for more specific research and baseline information on the actual involvement of women in various types of fishing economies rather than relying on information that is generalised and scattered.

Research on all aspects of coastal fisheries should also focus on gender differentiation. For example, research on fishing operations and technology, resources use and management and policy and planning issues must focus on specific tasks of males and females where possible.

Research policies should therefore focus on quantitative and qualitative research to assess the situation of women in fisheries in order to better address their particular needs. The research information should be timely and readily available to those concerned and interested in women's issues.

Exercise: Group discussion
OHP Strategies: How to put these strategies into practice?

1. Allocate and secure funds for research and development eg. personal and institutional support.

2. Identify and prioritise the research needs e.g. baseline ethnographic data on women's activities in the South Pacific, women's needs and resources, projects.

4. Create statistical and bibliographic databases on women in fisheries development.

5. Develop methodologies to evaluate the informal and diverse activities of women and find means to incorporate such information into the national production system.

6. Encourage research into ways of involving women in improving their socio-economic status within the household and the communities.

7. Create and facilitate networking and collaborative activities at all levels including fisherwomen, decision makers, researchers, institutions, and professionals in order to use resources and information more effectively and efficiently.

Project Development

Exercise: Individual reading and group discussion.

Participants divide into about 6 groups. Each group reads and discusses one of the Readings listed below. After a mutually agreed time, participants reconvene, and present for general discussion their findings on the desirability and feasibility of the approaches suggested.

Reading 4:3
H. Booth. *Checklist for use in the appraisal of projects to assist women's participation.* Suva: the author, 1994 (Prepared in the Ministry of Women ... under the ADB project *Socio-economic database on women*, July 1994) 8p.

Reading 4:5
CIDA. "Policies in support of women in fisheries. [and] A gender-relevant approach for fisheries development projects." From its *Les femmes et le developpement de la peche.* [np.nd.] pp.6-9; 10-12

Reading 4:11
FAO. *Women in fishing communities: a special target group of development projects; guidelines.* Rome: FAO,1988 iii,63p.

Reading 4:12
FAO; SIDA. "Review of selected fisheries development projects." from their *Gender issues in fisheries and aquaculture, including proceedings of the workshop on enhanced women's participation in fisheries development. Zimbabwe, 4-7 December 1990.* pp. 68-82

Reading 4:19
P. Schoeffel; S. Talagi. "A summary of recommendations." from *The role of women in small-scale fisheries in the South Pacific: report of case studies in Cook Islands, Papua New Guinea, Solomon Islands, Tonga, Vanuatu and Western Samoa.* London: Commonwealth Secretariat, 1989 pp.1-7.

Reading 4:21
D. A. Ziehi. "Women's role in aquaculture production" from FAO;SIDA. *Gender issues in fisheries and aquaculture, including proceedings of the workshop on enhanced women's participation in fisheries development. Zimbabwe, 4-7 December 1990.* pp. 91-109

7. CASE STUDIES AND EXERCISES IN PROJECT FORMULATION

Purpose: The purpose of this section is to find ways and means to incorporate women in Fisheries Development Plans

Objectives: When they have completed this section, participants should be able to formulate strategies to ensure that the participation of women and the role of gender issues are adequately addressed in coastal fisheries projects.

Note: This section consists exclusively of exercises, and contains no lecture notes.

Exercise: Group discussion

The purpose of this exercise is to discuss the feasibility of certain strategies that may be included in project formulation.

OHP Strategies: How may we put these strategies into practice?

1. Encourage subsistence activities for home consumption through fisheries extension education by stressing the importance of fish protein, nutrition and self-reliance.

2. Design gender-specific extension support for both women and men in areas where their needs are not the same.

3. Encourage women's participation in training through workshops and field days to develop skills in post-harvest technology.

4. Encourage follow-up training programmes and regular extension services to ensure that projects are sound and on-going.

5. Introduce only simple and appropriate technologies that facilitate semi-commercial production such as goggles for diving, punts, rain-jackets and torch lights. These can be promoted through subsidising appropriate gear and discouraging others by laying higher tariffs on those that are inappropriate such as large gill-nets.

6. Provide ice and storage facilities and, where necessary, processing techniques to maintain quality and freshness.

7. Encourage community collection centres for surplus production.

8. Widen credit facilities, gear and technology, training and other support systems to include women.

9. Upgrade marketing and distribution systems and infrastructure such as availability of ice, freshwater, shelter, reliable transportation and collection services where necessary.

10. Involve women in all aspects of aquaculture development eg. planning, development, operations and management.

11. Ensure appropriate resource management strategies for the sustainability of the commercial operations.

12. Take measures to avoid replacement of women by mechanisation and improved technology.

13. Create market opportunities for locally processed marine foods through consumer education and product development.

Exercise: Individual reflection and group discussions

The purpose of this exercise is to help participants recognise the socio-economic role of women and how it contributes towards the objectives of development.

Scenario: Vanua Levu coastal fishing village located some 80km away from the city on the North east coast of Viti Levu in Fiji.

Men and women fish together but they target different species using different gear and techniques. Men usually fish from boats using lines, gill nets or they dive using spearguns. Women use handlines to catch fin-fish but spend more time gleaning on the reef at low tide. Both men and women keep part of their catch for household consumption, but sell most of it.

Men sell their catch to the village co-operative, which also provides ice for maintaining freshness of the catch. The women transport their individual catches to the market by hiring a carrier from another village. As the women have no provision for storage, any surplus octopus and trochus must be boiled the same night and surplus fish must be processed by drying and salting.

The income received from the sale of fish by men is generally used for major investments, buying household durables, bulk food, school fees and for any other social payments. The income received by women is used immediately to buy household food items such as flour, biscuits, kerosene, tea and sugar.

The fishing co-operative purchases and markets all fin-fish and catch from the men. It does not assist women because it has fixed buyers who prefer fin-fish and other high value commodities like lobsters and prawns. It does not want to have to seek regular customers interested in the large quantities of octopus, edible seaweeds or bivalves that women collect.

The co-operative refuses also to purchase fin-fish from women or even to supply ice to them. It feels that the ice must be readily available for the male fishermen who cater for their demand to supply high value catch to the cooperative

Points for reflection and discussion:

1. Why does the co-operative feel that women's fishing is not as important as men's?

2. The men, as members of the household, may assist the women in bringing their catch home from the sea and in processing, but as members of the co-operative, they are unwilling to help the village women. Why? What can be done about it?

3. What are some of the likely development trends that could take place within this village if the situation continues?

4. What are some of the problems faced by the village women and how can they overcome them?

Exercise: Simulation

Purposes: The purpose of this exercise is to enable participants to consolidate what we have learnt and discussed in this module. Specifically, participants are asked to:

1. Determine the extent to which the development objectives are complementary or conflicting.
2. Identify the perceived needs of both men and women fishers.
3. From a gender perspective, identify the constraints of both men and women fishers.
4 Identify projects that may solve the problems of both groups.
5. Identify areas in which further information is needed.
6. Identify means of finding the required information.
7. Formulate strategies to ensure that the roles and functions of both men and women are recognised and enhanced.

This may be done by individual or small group reflection, followed by group discussion.

Scenario: SA LEVU

Geography: SA Levu is situated about 250 km south of Suva, the capital city. The total land area of the island is about 200 sq km. There are 3 fishing villages belonging to one tribe located on the Southern Coast of SA Levu Island. These villages share an extensive mangrove, reef and a sheltered lagoon area There are 3 trucks for internal transportation and a fortnightly ferry service from the mainland. In total there are 4 motorised punts and 5 non-motorised punts.

Fisheries sector development objectives: assume that the development objectives are as follows

1. To increase national fish production
2. To improve the socio-economic status of rural fishing communities.
3. To enhance the role of women in fishing communities.

Fisheries resources: Demersal fish are caught from punts using gill nets and handlines. The fisheries resources in the area are currently considered as under-exploited except for the giant-clams, beche-de-mer, and mud crabs. Although these commodities are still available and are the most targeted species, production statistics have already indicated that there has been a steady decline while effort has been more or less stable.

Economic activity: All 3 villages have a semi-subsistence lifestyle, deriving income from sale of copra and fish; both activities have variable income, and fishing for the market is done on Fridays as there are no storage facilities on the island. The only other sources of income besides copra and fish are irregular remittances for some households with family members in Suva.

Household budgets: Husbands are generally expected to pay for maintenance and repair of the house, boat or other community obligations; the wives are expected to pay for food and day to day household expenses including food items like sugar, flour, rice, biscuits and tea. Sometimes the money is also used towards payment of household loan or school expenses. However, there are periods when whatever is earned goes immediately to pay for food especially when income is low.

Division of labour and social factors: Men fish for demersal fish from punts in deep seas when there is need for cash or for subsistence consumption. If they are not fishing, they spend time doing community work, attend to gardens and plantations or sit around with fellow villagers to drink Kava (grog).

Women do a lot of community and church activities, but, after finishing their daily chores, give priority to collecting various kinds of marine products on the reef flats and mangrove areas. They also fish for hours inside the lagoon in waist deep water, using handlines. Their fishing gear consists of handlines, digging stick, goggles and hand nets. Women's fishing provides daily food, both through subsistence and by supplementing the household income through sale of any surplus catch at the market on Saturdays. They have to hire a punt to bring their catch to the market.

Women are responsible also for processing of catch. Sometimes they help their husbands in mending and repair of nets and other fishing gear. They have been cutting mangrove areas for firewood and do not realise that this is likely to create environmental problems in the near future.

Nutritional status: The nutritional status of adults is generally good but there are some cases of children being malnourished. This is because some parents prefer to feed their kids with the highly favoured and well advertised convenience foods, such as noodles, bread, biscuits, packaged snacks and sweet fizzy drinks bought from the city.

Fisheries Extension: The fisheries extension officer visits the villages once a fortnight. He spends most of his time chatting with men's groups, since he regards this as an information-seeking activity. He greets women out of respect but does not discuss any fisheries matters with them. He feels that talking to the menfolk is sufficient, as he is always constrained by the time factor, and perhaps feels uncomfortable in women's groups.

5 men from the 3 villages have taken the Rural Fisherman's Training Programme. 3 of the 5 have had their boats re-possessed by the bank because of default in loan repayments. Two new fishermen have requested the extension officer to facilitate a Development Bank loan for purchase of 2 outboard motors for their punts. His task now is to prepare a proposal for them so that their loan is approved.

Women's perception of their role: An interview in the village indicated that women and men work together towards household production. However, observation clearly indicated that there is a clear division of labour in both agriculture and fisheries, although the tasks complement each other in meeting household needs.

Furthermore, when women were asked about their role in the household, they indicated that they are satisfied, but at the same time complained that the responsibility for the family tends to fall on them, since they have to provide the basic necessities such as food and school expenses.

Exercise: draft a project proposal for Sa Levu

By group discussion, establish a common format for a project proposal, taking into account that detailed costings and justifications will not be possible in this exercise.

Then, working in small groups, draft a proposal that will incorporate the strategies identified in the previous exercise, and present the draft for group discussion.

Exercise: identification of national policies and projects needing to be changed.

Working individually or in small groups, identify for each country represented

a) development policies that conflict with the aims of sustainable development of coastal fisheries in which women play a major role.

b) fisheries projects in which the role of women needs to be addressed.

Resources required: material gathered in previous activities in this module and in the Policy Objectives section of Module 3. The Lecturer may wish also to arrange with the PIMRIS Coordinator in USP Library to make Development Plans available in case of need.

LIST OF READINGS AND RESOURCES REQUIRED

Reading 4:1
Asia and Pacific Women's Resource Collection Network. "Coastal and sea-based communities." from its *Asia and Pacific Women's Resource and Action Series: Environment.* Kuala Lumpur: APDC, 1992 pp.85-114

Reading 4:2
K. Bhasin. "Some thoughts on development and sustainable development." *ISIS*, (4/92;1/93): 10-18

Reading 4:3
H. Booth. *Checklist for use in the appraisal of projects to assist women's participation.* Suva: the author, 1994 (Prepared in the Ministry of Women ... under the ADB project *Socio-economic database on women*, July 1994) 8p.

Reading 4:4
M. D. Chapman. "Women's fishing in Oceania." *Human Ecology,* 15(1987):267-288

Reading 4:5
CIDA. "Policies in support of women in fisheries. [and] A gender-relevant approach for fisheries development projects." From its *Les femmes et le developpement de la peche.* [np.nd.] pp.6-9; 10-12

Reading 4:6
G. David; E. Cillauren. *Traditional village fishing, food security and development of fisheries in Vanuatu.* Port Vila: ORSTOM, 1992 27p.

Reading 4:7
E. Demby. "The role of women in the artisanal fishing sector of Sierra Leone." *EC Fisheries Cooperation Bulletin,* 6(Sept.1993): 13-14

Reading 4:8
T. Endres et al. "Women's activities in fishing in Burkina Faso." *EC Fisheries Cooperation Bulletin,* 6(Sept.1993): 18

Reading 4:9
FAO. "The role of women in small-scale fisheries." [Press Release] *World Food Day,* (16 October 1986) 8p.

Reading 4:10
FAO. "Small-scale fishermen: fishing for food." *Fighting Hunger: Information Bulletin of the World Food Day Secretariat,* 1(1986). 3p

Reading 4:11
FAO. *Women in fishing communities: a special target group of development projects; guidelines.* Rome: FAO,1988 iii,63p.

Reading 4:12
FAO; SIDA. "Review of selected fisheries development projects." from their *Gender issues in fisheries and aquaculture, including proceedings of the workshop on enhanced women's participation in fisheries development. Zimbabwe, 4-7 December 1990.* pp. 68-82

Reading 4:13
Fiji. Central Planning Office."Women in development." [and] "Fisheries." from its *Opportunities for growth: policies/ strategies for Fiji in the medium term.* Suva: the Office, 1993 pp.71-74; 88-90

Reading 4:14
L. Gina-Whewell. "Roviana women in traditional fishing." presented [at] *Science of Pacific Peoples Conference, 5-12 July 1992, Suva, Fiji.* [np.,np. 1992] 15p.

Reading 4:15
E. Matthews. "Women in fishing in traditional Pacific Island cultures." *SPC Regional Technical Meeting on Fisheries,* 23 (Information Paper 14). 7p.
Reading 4:16
C. H. J. Palin. " Women in fisheries, Ethiopia." *EC Fisheries Cooperation Bulletin,* 6(Sept.1993): 9-10
Reading 4:17
V. Ram. " Women in commercial fisheries in the South Pacific: a focus on the situation in Fiji." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 pp.105-120
Reading 4:18
P. Schoeffel. "Women in the fisheries of the South Pacific." from *Women in development in the South Pacific, barriers and opportunities: papers presented at the conference held in Vanuatu 11-14 August 1984.* Canberra: NCDS, ANU, 1985 pp. 156-175
Reading 4:19
P. Schoeffel; S. Talagi. "A summary of recommendations." from *The role of women in small-scale fisheries in the South Pacific: report of case studies in Cook Islands, Papua New Guinea, Solomon Islands, Tonga, Vanuatu and Western Samoa.* London: Commonwealth Secretariat, 1989 pp.1-7.
Reading 4:20
T. Taniera; E. T. Mitchell. *Women and fishing: notes from Kiribati.* [np; np; August 1992] 3p.
Reading 4:21
D. A. Ziehi. "Women's role in aquaculture production" from FAO;SIDA. *Gender issues in fisheries and aquaculture, including proceedings of the workshop on enhanced women's participation in fisheries development. Zimbabwe, 4-7 December 1990.* pp. 91-109

Resources needed
Video on women in development [for section 1]
Slides [for section 4]
OHP as indicated in text
Debaters, room etc for public debate [for section 4]
Transport etc for visits to markets [for section 4]
Fisheries sector plans and projects and development plans [for sections 6 & 7 - liaise with PIMRIS Coordinator/USP Library?

MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

MODULE FOUR: LIST OF READINGS

Reading 4:1
Asia and Pacific Women's Resource Collection Network. "Coastal and sea-based communities." from its *Asia and Pacific Women's Resource and Action Series: Environment.* Kuala Lumpur: APDC, 1992 pp.85-114

Reading 4:2
K. Bhasin. "Some thoughts on development and sustainable development." *ISIS*, (4/92;1/93): 10-18

Reading 4:3
H. Booth. *Checklist for use in the appraisal of projects to assist women's participation.* Suva: the author, 1994 (Prepared in the Ministry of Women ... under the ADB project *Socio-economic database on women*, July 1994) 8p.

Reading 4:4
M. D. Chapman. "Women's fishing in Oceania." *Human Ecology*, 15(1987):267-288

Reading 4:5
CIDA. "Policies in support of women in fisheries. [and] A gender-relevant approach for fisheries development projects." From its *Les femmes et le developpement de la peche.* [np.nd.] pp.6-9; 10-12

Reading 4:6
G. David; E. Cillauren. *Traditional village fishing, food security and development of fisheries in Vanuatu.* Port Vila: ORSTOM, 1992 27p.

Reading 4:7
E. Demby. "The role of women in the artisanal fishing sector of Sierra Leone." *EC Fisheries Cooperation Bulletin*, 6(Sept.1993): 13-14

Reading 4:8
T. Endres et al. "Women's activities in fishing in Burkina Faso." *EC Fisheries Cooperation Bulletin*, 6(Sept.1993): 18

Reading 4:9
FAO. "The role of women in small-scale fisheries." [Press Release] *World Food Day*, (16 October 1986) 8p.

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FAO. "Small-scale fishermen: fishing for food." *Fighting Hunger: Information Bulletin of the World Food Day Secretariat*, 1(1986). 3p

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FAO. *Women in fishing communities: a special target group of development projects; guidelines.* Rome: FAO,1988 iii,63p.

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FAO; SIDA. "Review of selected fisheries development projects." from their *Gender issues in fisheries and aquaculture, including proceedings of the workshop on enhanced women's participation in fisheries development. Zimbabwe, 4-7 December 1990.* pp. 68-82

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Fiji. Central Planning Office."Women in development." [and] "Fisheries." from its *Opportunities for growth: policies/ strategies for Fiji in the medium term.* Suva: the Office, 1993 pp.71-74; 88-90

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C. H. J. Palin. " Women in fisheries, Ethiopia." *EC Fisheries Cooperation Bulletin,* 6(Sept.1993): 9-10

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V. Ram. " Women in commercial fisheries in the South Pacific: a focus on the situation in Fiji." from G. R. South (ed.) *Marine resources and development.* Suva: PIMRIS, USP Library, 1993 pp.105-120

Reading 4:18
P. Schoeffel. "Women in the fisheries of the South Pacific." from *Women in development in the South Pacific, barriers and opportunities: papers presented at the conference held in Vanuatu 11-14 August 1984.* Canberra: NCDS, ANU, 1985 pp. 156-175

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T. Taniera; E. T. Mitchell. *Women and fishing: notes from Kiribati.* [np; np; August 1992] 3p.

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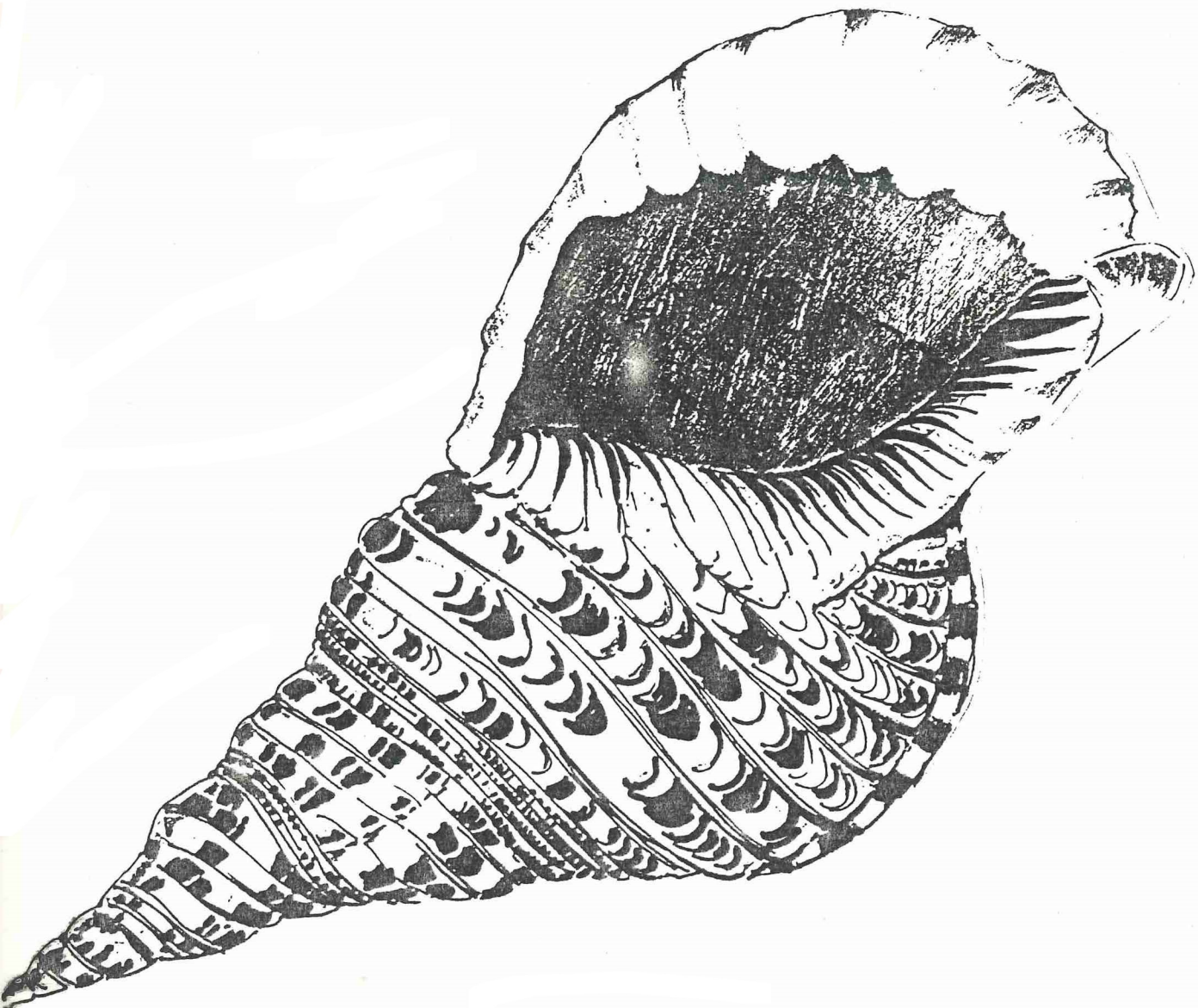
COASTAL FISHERIES DEVELOPMENT AND MANAGEMENT
MODULE FIVE: ALTERNATIVE STRATEGIES FOR MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

Participant's guide



1. INTERNATIONAL CONVENTIONS AND THE ROLE OF INTERNATIONAL ORGANISATIONS IN MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

Outline

1 Introduction: the status of coastal fisheries

1.1 Importance of coastal fisheries management and development

1.2 International conventions

1.3 Involvement of major international organisations in the execution and implementation of the international conventions

1.4 Effects of UNCLOS on the activities of regional institutions in the South Pacific

2. INTERNATIONAL POLICIES AND STRATEGIES RELEVANT TO SUSTAINABLE COASTAL FISHERIES IN THE SOUTH PACIFIC REGION

2.1 UNCLOS provisions relevant to coastal fisheries

2.2 UNCED Agenda 21 provisions relevant to coastal fisheries

3. ANALYSIS OF INTERNATIONAL CONVENTIONS AND GUIDELINES IN RELATION TO CURRENT NATIONAL AND REGIONAL POLICIES AND STRATEGIES

3.1 Major goals, objectives and priorities of fisheries development plans

3.2 Case study: Fisheries Sector, Mari

3.2.1 Background

3.2.2 Development constraints

3.2.3 Development prospects

3.2.4 Policies and strategies

3.2.4.1 Strategies for the given goals and objectives

3.2.4.1.1 Scenario

3.3 Case studies: strategies that promote sustainable development of coastal fisheries and those that do not

3.3.1 Case study: fisheries development in Kerala.

3.3.2 Case study: Benin fisheries project

4. ALTERNATIVE STRATEGIES TO PROMOTE THE DEVELOPMENT AND MANAGEMENT OF COASTAL FISHERIES

4.1 Major problems in current coastal fisheries policies and strategies

4.2 Alternatives

4.3 Possible guidelines and strategies

5. POSSIBLE CONSEQUENCES OF IMPLEMENTING ALTERNATIVE STRATEGIES IN COASTAL AREAS

5.1 Case studies
5.1.1 Philippines: initiatives to manage a heavily used and abused marine environment
5.1.1.1 Coastal Adaptive Management and Resource Assessment (CAMRA)
5.1.1 2 Lingayen Gulf Coastal Area Management Plan
5.1.1.3. Artificial reefs
5.1.2 Bay of Bengal Programme: a regional approach to management
5.1.2.1 Aquaculture development
5.1.2.2 Participatory development
5.1.3 Thailand: community management of coastal resources
5.1.4 Torres Strait, Australia: guidelines from traditional resource users
5.1.4.1 Marine Strategy for Torres Strait (MaSTS)
5.1.5 Tuvalu Fisheries Development Plan
5.1.6 South Pacific Marine Protected Areas
5.1.7 Customary Marine Tenure (CMT) systems
5.1.7:1 Introduction to the case study
5.1.7.2 Case studies and exercise

6. FORMULATION OF MANAGEMENT PLANS FOR COASTAL FISHERIES DEVELOPMENT: EXERCISE

6.1 Background analysis: factors to be taken into account in the design of fisheries management and development plans
6.2 Plan design and formulation
6.3 Presentation
6.4 General discussion
6.5 Appendices
6.5.1 Checklist of policy instruments for fisheries management and development in the South Pacific region
6.5.2 Draft plan outline
6.5.3 List of Readings

COASTAL FISHERIES DEVELOPMENT AND MANAGEMENT MODULE FIVE: ALTERNATIVE STRATEGIES FOR MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

Terminal objective:

To develop an appropriate plan for sustainable coastal fisheries.

Performance objectives:

1) Identify current fisheries plans and policies that enhance the development of sustainable fisheries.

2) Create alternative strategies appropriate to the development and management of coastal fisheries.

3) Draft an alternative plan and identify suitable projects.

Intermediate objectives:

1.1	Assess the importance of coastal fisheries management and development.
1.2	Describe international initiatives and their regional and national implications.
1.3	Identify international initiative for policies and strategies on sustainable coastal fisheries.
1.4	Identify and assess current national policies and strategies in line with the above.
2.1	Create alternative strategies appropriate to the development and management of coastal fisheries.
2.2	Determine new policies and strategies appropriate for regional and national needs.
2.3	Prescribe ways and means to implement the above.
2.4	Identify problems and prospects.
2.5	Define and list the institutional changes required.
3.1	Discuss case studies and projects in coastal areas
3.2	Develop a national plan for coastal fisheries management and development.
3.3	Identify and design specific projects in specific areas of work.

1. THE ROLE OF INTERNATIONAL ORGANISATIONS IN MANAGEMENT AND DEVELOPMENT OF COASTAL FISHERIES

Purpose: The purpose of this section is to analyse the roles of international organisations in the sustainable management and development of coastal fisheries.

Objectives: On completion of this module, participants should be able to:

describe the status of coastal fisheries.
explain the importance of coastal fisheries management and development.
describe the initiatives of international bodies in this direction.
analyse the regional and national implications of such initiatives.

1. Introduction: the status of coastal fisheries

OHP & C&P The world's two marine fishing industries.

The world's two marine fishing industries - how they compare

	Large scale	*Small scale*
Number of fisherfolk employed	Around 500'000	Around 12'000'000
Annual catch of marine fish for human consumption	Around 29 million tonnes	Around 24 million tonnes
Capital cost of each job on fishing vessels	$ 30'000-$ 300'000	$ 250-$ 2500
Annual catch of marine fish for industrial reduction to meal and oil, etc.	Around 22 million tonnes	Almost none
Annual fuel oil consumption	14-19 million tonnes	1.4-1.9 million tonnes
Fish caught per tonne of fuel consumed	2-5 tonnes	10-20 tonnes
Fisherfolk employed for each $ 1 million invested in fishing vessels	5-30	500-4000
Fish destroyed at sea each year as by-catch in shrimp fisheries	6-16 million tonnes	None

Original in *NAGA*, the ICLARM Quarterly

Exercise: research, presentation and group discussion.

Working individually or in country groups, participants prepare an overview of the status of coastal fisheries in their individual country.

Individuals/groups present their overviews to the full group, which compares the nature and the degree of problems and identifies the causes of the problems.

1.1. Importance of coastal fisheries management and development

1.1.1 Coastal fisheries in the ocean ecosystem

OHP Three major aspects of ocean management:

The underlying unity of the oceans requires effective global management regimes.

The shared nature of ocean resources comprising regional sea areas calls for regional management of the ocean.

The major land-based threats to the ocean require effective national actions based on international cooperation.

1.2. International conventions

1.2.1 Law of the Sea and coastal fisheries

OHP United Nations Conferences on Law of the Sea

UNCLOS I was held in Geneva from February to April 1958. Four Convention were adopted and a protocol on compulsory settlement of disputes was prepared by the International Law Commission

Convention on Territorial Sea
Contiguous zone
Continental shelf
Convention on fishing and conservation of the living resources of the high seas

UNCLOS II was held in Geneva in March and April 1960. The conference made a further attempt to come to some agreement on the breadth of the territorial sea and a contiguous zone in which states could exercise exclusive fishing rights. The attempt was unsuccessful because of disagreement on the width of the territorial sea.

UNCLOS III took place between 1973 to 1982 with several negotiating sessions. In December 1982, the final version of the UNCLOS III document was signed by 117 states. 61 states have now already ratified the Convention and on November 16, 1994 the Convention will enter into force.

The provisions of the 1982 Convention are either new laws on issues not dealt with in 1958, or clarifications of existing principles.

The Law of the Sea Convention is important in that it clarifies the law regarding the extent of territorial jurisdiction. It also develops new laws regarding access and control over living and non-living resources adjacent to the coastal states. These relate to:

island states and archipelagos;

protection and preservation of the marine environment;

exploitation of non-living resources beyond territorial jurisdiction;

the transfer of technology and the settlement of disputes.

1.2.1.1 The impact of UNCLOS

1.2.2 United Nations Conventions on Environment and Development

OHP The five Rio documents

The Rio Conference resulted in two international agreements, two statements of principles and a major action agenda on world-wide sustainable development. These are:

> The Rio Declaration on Environment and Development. Its 27 principles define the rights and responsibilities of nations as they pursue human development and well being.
>
> Agenda 21, (an agenda for the 21st century) a blueprint on how to make development socially, economically and environmentally sustainable.
>
> A statement of principles to guide the management, conservation and sustainable development of all types of forests, which are essential to economic development and the maintenance of all forms of life.

Two major international Conventions were negotiated separately from but in parallel with preparations for the Earth Summit and were signed by most governments meeting at Rio.

> The aim of the United Nations Framework Convention on Climate Change is to stabilise greenhouse gases in the atmosphere at levels that will not dangerously upset the global climate system. This will require a reduction in our emissions of such gases as carbon dioxide, a by-product of the use of burning fuels for energy.
>
> The Convention on Biological Diversity requires that countries adopt ways and means to conserve the variety of living species, and ensure that the benefits from using biological diversity are equitably shared.

1.2.2.1 Agenda 21

1.2.2.1.1 Agenda 21: Chapter 17, Managing of Oceans

Readings:

Reading 5:25

United Nations. "Programme areas" [A: Coastal and marine areas; B: Marine environmental protection; C: Marine living resources, high seas; D: Marine living resources, national jurisdiction; E: Critical uncertainties, marine environment and climate change; F: Strengthening cooperation and coordination; G: Sustainable development of small islands] From its *Report of the UN Conference on Environment and Development, Rio de Janiero, 3-14 June 1992*. NY: UN, 1992? (A/Conf.151/26,vol. II, pp. 131-166)

Reading 5:26

United Nations. "Protection of the oceans, all kind of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources. From its *Programme of action for sustainable development: the final text of Agreements negotiated by Governments at the United Nations Conference on Environment and Development, 3-14 June 1992, Brazil*. NY:UN, 1992 pp. 147-165

1.2.3 Convention on Climate Change
1.2.4 Convention on Biodiversity
1.2.5 The Law of the Sea and the United Nations Conference on Environment and Development
1.3 Involvement of major international organisations in the execution and implementation of the international conventions.

United Nations Environment Programme (UNEP)
Food and Agriculture Organisation (FAO)
Reading 2:5
FAO. *Strategy for fisheries management and development.* Rome: FAO, 1986 (pp.[5],1-26)
Additional Reading [not in set]: FAO Policy on Food Production(Fisheries) and Resource Management.
International Ocean Institute (IOI)
Greenpeace
International Maritime Organisation
United Nations Educational, Scientific and Cultural Organisation (UNESCO)
Reading 5:23 "Unesco activities relevant to the management of coastal areas and resources." [Presented at] *World Coast Conference, The Hague, 1-5 November 1993.* [?Paris: Unesco], Sept.1993 10p
United Nations Development Programme.
Exercise: Readings and discussion of relevance of these organisations to coastal fisheries. Participants give examples of their experience with programmes and activities.

1.4 Effects of UNCLOS on the activities of regional institutions in the South Pacific.
1.4.1 Law of the Sea and the South Pacific
Reading 2:4
ESCAP. "National and regional maritime policies" from its *The Law of the Sea in the South Pacific: a study on the integration of marine affairs activities within government concerns.* NY: UN, 1991 (pp.5-14)
Reading 5:24
United Nations. *The Law of the Sea: official text of the United Nations Conference on the Law of the Sea with annexes and index. Final Act of the third United Nations Conference on the Law of the Sea: introductory material on the Convention and the Conference.* NY:UN, 1983. pp.1-17;70-105.

1.4.1.1 Role of the Forum Fisheries Agency in coastal fisheries
1.4.1.2 South Pacific Regional Environmental Programme (SPREP)
Reading 5:22
SPREP. "Programme 4: Coastal management and planning." From its *1991-1995 Action Plan for managing the environment of the South Pacific region.* Apia: SPREP, 1993 pp.14-15
1.4.1.3 South Pacific Commission (SPC)
Reading 5:20
SPC. "Coastal fisheries programme." *SPC Regional Technical Meeting on Fisheries,* 25 (Working Paper 1, 1994):1
Reading 5:21
SPC. *Coastal fisheries programme.* Noumea: SPC, 1994. [8p]
1.4.1.4 Other regional organisations

Exercise:TABLE: SERVICES OFFERED BY REGIONAL IGOs

This table provides a list of services that individual IGOs offer for all or some of the resources with which they are concerned. Match the services and the organisation by putting a mark in the appropriate column. Is there any duplication of effort in coastal fisheries management? Are any essential services neglected?

SERVICES	REGIONAL IGOs					
	FFA	FORUM	SOPAC	SPC	SPREP	USP
Advice & assistance - Scientific - Technical - Legal - Managerial - Statistical						

Education & training
 	
- Formal
  - degree level
  - other formal
- Nonformal
  - workshops
  - training courses
  - attachments & internships
  - " grassroots" extension
	*	*	*	*	*	*
						
						*
						*

SERVICES	REGIONAL IGOs					
	FFA	FORUM	SOPAC	SPC	SPREP	USP
Regional & extra-regional consultation - Regional conferences, negotiations etc - programmes & projects - policy formulation - Resources management - EEZone management - Extra-regional conferences, negotiations etc - with other IGOs & bodies - with DWFNs & industrial interests - re treaties etc on access & uses Research, information & data collection, organisation, analysis, evaluation & dissemination - Type - scientific - technical - legal - economic - political - social - Form & method - meetings etc - correspondence & personal contact - publication - print - audiovisual - database - statistical - bibliographic - register & other fulltext						

2. INTERNATIONAL POLICIES AND STRATEGIES RELEVANT TO SUSTAINABLE COASTAL FISHERIES IN THE SOUTH PACIFIC REGION

Purpose: The purpose of this section is to identify international policies and strategies to enhance and facilitate management and development of sustainable coastal fisheries in the South Pacific region.

Objectives: On completion of this section, participants should be able to:

Describe UNCLOS 111 provisions relevant to coastal fisheries management and development in the South Pacific.

Describe UNCED policies and strategies relevant to coastal fisheries and development in the South Pacific.

2.1 UNCLOS provisions relevant to coastal fisheries

OHP: Parts of UNCLOS III directly relevant to coastal fisheries:

Part II	Limits of the Territorial Sea
Part XII	Protection and Preservation of the Marine Environment
Part XIII	Marine Scientific Research
Part XIV	Development and Transfer of Marine Technology
Part XV	Settlement of Disputes

OHP Exercise:Reading and Discussion

Participants use the following Readings and previous discussions in this module to identify specific sections and articles that may have direct influence on coastal fisheries management and development in the South Pacific.

Reading 2:4
ESCAP. "National and regional maritime policies" from its *The Law of the Sea in the South Pacific: a study on the integration of marine affairs activities within government concerns.* NY: UN, 1991 (pp.5-14)
Reading 5:3. P. W. Birnie. "The Law of the Sea and the United Nations Conference on Environment and Development." From E. M. Bergese et al. (eds.) *Ocean Yearbook*, 10(1993):13-39
Reading 5:24
United Nations. *The Law of the Sea: official text of the United Nations Conference on the Law of the Sea with annexes and index. Final Act of the third United Nations Conference on the Law of the Sea: introductory material on the Convention and the Conference.* NY:UN, 1983. pp.1-17;70-105.

2.2. UNCED Agenda 21 provisions relevant to coastal fisheries

2.2.1 Relevant extracts from Readings 5.25 and 5.26, with comments.

Reading 5:25

United Nations. "Programme areas" [A: Coastal and marine areas; B: Marine environmental protection; C: Marine living resources, high seas; D: Marine living resources, national jurisdiction; E: Critical uncertainties, marine environment and climate change; F: Strengthening cooperation and coordination; G: Sustainable development of small islands] From its *Report of the UN Conference on Environment and Development, Rio de Janiero, 3-14 June 1992*. NY: UN, 1992? (A/Conf.151/26,vol. II, pp. 131-166)

Reading 5:26

United Nations. "Protection of the oceans, all kind of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources. From its *Programme of action for sustainable development: the final text of Agreements negotiated by Governments at the United Nations Conference on Environment and Development, 3-14 June 1992, Brazil*. NY:UN, 1992 pp. 147-165

2.2.2.1 Sustainable use and conservation of marine living resources for fisheries development
2.2.2.1.1 Objectives
2.2.2.1.2 Management related activities
2.2.2.1.3 Data and information
2.2.2.1.4 International/ regional cooperation and coordination
2.2.2.1.5 Means of implementation
2.2.2.1.5.1 Scientific and technological
2.2.2.1.5.2 Human resource development
2.2.2.1.5.3 Strengthening support systems (capacity building)
(**Source:** UNCED,1992: 159

Exercise: Discussion
Suggested topic: to what extent are the objectives attainable?

3. INTERNATIONAL CONVENTIONS AND GUIDELINES IN RELATION TO CURRENT NATIONAL AND REGIONAL POLICIES AND STRATEGIES

Purpose: The purpose of this section is to identify and assess current policies and strategies that are in line with the above international conventions and guidelines, and those that are not.

Objectives: On completion of this section, participants should be able to:

Describe the major goals, objectives and priorities of fisheries development and management plans of their countries.

Identify strategies employed to achieve the given goals and objectives.

Distinguish between strategies that promote the sustainable development and management of coastal fisheries and those that do not.

3.1 Major goals, objectives and priorities of fisheries development plans

OHP Major forces influencing the development of ambitious fisheries programmes.

1. The increase in the acceptance of the ideology of planned development and therefore, the building up of state planning administration with strong belief that growth and change can and must be initiated from above. In a sense, the whole society was viewed like an engine, and the starter was in the hands of experts and national policy makers.

2. The rise of the ideology of modernisation, according to which the new cannot come about of the old because the old is seen as backward and lacking dynamism. Its response mechanism was considered too slow to provide the basis for growth and change.

3. The discovery of vast quantities of fisheries resources in waters of developing countries and the availability of efficient technology to harvest these resources by developed countries.

4. The rapid emergence of international markets for frozen fish in developed countries with high income elasticities of demand for tropical species,eg. prawns, lobster and tuna.

5. The pressure of strong balance of payments constraints in developing countries wishing to modernise.

6. Financial and technological support from foreign interests and international organisations.

OHP:Resulting programmes = shifts from traditional to modern technology.

Production: adoption of mechanised vessels, powerful inboard motors, large storage facilities, fish finders, etc.

Processing: use of freezing technology, ice plants, refrigerators, cold storage insulated vans, etc.

Marketing: modernisation of transportation means, packaging and marketing channels

Infrastructure: construction of fishing ports, harbours, roads, and enhancement of shore facilities

3.1.2 National objectives

OHP National objectives and fisheries objectives

National

Achieving real economic growth
Generating employment for growing labour force
Promoting equitable distribution of benefits and improving social conditions, particularly in rural areas
Maintaining financial stability
Fostering national unity and identity

Fisheries

Employment and income generation
Increased value added production for export
Increase fish production to satisfy local demand

3.2 Case study: Fisheries Sector, Mari.

3.2.1 Background

The fisheries sector contributes 1.6 percent of GDP and is an important potential area of growth in the economy. The industry is important to subsistence fishermen, and also provides a real opportunity for export-led growth.

Mari Fisheries Division recently established a hatchery for giant clams to reseed overfished reefs. Beche-de-mer processing and drying is a significant industry. Rural collectors are also heavily involved in the supply of trochus shell to the two pearl button factories that are now in operation.

The various tuna species in Mari waters offer much potential for further development of the fisheries sector.

The recent growth of private sector investment in industrial fisheries has expanded export oriented development. Mari Fish Co. Ltd. has undergone significant expansion and improvements to its facilities with considerable financial assistance from the government. This has created greater storage and production capacity and will now enable the company to diversify into other fisheries related activities.

3.2.2 Development constraints

People continue to use marine and inland river resources to provide food for their families. Areas near large population centres have noticeably fewer of the most popular subsistence species. These species are sometimes, but not always important for local commercial markets. There is still very little value added processing before sale. This needs to be changed in order to boost the current level of sales and create new employment opportunities.

Signs of over-exploitation of sedentary resources such as beche-de-mer, trochus, mother of pearl shells, mangrove crabs and freshwater clams have been increasingly noticed. Assessment of these stocks is essential for marine resource management. Destructive fishing methods such as the use of dynamite, traditional poisons and bleach are illegal but widely practised.

Fisheries Regulations need to be reviewed so that industrial fisheries and export licensing are adequately included. The current regulations were established in 1950 and are now out of date. They were designed mainly to govern artisanal fishermen who did not own boats.

The lack of organisation amongst fishermen prevents them from establishing a united front to push for improving the distribution and marketing of fish.

There is a lack of major infrastructure such as jetties, slipways, repair facilities, ice plants, and spare parts for vessels and engines in most rural and outer islands. A shortage of berthing, unloading and resupply facilities also exists at even major ports due to an increase in medium scale industrial "sashimi" fisheries.

Inadequacies of such infrastructures in rural areas and outer islands have hindered the development of coastal marine resources. The high costs and lack of transport links between remote areas and the main markets of the country cause a number of inefficiencies in the marketing of marine resources.

The location of Mari Fish Co. Ltd. forces it to transport raw materials a great distance, which amounts to costs of approximately $1 million dollars per annum. Moreover, since Yon Corporation Ltd. the local fish supplier has been slow to develop, Mari Fish Co. Ltd. has had to import a large amount of fish from overseas despite great catch potential existing locally.

The viability of Mari Fish Co. depends on the high prices it receives from the EC under the Lome Convention as well as the efficiency of its factory operations. The preferential prices are however likely to decline together with the price of sugar in the near future. Thus there is an urgent need for Mari Fish Co. to improve its competitiveness by improving its efficiency if it is to survive in the international scene.

Although the Mari government remains committed to reducing the relative size of the public sector, it must take greater responsibility in the management of the rapidly expanding fisheries sector to ensure that exploitation is limited to sustainable levels only.

3.2.3 Development prospects

The deployment of increased numbers of fish aggregation devices is likely to significantly boost the catching capacity of the Mari skipjack pole and line fleet.

The harvesting of sedentary marine resources such as beche-de-mer, trochus and pearl shell seems to possess much potential for export development, though it will be necessary to establish management regimes that ensure the harvest is sustainable.

The development of prawn, seaweed, crab and giant clam aquaculture ventures should make positive contributions to Mari's export earnings as well as improving the diet of rural families.

A Marine Environment Master Plan has been commissioned in order to provide the basis for developing marine environment management policies.

There is high competition in the international arena, but Mari Fish Co. has the potential for further growth and an international reputation for quality. With upgraded production and storage facilities, Mari Fish Co. will soon be able to double its canned fish exports. The company is also planning to diversify into the trading of frozen fish and other activities such as longlining. There is potential for Mari to exploit the enormous tuna resources in the regional waters of neighbouring island nations. Employment is expected to rise as production increases.

3.2.4 Policies and strategies

The main components of policy and strategy for fisheries in Mari are as follows:

a. To expand and consolidate tuna fisheries within Mari's Exclusive Economic Zone (EEZ) under the industrial fisheries programme.

b. To encourage greater efficiency, and to improve the quality of fish available to consumers in the small-scale commercial fisheries sector.

c. To assist rural fishermen in their transition from subsistence to small-scale commercial fishing.

d. To develop aquaculture through continued research into appropriate production technologies and extension programmes.

e. To further develop the EEZ and territorial water fisheries

f. To improve the quality and increase the value added processing of exports

g. To regulate and control all fisheries, on the principles of optimum utilisation and long-term sustainability.

h. To encourage local fishers in the implementation of sound business management methods.

i. To improve the handling and processing capacities of domestic fisheries

Exercise: Discussion

1. What is the focus of the policies and strategies outlined?

2. What will be the effects of implementing
   items a and e?
   items c and h?
   items b and i?

3. Do the policies and strategies adequately deal with the development constraints?

3.2.4.1 Strategies employed to achieve the given goals and objectives

Clearly the focus of these policies and strategies is to increase production levels in order to increase effective consumption and to increase income from fisheries resources. This sort of focus indicates the priority areas by the government. It would be interesting to see details on projects and programme areas that result from government priorities such as these.

From the given objectives and strategies, let us identify the priority areas for fisheries in Mari Islands:

Increasing production through technological improvement and aquaculture

Increasing and improving processing for value-added production as well as increasing effective real consumption levels through reduction of spoilage

Expanding tuna fisheries to increase value added, and foreign exchange

Assisting rural fisher to become commercially successful through extension support and training in sound business management practices.

Ensuring that fisheries exploitation is within the optimum levels through regulating of fishing activities.

To increase production, commercialise and create more employment and income in both catching and processing in coastal areas means involving more people in the coastal fisheries and improving the efficiency of those already in the sector. For example, one strategy entails helping fishers move from subsistence to commercial practices.

Such a strategy pushes the fishery towards overcapitalisation. If the coastal fishery aims to meet the domestic demand for fish and fisheries products, the growth in targeted coastal fish stocks should be higher than the growth in demand for yields from such stocks.

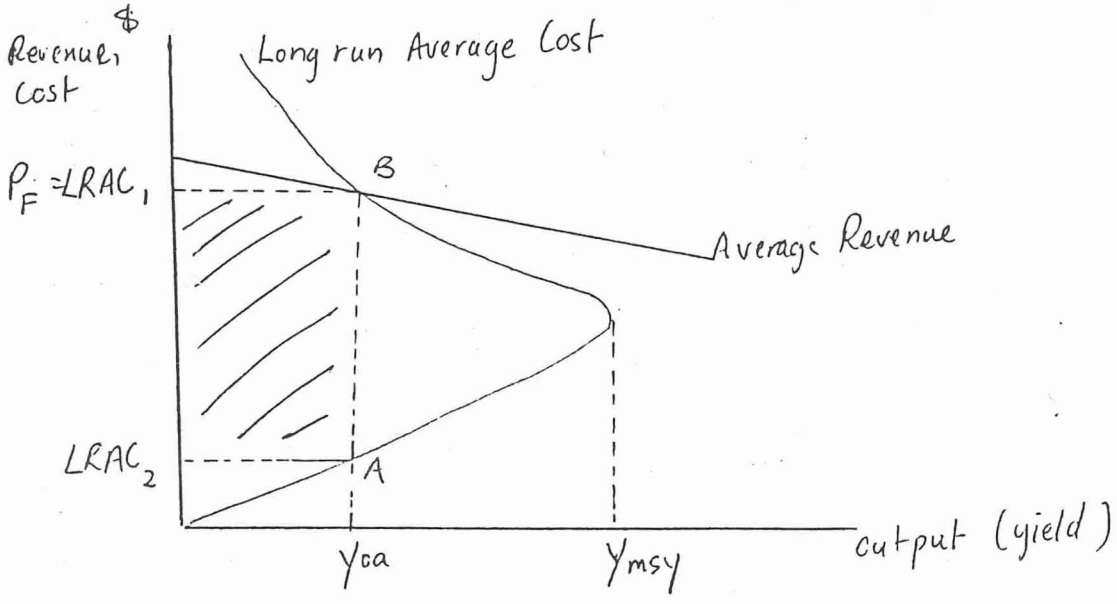
Increasing the number of fishers and improving efficiency may initially increase catch levels and projects. This attracts even more fishers and capital until the maximum sustainable yield levels are surpassed. The fishery begins to decline and may collapse. This can be devastating to those fishers and families who depend on the fishery for income and survival, an to those who work in processing facilities, markets, and other subsidiary businesses. An economy built around one resource, such as tuna, could be severely affected in such a case.

3.2.4.1.1 Scenario:

Objective : Increase income levels of fishers

Consider a situation where demand for fish is greater than the potential supply. Fishing effort will increase. In an open access situation it will increase beyond the maximum sustainable yield level (MSY). The situation leads to over-exploitation, ie. beyond the point of MSY. If production is beyond MSY, the catch is taken at a higher cost. That is also because of the increase in effort (too much effort) to exploit the dwindling stocks.

This is illustrated in the diagram:



So the output is Y^{oa} which is below MSY and at a higher cost. Long run average cost curve (LARC) is the backward bending supply curve of the fishery based on the long run production.

Therefore producing Y^{oa} beyond MSY means that the Price P^1 = $LRAC^1$. The price is equal to the average cost of production. There is no profit (income).

How can we solve this situation in order to increase income levels now?

Our aim is to introduce a management scheme to move the fishery from $LRAC^1$, to $LRAC^2$. The rationale of moving to $LRAC^2$ is to have the same output but at a lower cost. The cost would be reduced but the price would be same, because output is the same. We now can see that there is a profit achieved by reducing the fishing effort, ie. number of fishers, boats and gear. Therefore, depending on the nature of management regulation, fishers' incomes and/or government's revenue can increase.

Another advantage of operating at Y^{oa} at cost level A (below MSY) is that fish populations are subject to environmental fluctuations. Operating below MSY gives an important margin of safety in case of a natural downturn in local resource levels.

We must remember how we arrived at such a situation in the long run. It required short-term sacrifices of reducing effort, by reducing the number of fishers and limiting their effort. Therefore success really depends upon how the fishery is managed and not the level at which it is managed. What does the management authority perceive as the correct level of fishing activity?

From the above example, let's look at the policy that all fisheries must be exploited at optimum levels.

Increasing production through technical improvement and increasing employment will not necessarily improve income levels of fishers in the long run. This policy does not create sustainable coastal fisheries. There are really conflicting goals unless clear plans are made to achieve balance between exploiting marine resources and conserving them for future use.

How are we going to deal with the problem of multi-species coastal fisheries where there is a decline in species that have high economic value and an abundance of species that have low economic value?

If there are export markets for a species, then we must ensure that alternative sources of affordable protein are available, reliable and acceptable to the population. The level of export must balance the given level of resource at its potential yield on a sustainable basis. Often there is a danger of over-exploiting for export because of the financially rewarding short-term gains, e.g. trochus, beche-de-mer, giant clams and turtles.

In terms of resource management, the plan indicates regulating fisheries at optimum harvesting levels for long term sustainability, but does not specify these optimum levels. Is it controlling the level of output that we harvest? Is it MSY? For how many species in coastal areas have we estimated the MSY? In the multispecies coastal fisheries, obviously we need more scientific and biological surveys to determine the stock levels, growth patterns and so on. Do we wait to have all scientific evidence before we embark on a management regime?

Exercise: Discussion Suggested topics.

Many coastal fishers in the South Pacific depend on the mullet fishery. What criteria would you use to determine at what level the mullet fishery should be exploited ? Consider both management and development aspects.

Most Pacific Island countries emphasise industrial tuna development. What impacts does this emphasis on tuna have on coastal fisheries ?

What happens to budget allocation; resource and staff allocation; extension support?

Exercise:Small group and plenary discussions

One has to look at specific projects and programme areas in order to determine the impact of industrial scale fishing on the development and management of coastal fisheries. This will involve analysis from the time the project is formulated (based on given fisheries policies and strategies) to implementation. The project's performance of whether the objectives and goals have or have not been achieved must then be measured.

Participants divide into country or sub-regional groups.

Each group studies the Mari strategies, identifies those common to the group, and lists projects, programme areas and status and evaluates their problems, successes and the potential futures.

After a mutually agreed time the groups reconvene, present their conclusions and establish similarities and differences between the conclusions.

3.3 Case studies: strategies that promote sustainable development of coastal fisheries and those that do not.

3.3.1 *Case study of fisheries development in Kerala.*[Adapted from Kurien, 1985; adapted from: Plateau, J-P. 1989.]

This case study gives an account of the modernisation experience of the small-scale fisheries of Kerala, where fish are an important source of protein, food, employment and foreign exchange.

In the mid 1950s there was an uncontrolled introduction of modern technology together with the establishment of a seafood export industry mainly targeting at prawn fishery. In 1956, when Kerala state was created, the fishery administrations sought to modernise the ancient state of Travencore-Coshin. The new fisheries projects emphasised modern technology, heavy infrastructure, efficient producers, and massive injections of foreign and national capital.

In the words of J. Kurien:

> The early 1960s heralded in the export-oriented approach to fisheries development.....This increased export of prawns by private firms to the US and Japanese market; the confirmed location of economically exploitable, untapped prawn resources off Kerala, the demonstration and introduction of the more catch-efficient technique of bottom trawling by the Norwegians made both the Indo-Norwegian Project and the fisheries administration of Kerala devote their undivided attention to the pursuit of prawns (Kurien, 1985:A-76).

As modernisation took effect, private capital began to flow. This was further supported by foreign investment and assistance. Also people outside the fishing communities and fisheries sector started investing, including the multinational and national industrial enterprises.

The outcome of this shift of priorities was really amazing. In the early 1950s, fishing was a low technology subsistence activity. In 1979 the total number of mechanised boats in operation in Kerala state was estimated at around 3500, most of which were 32-foot trawlers engaged in fishing prawns and shrimp. The number of those operating from Sakthikulangara-Needakara Harbour exceeded 1500 during normal times but could well exceed 3000 units during the main (prawn) fishing season. While the contribution of the mechanised sector was only 9.6% of the total catch in Kerala in 1969, it rose to 42.8 percent by 1975 and 1979 (Krishnakumar, 1980:1-2; Pillari, 1980:10).

This shift of priorities was of course reflected in state expenditures. The total amount of money allocated to the development of fisheries was raised considerably, and a new pattern of investment priorities emerged from the destination wise structure of these expenditures: a much larger proportion of the money earmarked for fisheries development went to finance mechanised trawler boats primarily designed for prawn-catching, and into the building up of the related infrastructure and training facilities. The average annual amount spent by the state of Kerala for fisheries development increased from Rs 1.2 million during the years 1955-60 to Rs13.75 million during the period 1961-9, and to more than Rs 20 million during the 1970s (computed from Kurien, 1985;A-74, A-77, A-79.)

The share of state expenditure accruing to the modern fisheries sector (production units, infrastructure, processing, marketing and training facilities) rose from an average of 25 percent during years 1955-60 to as much as 84 percent during 1961-9 (computed from Kurien, 1985:A-74, A-77, A-79). This shift took place when not less than 70 percent of the prawn landings in the country were caught by artisanal fishermen (Kurien, 1985:A-77).

As a result of such trends only those artisanal fishermen who could afford the technology could participate whereas other fishermen became merely fish workers. Also there was a large inflow of migrant labour as low paying, unskilled jobs became more plentiful.

There was strong competition within the inshore areas between the mechanised boat operations and non-motorised boat operations. This resulted in increased social conflict between the two groups and cases were reported of damage to gear and vessels, etc. as the stocks of prawns and fish started declining.

Because of high prices of prawns and fish there was further capital investment in processing and boat improvement. This led to a vicious circle of overfishing in the inshore areas to counter the declining output which caused the fishery to further intensify the effort.

As processing technology improved, the artisanal women vendors were displaced and gradually the traditional skills of salting and drying started to disappear. The decline of resources also had a direct impact on the consumers who depended on fish for their food and nutrition.

There was increased conflict between the artisanal fishermen and the industry. The situation then became receptive to political organisation, through NGOs, church groups, etc. Eventually fishermen's unions were established. The Kerala Independent Fishermen's Federation became concerned with depletion of resources. They lobbied for the Marine Fisheries Regulation Act which was passed in 1980. One of their recommendations, was the reservation of a coastal zone exclusively for artisanal fisheries and ban on trawling. However, the investors in the industry had strong political influence and the KIFF was unable to regulate fishing activities. The situation was further aggravated by the adoption of outboard motors and other technical innovations within the artisanal sector. Thereafter ecological problems created by both mechanised boats and motorised artisanal boats.

The fisheries workers engaged in organised political action, and the fishermen organised into cooperative groups. The cooperative projects were also concerned with trying to improve production through better extension and training and further improvements in the vessels and gear.

Essentially, developing countries with access to the sea have traditionally followed a pattern in which their artisanal fishing communities, using labour-intensive and simple (but not stagnant) techniques for the catching, processing (curing, drying, smoking) and marketing of fish, were able to supply low-cost protein to local consumers and could also possibly export cheap processed fish to regional markets with similar levels of living and purchasing power. Thus, on the eve of Kerala's independence, prawns were not a luxury product. Most of the harvest was dried and exported to Southeast Asian countries while the remainder was locally consumed and, when bumper catches occurred, they were used as manure for coconut (Kurien, 1985:A-82, note 26).

The following article looks further at the impact of the modernisation of the prawn fishery in Kerala. It gives an outline of how people tried to cope with the changing economic and social environment when the industry started to collapse because of decrease in the resource.

Reading 5:15
W. Meynen. "Fisheries development, resources depletion and political mobilization in Kerala: the problem of alternatives." *Development and Change*, 20(1989):735-770

OHP Exercise: individual/small group work & plenary discussion

Individual participants or small groups identify and list development issues that could serve as relevant lessons for our coastal fisheries planning. After a mutually agreed time, the whole group reconvenes to discuss and compare identified issues.

3.3.2 *Case study: Benin fisheries project*

A major programme on integrated development of artisanal fisheries was undertaken by a prominent international agency in several countries including Benin in West Africa. The purpose of the programme was to help countries develop and manage their artisanal fisheries so as to get the maximum social and economic benefits.

The targeted beneficiaries of this fisheries development project were fishermen, boatbuilders, repairman, small operators associated with village fishery and their families. The project in Benin was considered as a model. Following is a review of the experience of the project.

Benin fisheries project

The model project was based at Cotonou, Benin from where it proceeded to work in the coastal fishing villages. A training facility for fishermen was established at Cotonou, as a Community Fishery Centre, where improvements to fishing gear and methods and fishing vessel mechanisation were stressed.

Non-fisheries activities were conducted in the villages according to local needs and requests. These included vegetable gardening, handicraft production, livestock raising and salt making. The single most important and beneficial outcome of the non-fishery exercises was the construction of an access road to the village of Avlekite. This was built largely by voluntary labour with project support and the assistance of a nearby roadwork station.

As village fishermen who were assisted became more productive, they mostly elected to move to Cotonou port which formed a much better base of operations. Vessels could enter and leave the harbour regardless of beach surf conditions which hampered operations from the villages. There was an active fish market in Cotonou and ample services for boat repair, engine maintenance and supply of fuel and ice. Fishermen working from Cotonou were also largely free of the compulsory rest day enforced according to traditional religious criteria in the various villages.

The project had considerable success with introducing new methods of fishing, particularly bottom-set gillnetting on offshore reefs, and with the installation of propulsion engines on the large fishing canoes. Some progress was made on improvements to fish handling and attempts were made to assist and upgrade traditional fish-smoking practices.

As the more progressive fishermen left the villages to work from the main port, work in villages focussed increasingly on income-generating activities for women. Local women's groups cooperated enthusiastically and, where feasible, the project assisted with small amounts of credit.

Two critical factors became apparent as the village work progressed and these proved to be of major importance in all the Integrated Development of Artisanal Fisheries (IDAF) projects. They concerned the resource base of the villages and the ethnic nature of the fishermen population.

The Benin villages were small and had only slender resources in terms of land, soil, water, trees and facilities or amenities. Since most of the fish catches were marketed in Cotonou, there was little scope for local fish processing. Economic development cannot take place without improvements in productivity and these require resources in the form of raw materials, land facilities, human skills and access to markets. Without an "economic engine" there are no surplus earnings which can be tapped to fund social improvements in areas such as water supply, health clinics, schools and communications.

The ethnic structure of the fishing community was an unexpected constraint to village work. In general, the more homogenous the target group the easier it is for project personnel to work among and to encourage people's participation. Studies by the programme anthropologists revealed that over 70 percent of all marine fishermen in West Africa came from two tribes. Fishermen from those tribes migrated within the region and often settled temporarily or semi-permanently in coastal villages. The Benin village fishermen were mostly temporary immigrants and did not integrate with the indigenous population. Their encampments reflected their lack of local roots and they were reluctant to contribute in cash or labour to the development of social amenities. This made integrated village development work more difficult.

The combined lack of resources and social cohesion in the Benin villages resulted in rather meagre successes from the activities. The absence of an economic engine made it difficult to finance improvements in health and social welfare. One conclusion from this project is that some situations need modest long-term inputs to improve the general livelihood, rather than large inputs to projects with short term benefits.(**Source**: FAO. *Internal study on integrated approach to small-scale fisheries development.* (Rome: FAO, 1987)

The following reading focuses on some of the constraints in coastal fisheries development in small island countries and outlines some recommendations for sustainable development including the need for regional cooperation.

Many other coastal fisheries development projects have had limited success — for example the commercialisation of the rural fisheries in Pacific Island countries with the introduction of improved vessels such as the FAO designed 28 footers, and the Hartleys, and some aquaculture projects such as seaweed project in Fiji.

Reading 5:7
FAO. "Coastal fisheries development in small island countries: constraints and strategies for sustainable use."[for] *Inter-regional Conference of Small Island Countries on Sustainable Development and Environment in Agriculture, Forestry and Fisheries, Christ Church, Barbados, 7-10 April 1992*. [np:np, 1992?] i,9p

Exercise: Discussion

What can we, as Pacific Island coastal fishery managers, learn from the Benin-type project implementation?

4. ALTERNATIVE STRATEGIES TO PROMOTE THE DEVELOPMENT AND MANAGEMENT OF COASTAL FISHERIES.

Purpose: The purpose of this section is to assist participants to establish alternative strategies that are appropriate to the development and management of coastal fisheries.

Objectives: On completion of this section, participants should be able to:

determine policies and strategies appropriate to the region and country;

prescribe ways and means to implement the policies and strategies;

identify key issues involved;

analyse problems and prospects;

list the major institutional changes required.

4.1 Major problems in current coastal fisheries policies and strategies

OHP Fishermen catch large fish using modern, efficient nets, lines and other gear.

Fish brought to the wharf and landing sites are quickly unloaded into trucks that transport fish to the local market straight away or to the airport for export.

Fish for the export market are airfreighted and kept under ideal conditions to maintain the quality hence has high value.

In places where there are less fish, and the demand is high, aquaculture techniques provide an alternative means of supplying the required amounts.

OHP: Some problems inherent in this way of looking at fisheries development:

It tends to target single species, with potentially devastating biological and economic consequences.

It relies on technology upgrades that may not be appropriate to the local situation.

It disrupts or ignores traditional marine tenure and knowledge.

It disrupts or ignores the subsistence sector, consequently ignores the contributions of women.

It separates fisheries development concerns from other aspects of local development.

4.2 Alternatives

4.2.1 Integrated Coastal Zone Management (ICZM)

4.2.1.1 Objectives

4.2.1.2 Activities

OHP *Matrix of possible interactions...* Source: UNEP.OCA/PAC 1993

Activities / Effects	Urbanization	Tourism	Industry	Energy Production	Fisheries & Aquaculture	Transport	Agriculture	Possible Preventive Actions
Marine Pollution	↑↑ ↑↑ ↑↑	↑↑ ↑↑ ↑↑	↑↑ ↑↑	↑↓	↑↑ ↑↑	↑↓	↑↑ ↑↑	Adequate facilities of effluent Collection and treatment Restrictions on non point sources
Freshwater Pollution	↑↑ ↑↑ ↑↑	↑↑ ↑↑ ↑↑	↑ ↑↑ ↑↑	↑ ↑↓	↑↑ ↑↑	↑↓	↑↑ ↑↑ ↑↑	As above and protection of water catchment areas Prevention of overpumping
Air Pollution	↑↑ ↑↓	↑↑	↑↓ ↑↓	↑↓ ↑↓		↑↓ ↑↓	↑↓	Pollution abatement equipment Restrictions on fuels burned Encouragement of public transport
Loss of marine resources	↑↓ ↑↓	↑↓ ↑↓	↑↓ ↑↓	↑↓	↑↑ ↑↓	↑↓	↑↓	Management of fisheries Designation of marine reserves Restrictions on extraction Encourage natural beach processes
Loss of land resources	↑↓ ↑↓	↑↑ ↑↓ ↑↓	↑↓ ↑↓	↑↓ ↑↓		↑↓ ↑↓	↑↓	Designation of protected areas Protect open spaces Rehabilitate damaged open spaces Keep spatial options open
Loss of cultural resources	↑↓ ↑↓	↑↑ ↑↓ ↑↓	↑↓	↑↓		↑↓ ↑↓		Designation of sites, buildings & monuments Encouragement of new, compatible uses Restrictions on building height and materials Rehabilitation of stone damaged by corrosion
Loss of public access	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓	↑↓ ↑↓	↑↓ ↑↓		Regulations to guarantee public right of access Prevention of obstacles to access Clear definition of public and private rights to resources
Soil degradation	↑↓		↑↓	↑↓			↑↑ ↑↓ ↑↓	Air pollution abatement equipment Good farming practice to prevent soil erosion
Noise and congestion	↑↑ ↑↓ ↑↓	↑↑ ↑↓ ↑↓	↑↓ ↑↓	↑↓		↑↓ ↑↓		Noise abatement equipment at source Acoustic bubbles and acoustic barriers Restrictions on locations of noise sensitive activities

MATRIX OF POSSIBLE INTERACTIONS BETWEEN ECONOMIC ACTIVITIES AND EFFECTS ON COASTAL RESOURCES

4.2.1.2.1 Issues OHP

1 Integration of management and development activities in coastal areas

2 People centred development & community participation

3 Research and scientific information

4 Training, formal and informal

5 Conservation

6 Development: production, marketing, processing, infrastructure

7 Government support systems

8 Local, regional, and international cooperation and coordination

9 Appropriate technology

10 Regulations and enforcement

11 Financial support

4.3 Possible guidelines and strategies

Exercise: individual and small group work and plenary discussion
Purpose: to develop an agreed checklist of guidelines and strategies.

Working as individuals or in small groups, participants study the draft checklist; divide the guidelines and strategies into the categories listed below; add other guidelines or strategies and reword if necessary; and prepare their version.

- Coastal resource management
- Fishing operations and production
- Post-harvest handling and processing
- Marketing and distribution
- Fishers and fishing communities
- Government support systems

After a mutually agreed time, they reconvene to discuss their findings; identify means of implementation with focus on training, research, cooperation and coordination and financial evaluation; and make any necessary changes to their own checklists.

Draft checklist

1. Project planning and development must take into account the needs of the local community rather than itself creating a need. Planning and development may include a thorough assessment of the resource base, traditional and current resource use patterns, social institutions and division of labour.

2. Involve all members of the community in the identification, planning and implementation of projects.

3. Determine the involvement of women in coastal fisheries activities should be determined and include them in all appropriate fisheries development projects and plans.

4. Do not neglect sectors outside fisheries, ie. fishing projects can work in concert with agriculture, education, health and nutrition, or general community development projects.

5. Export fisheries development should not continue at the expense of all other fisheries activities.

6. Sustainable development of fisheries resources requires stewardship of the resources so they will remain productive.

7. Development at all costs is unnecessary and unhealthy; it leads to dependence on outside sources when the local environment has been exhausted.

8. Developing countries should learn from the mistakes made by the developed world and other developing countries; they should not repeat those mistakes.

9. Do not neglect or destabilise subsistence fishing activities or communities. Cash generating projects should aim to preserve the low impact, subsistence lifestyle.

10. Encourage small-scale, locally introduced cooperative projects.

11. Improve and support extension services. Periodic meetings should be held between communities and extension staff; local people should be trained as community liaison staff (community action projects).

12. Encourage regional and international grassroots cooperation.

13. Expand the development of small-scale aquaculture to include the often neglected species that are used by subsistence fishing peoples. Discourage the introduction of exotic species.

14. Use the local food production system (water and land-based) when developing nutrition strategies.

15. Adopt technologies that are appropriate ie. cost-effective; environmentally less destructive; augment rather than displace human skills; and depend on renewable energy sources.

16. Restrict employment in areas where there are limited economic resources or over-exploited stocks. Technology employed should be labour-intensive.

17. If resource surveys indicate potential in deep sea areas, provide appropriate conditions including training, extension and technical support to fishers who wish to move to deeper waters.

18. Carry out thorough feasibility studies and trials before embarking on actual commercial ventures.

19. Concentrate improved post-harvest handling and processing on low cost labour-intensive techniques. For example, community smoking plants should be encouraged where appropriate.

20. Assist women to develop post-harvest handling and processing skills and facilitate their access to the necessary infrastructure and technology.

21. Closely monitor fisheries regulations such as registrations of vessels, closed seasons, gear restrictions, and size limits. The enforcement section should work closely with divisional, regional and provincial governments in implementing the regulations in coastal areas. Include appropriate people from local communities.

22. Grant rights of ownership of fishing vessels operating in coastal waters to local fishers, not to outside enterprises.

23. Make safety equipment available to deep water fishers. The use of such equipment should be a critical component of every fishing trip. Fishers should be encouraged to carry an auxiliary engine, water, food rations, ropes, oars, makeshift sails, etc.

24. Study carefully proposals for artificial reefs to enhance the productivity of the coastal waters. Investments should be made only in suitable locations.

25. Train and equip the youth of fishing communities to establish small service centres for engine equipment and fishing craft, repair and maintenance. These could be promoted as self-employment ventures.

26. Estimate MSY levels of different species in coastal areas. Stock assessments should be done on a regularly..

27. Promote programmes for the protection and proper management of mangroves. The cutting and reclamation of mangroves should be banned and re-planting programmes pursued.

28. Find alternative economic opportunities outside fish harvesting activities in order to reduce over-capitalisation of the fishery.

29. Improve communication skills of fisheries officers and extension workers so that they can better liaise with fishermen and women and exchange research and development information.

30. Develop and make available to coastal communities information resource materials that are relevant and appropriate to the needs and interests of specific target groups.

31. Planners and developers must have access to reliable and consistent statistical data on production, investment, costs, prices, marketing, information, level of effort, types of effort, etc.

32. Encourage the integrated development of fishing communities via improved access to educational opportunities, health facilities, protein supplies from non-fishery sources, control over population growth,etc.

33. Reinforce exclusive rights over fisheries to fishing communities and small-scale operators. Such allocation of management authority to local communities can reduce management costs.

34. Achieve multiple use of coastal resources via adoption of controls over all relevant uses. This may involve the creation of special management units composed of different user groups.

35. Use fiscal measures to achieve government objectives for management and development. These may include taxes; license fee: subsidies; grants; import & export tariffs; price control; low cost loans.

36. Document traditional knowledge and practices of local communities in fisheries to enhance the understanding of fisheries sciences and to assist in formulating of appropriate strategies

37. Promote multidisciplinary education, training and research on marine living resources, particularly in the social and economic sciences

38. Train and sensitise sector specialists and policy makers in issues affecting integrated coastal and ocean management.

39. Provide specialised training on specific technical,legal and managerial requirements for users, implementers and operators. Such training might focus on technology transfer issues, development and application of regulations concerning new uses of coastal areas, identification and resolution of cross-sectoral conflicts.

40. Set up marketing systems in such a way as to reduce the effects of glut and scarcity in supply conditions to avoid price fluctuations.

41. Provide fishing communities with a viable system of transport suitable for taking fish and fisheries products to market eg. community carriers.

5. POSSIBLE CONSEQUENCES OF IMPLEMENTING ALTERNATIVE STRATEGIES IN COASTAL AREAS.

Purpose: The purpose of this section is to analyse, through case studies, some of the possible consequences of implementing alternative strategies in coastal areas.

Objective: To examine the appropriateness of possible guidelines for fisheries development and management strategies in coastal areas.

5.1 Case Studies

5.1.1. Philippines: various initiatives to manage a heavily used and abused marine environment

Background

Location	Southeast Asia
Land area	115,830 mi^2 (300,000 km^2)
Population	70,000,000
Political status	independent since 1946
Institutional support for fisheries	Bureau of Fisheries and Aquatic Resources Department of Agriculture
Existing fisheries	• fisheries are major source of foreign exchange, especially prawns and shrimp to Japan • extensive freshwater and brackish water aquaculture
Special concerns	• severe coral reef and coastal area degradation in many areas • many coastal areas are overfished • destructive fishing methods are rampant, especially the use of explosives and poisons • fishermen change gear and fishing methods extremely quickly to adapt to the rapidly changing environment.

Goals: The Philippines is an example of a country that desperately needs to develop effective strategies to manage the use of its coastal resources. Since fishermen are so adaptive to the changes in the deteriorating environment, any successful strategy has to be flexible. Some areas of the coast must be rehabilitated because they have been severely damaged by pollution from mining operations and coastal developments and from destructive fishing practices. Community participation is vital to any management plan. Previous national regulatory policies have failed for numerous reasons, including a lack of proper enforcement and poor local knowledge regarding environmental effects of common practices.

Strategies: Many approaches to the dilemma of Philippines' fisheries and coastal resources have been proposed and attempted. Because regulatory approaches have generally failed, and the environment is so debilitated in some areas, many of these approaches have been quite innovative. The following case study outlines four separate attempts to manage the Philippines' coastal environment. They are in no way all inclusive, but they serve as an informative framework of approaches to a difficult situation. They also illustrate some of the difficulties that could be encountered when devising and implementing any development and management strategies.

5.1.1.1. Coastal Adaptive Management and Resource Assessment (CAMRA)
CAMRA's main aim was to train local coastal environmental fishery monitors to collect information on fisheries catch and effort. During a trial run, students in or near their home villages, collected data that has been called "among the most instructive available in Southeast Asia" (McManus 1989:381). This data has been used to determine the probable state of under- or overfishing in many areas in the Philippines.

A second plan aimed to develop regulations tailored to each local situation with a built in provision for continuous evaluation and occasional revision. It was an attempt to keep up with the rapidly changing local situations.

The final goal of the plan was a project to train environmental community organisers to act as links between the national programmes and the villages. These organisers, who would work in or near their home area, would be responsible for resource and socio-economic assessment, environmental education, community organising, and networking with research institutions, etc. on behalf of the local community.

Exercise: Group discussion: What are the advantages and disadvantages of using community members as environmental monitors?

5.1.1.2 Lingayen Gulf Coastal Area Management Plan
A regional effort, the ASEAN/US Coastal Resource Management Project, began in 1986. In the Philippines, the project resulted in a multidisciplinary and inter-sectoral effort to produce an integrated management plan of a major fishing grounds on Luzon, the largest island. The Gulf is heavily used by artisanal and commercial fishermen, especially trawlers, and 16 towns, 2 cities, and a mining district line its shores.

The management plan comprises eight interrelated programmes. The most serious problem with this management plan is that it received only enough funds to initiate it. It relies on future funds to enlarge the individual projects to include new areas. Plan designers estimate that four times the amount of funding is needed for the project's success.

a. Fisheries management: fishermen's organisations were granted exclusive use rights. This replaced the original open access policy to the fishing grounds.

b. Alternative livelihood for fishing families: encourages maguey production, peanut production, saltmaking, and environmentally sound aquarium fishing.

c. Aquaculture development: calls for an efficient saltwater canal system to increase the production in existing brackish water ponds and encourages seaweed culture, cage farming, and oyster culture.

d. Environmental quality management: includes a warning system to detect serious water quality deterioration, a provision for sanitary landfalls and garbage compacting machines for two urban areas, and an environmental information and education campaign.

e. Critical habitat rehabilitation and enhancement: four community managed marine areas were set up and 2500 ha (out of 12,000 ha that need rehabilitation) of mangrove areas chosen for rehabilitation.

f. Linked habitats rehabilitation: 1000 ha of denuded, steep slope, upland areas will be rehabilitated.

g. Coastal zonation: aquaculture, mangrove rehabilitation, coral reef reserves, fisheries and general; based on current uses (unless seriously unsustainable) and data from geographic information systems.

h. Institutional development: intensive one-month training courses, for 60 key implementers, in rapid rural appraisal, programme planning, project development and environmental impact assessment.

Exercise: Group discussion:
Topics:
1. What do you think about the CAMRA project?
2. What possible suggestions can you add to make this strategy work?
3. What problems do you see with the Lingayen Gulf Coastal Area Management Plan?
4. What remedies can you suggest?

5.1.1.3 Artificial reefs

The Philippines' Artificial Reefs Program began in 1977, but was greatly expanded in 1986. It is continuing to grow under two national programmes. Artificial reefs made of old tyres, concrete structures, or other inexpensive materials are placed in coastal areas. In shallow areas, hard corals and other invertebrates encrust on the structures. In deeper waters, the reefs become encrusted with barnacles, tunicates and sponges rather than hard corals. Regardless of how deep the water is, these structures act as underwater fish aggregation devices and can be used to enhance the habitat by providing shelter and a source of food for many species.

However, several circumstances need to be considered when using artificial reefs as a management strategy.

- In relatively healthy marine areas, these structures could compete as a habitat with healthy reefs. So while it may appear that stocks are improving, the fish may just be spreading out from a more concentrated state.

- There is potential overfishing by attracting fishermen to a small area.

- In the Philippines these structures have the potential of being used as a "lame excuse to carry on with the destruction of natural reefs, the dumping of waste materials and the over-exploitation of fish and other marine life" (Chou 1991:5). Care should be taken not to allow artificial reef deployment to become a viable substitute for healthy natural reef environments.

- Ownership disputes have occurred because of open access and uncontrolled harvesting.

- If not built or deployed properly, they could easily be damaged by storms or trawls.

- Fishing with the use of explosives and poisons is still rampant in the Philippines. Artificial reefs have been blown up by fishing associations whose members were owners of the reefs, when they decided that there were enough resident fish to warrant such action.

Exercise in problem solving, role playing and negotiation

Purpose: develop a management plan for a particular coastal area in the Philippines affected by the above project experience

Method: Participants divide into 5 groups each of which has special interests: homes, businesses, or other concerns.

Group 1 Planners
Group 2 Fishermen's association (includes at least one blast fisherman)
Group 3 Aquaculturalists
Group 4 Environmental NGO concerned about coastal development
Group 5 Villagers who rely on subsistence fishing

Each group discusses individual concerns, demands, ideas, etc. After a mutually agreed time, groups reconvene to work together to develop the management plan.

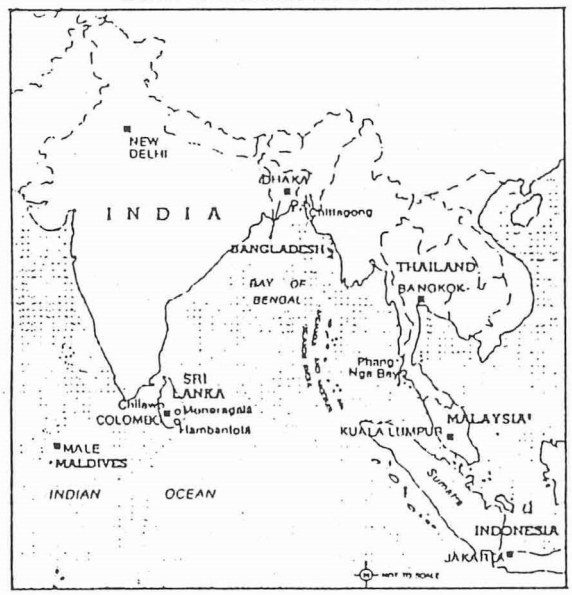
5.1.2. Bay of Bengal Programme: a regional approach to management

The Bay of Bengal Programme (BOBP) is a regional initiative in Asia, started in 1979. It is coordinated primarily by FAO, and funded by Denmark, Sweden, the United Kingdom, member governments, the Arab Gulf Fund for UN Development Organizations, and UNDP. The seven participating countries, India, Sri Lanka, Bangladesh, Thailand, Malaysia, Maldives and Indonesia, have coastlines bordering the Bay.

Goals: BOBP/s main goal is to aid the governments of the countries bordering the Bay to improve the conditions of small-scale fishing peoples. BOBP projects aim to develop, demonstrate and promote new ideas to achieve that goal. One of the many positive outcomes of the Bay of Bengal Programme is the wealth of information produced about its projects. The BOBP's newsletter and technical reports about the projects in the different countries can be very useful guidelines for fisheries development projects elsewhere.

OHP BOBP member countries

BOBP MEMBER COUNTRIES



Strategies: BOBP projects fall into four main categories: community organisation and extension, coastal aquaculture, fishing and post-harvesting techniques, and fishery research. The following lists outline some of the projects undertaken as part of this programme.

a. Community organisation and extension: the emphasis is on active community participation in development.

- A radio programme for fisherfolk in Sri Lanka
- A credit project to provide banking services to fisherfolk in Sri Lanka
- A comic book about fisheries management designed for fishing peoples
- Improving the conditions of fisherwomen and their families
- Non-formal primary education for children of marine fisherfolk in India
- A study of the food and nutrition status of small-scale fisherfolk in India's east coast states
- Training requirements for extension work with artisanal marine fisherfolk

b. Coastal aquaculture

- Seaweed production and culturing in India and Sri Lanka
- Agar and alginate production from seaweed in India
- Aquaculture technology transfer to the small-scale fisherfolk of Thailand
- Mud crab resources and culturing studies and projects in Thailand, Malaysia, Sri Lanka, Bangladesh
- Improving the capture, handling and nursing of shrimp fry in India and Bangladesh
- Small-scale culture of the flat oyster (*Ostrea folium*) in Malaysia
- Pen culture of shrimp by fisherfolk in India
- Impacts of small-scale aquaculture development projects in south Thailand

c. Fishing and post-harvesting technology

- Development of outrigger canoes in Sri Lanka and Indonesia
- Design and trial of ice boxes for use on fishing boats in India
- Design and demonstration of motorised beach-craft in India and Sri Lanka
- Study of use of fish aggregating devices in Sri Lanka
- Boat hauling devices in the Maldives
- A study of the performance of selected small fishing craft on the east coast of India
- Introduced inexpensive fishing gear, such as longlines, to diversify fishing methods
- A study of the possibilities of using prawn trawler by-catches

d. Fishery resources

- Investigations of various resources in the region:
    - hilsa in Bangladesh
    - tuna in the Andaman Sea and in the EEZs of Sri Lanka and Maldives
    - mackerel in the Malacca Straits
    - reef fish in Maldives
- Bio-economics in small-scale fisheries: BOBP is hoping that fishing communities will become actively involved in fisheries management by participating in the collection of data and exchange of information with social scientists about the fishery resources they know best

Overall, the BOBP appears quite comprehensive. Many individual projects were implemented to work to improve the state of the fishing peoples who depend on the Bay and its environment. Many issues are involved in improving the welfare of fishing peoples: economics, nutrition, limited resources, appropriate technology, education (or lack of it), etc. Therefore, a multifaceted approach to management and development in the region was taken.

The BOBP is a unique example of a large coordinated effort to tackle the many issues involved in developing and managing the fisheries of the Bay of Bengal. The management effort is complicated by the fact that eight countries line the Bay, with their eight separate political and social agendas. Seven of the eight countries are directly involved in the Programme, while the eighth (Myanmar (Burma)) occasionally participates. In addition, as is the case elsewhere in Asia, large populations are involved (see Table). Note that not all of these people live near the Bay; these are total population figures. However, several large cities line the shores of the Bay, including Calcutta and Madras in India each with over one million people.

OHP

Total population figures for the Bay of Bengal Programme participating countries.	
Bangladesh	116,600,000
India	866,400,000
Indonesia	193,600,000
Maldives	226,000
Malaysia	18,000,000
Sri Lanka	17,400,000
Thailand	56,800,000
TOTAL	1,269,026,000

At the project level, the BOBP has had some serious problems. Two of the many projects will illustrate the problems that could arise when implementing coastal development strategies.

5.1.2.1 Aquaculture Development

Shrimp farming had not been successful in the Bay of Bengal area for many reasons, chief among them was the difficulty of transferring culture technology to people in the villages. Seaweed farming was seen as a good alternative pilot project for the region. Care was taken to use appropriate new technologies acceptable to the local fishing peoples. The goal was to create small-scale income generating projects. Unfortunately, all seaweed aquaculture pilot projects failed in villages in South India and Sri Lanka.

Trials in Malaysia to grow seaweed (*Gracilaria*) in open sea culture were successful. But when this was tried at the chosen sites off southern India, it did not work. Rabbitfish ate all the plants in one case and the seaweed did not grow at all in another. Site selection was blamed, even though these pilot projects were carried out in villages near the "seaweed belt" (the offshore islands where the seaweed grows naturally). These islands were the areas where the projects should have been implemented but they were declared a national park to protect dugongs, and hence off-limits to any development projects. This, in fact, was one reason the actual sites were chosen; so the traditional seaweed harvesters would raise the seaweed when they were excluded from collection sites in the islands reserve area.

Unfortunately, none of the projects produced harvestable plants. The reasons for failure were said to be:

- grazing by rabbitfish
- differences between native habitat of seaweed (offshore islands) and the farm site nearshore)
- unpredictable life cycle changes
- lack of access to alternative sites

BOBP abandoned further pilot projects because longterm research was necessary and staff thought it unlikely that fisherfolk would participate in projects needing a lengthy gestation period. The staff, however, still wrote that "technology is suitable . . . farming . . . has the potential to develop into income generating activity . . . if the problems could be ironed out . "

Exercise: Individual reflection and group discussion based on the following questions:

1. Is this a realistic attitude?

2. Do you commonly find yourself in similar situations where you need to justify projects?

3. What do you do? Are there other ways to respond?

5.1.2.2. Participatory development

A BOBP project aimed to improve the living standards of fisherwomen in two villages in Bangladesh. This project specifically targeted women's groups and women; when men were consulted, no activities resulted.

It used the participatory approach, which requires the following:

- "The relationship between project personnel and the target group is that of counterparts in development. The ideas, knowledge, advantages and limitations of both parties are weighed when activities are planned." In other words, the target group must participate in all stages of the project.
- Emphasis is on the group, not on individuals.
- Project personnel must have respect for and trust in the group.
- Important practical skills are learned by experience in the field.

Most of the targeted households were very poor people who worked on fishing boats or who sold fish. When the project began, 2/3 of families were in debt and only 6% of the children were nutritionally healthy; 23% were severely malnourished. Most people could not afford 2 meals a day. During interviews the reasons given were:

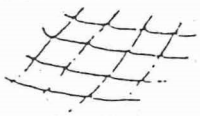
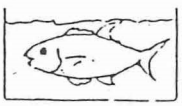
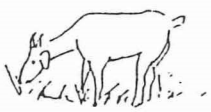
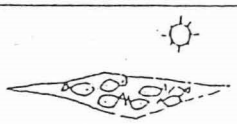
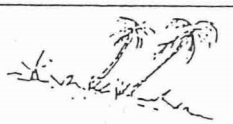
the loss of the village's fish landing centre, (the women then had to travel 20 km to meet the fishing boats in order to buy fish to sell);
fewer job opportunities;
population pressure on the resources;
poorer villagers unable to compete with others with modern fishing technology.

Individual projects are shown on the chart.

OHP: Fisherwomen activities ... May 1985

13 fisherwomen groups : 178 members

2 field workers and 9 link workers. 2 marine fisheries officers/counterparts.

 Net Making	164 members engaged in net-making (large mesh drift net 210d 30 PA twine, size 1000 × 52 210 mm meshes double knot). They earn Tk 165 per net made Up to June 1984, 392 nets were constructed, and the net-makers earned Tk 63,918 ($ 2567.00)
 Fish Farming	In one village two fish ponds were leased, 2410 fingerlings of various carps were released in July 1983. One pond was harvested in June 1984. Earnings barely covered expenses No profits. (77 members involved).
 Chicken Raising	43 members reared about 160 chicken to sell eggs as well as meat.
 Duck Raising	46 members engaged in rearing some 200 ducks.
 Goat Raising	24 members reared 24 goats. Young ones sold for profit.
 Fish Drying	6 fisherwomen given loans of Tk 300 to 500 for fish drying and storing and sale for profit during the lean season.
 Fish Marketing	37 fisherwomen given loans of Tk 210 for fish marketing.
 Savings	Savings of Tk 100 by each. Total savings up to April 1985 : Tk 16,350 ($ 555.18)
 Fruit Trees	Two fruit trees (guava and coconut) were distributed to 75 members. Very few survived.
 Health Improvement	a. Training on preventive health care for 120 women. b. Training for 70 women on supplementary and weaning food plus follow-up practical training.

Unfortunately, few of the profit-generating projects did actually generated any profit. The only profitable activity that resulted was the net-making project. The health training project was successful, but the trainees were unsuccessful in convincing the village women to change their food preparation habits in order to provide healthier food for their children.

The project staff encountered several serious obstacles

1. The fieldworkers created a dependency syndrome because they concentrated on the end products rather than on transferring knowledge and positive practices. As a result the target group saw the project as a welfare programme, rather than a project to increase self-sufficiency.

2. There was no institutional infrastructure in or near the villages to support the project. There was no bank, school, or dispensary. In addition, the Fisheries Department was so focused on the technological aspects of fisheries development that they were unable to continue the project.

3. Projects in which the women had no previous experience were not successful.

4. Fieldworkers took a long time to adjust to the living conditions. In addition, the language barrier between the project coordinator and the field staff delayed project activities.

5. It was difficult to find qualified women workers in villages because of customary restrictions placed on their ability to travel freely.

6. Finally, the allotted time and funding for the project was sufficient only for its implementation as a pilot project. There was the added fear that "when a project trying out different approaches to human resource development winds up after merely testing an approach, the target groups may resent the fact that they were 'guinea pigs.' Their hostility will hinder further development."

Exercise: Individual reflection/ group discussion on the problems,eg:

For nearly 20 years, the Bay of Bengal Programme has relied heavily on international funding, both bilateral and multilateral. Each member country is responsible for securing funds for its individual projects, but much of the funding comes from one or two sources. However, one of the goals of many international donors is for programmes to evolve towards self-sufficiency, or sustainability: to encourage local take-over of a programme so that it will survive when funding and outside assistance has finished.

An editorial in the BOBP newsletter discussed possible discontinuation of funds from major sources, Sweden and Denmark.

> The country representatives were greatly disappointed by the news . . inside and outside the meeting they expressed their deep concern about the future. Something must be done to ensure the Programme's continuance, they felt.

5.1.3 Thailand: community management of coastal resources

Background

Location	Southeast Asia
Area	southern Thailand has 2600 km of coastline
Population	entire country: 56,800,000
Institutional support for management	Yad Fon Association (NGO) Forestry Department
Existing fisheries	• ~ 30,000 artisanal fishing households • commercial purse seine fleets
Special concerns	• several fishing communities have collapsed because of increasing competition with the commercial fleets and because of decreasing resource abundance • mangrove areas are cleared for charcoal making and are destroyed for conversion to shrimp ponds or threatened by pollution from shrimp farms • coral reefs threatened by waste water discharges, anchors of tourist boats, souvenir coral collection, and use of poisons and explosives for fishing

Villagers in 17 small fishing communities decided to protect the mangroves, seagrass beds and fishing areas when they became concerned about the deteriorating state of their livelihoods. They tried to find the reasons that they were not doing as well as they had in the past. They pushed to stop the use of destructive fishing methods by members of their communities. In 1985, the communities began working with Yad Fon Association, a non-governmental organisation involved in rural community development.

Together the communities have:

- set up a community mangrove forest supported by the Forestry Department. Since the initial forest was set up, four other communities have joined in the protection of the mangroves.
- banned illegal fishing or destructive methods from 133 km^2 of seagrass beds
- formed a network with provincial authorities, universities and NGOs to conserve coastal resources
- set up some self-reliant local organizations
- been selected as models of community development by the national government

Exercise: Individual reflection/group discussion on questions such as:

1. Considering the background of Thai Coastal Fisheries, what problems can you see in implementing such a plan?
2. What sort of institutional changes are required and how it may be achieved?

5.1.4. Torres Strait, Australia: guidelines from traditional resource users

Background

Location	Passage between northeast Australia and southwest PNG
Area	~ 35,000 km^2 (water area)
Population	~ 6300 (living on islands only)
Institutional support	• Ocean Rescue 2000 Program (established by Commonwealth Dept. of Arts, Sport, the Environment and Territories) • Torres Strait Island Coordinating Council
Existing fisheries	subsistence, artisanal, commercial and recreational fisheries
Special concerns	• Torres Strait islanders have little input into the management, protection and utilisation of the resources of the Strait • Current policies are jurisdictionally complex or overlapping; a regional approach to the management of the Strait's resources is necessary • dugongs and turtles are important subsistence foods • the Strait is in one of the world's most biologically diverse areas, the IndoPacific marine faunal province

5.1.4.1 Marine Strategy for Torres Strait (MaSTS)

This strategy was conceived by the Torres Strait Islanders as a response to the threats to the marine environment, ocean tanker accidents, mining activities, and coastal development. The strategy attempts to form a regional, comprehensive management plan in an area where there is a mix of policies and programmes. The Torres Strait Islanders have prepared these environmental management guidelines because as they write, "Torres Strait is our life. We cannot abdicate our responsibilities for it."

The strategy aims to:

- establish locally based arrangements to develop and coordinate marine resource management and monitoring
- provide information about the natural environment of the Strait
- develop guidelines to minimise environmental impacts of development
- provide solutions to current locally generated pollution problems
- work to reduce regional marine pollution threats (ie, mining)
- facilitate the implementation of indigenous islander rights in fisheries agreements, treaty renegotiation, and management policies
- reconcile technological and traditional management concepts
- coordinate and develop joint research programs with outside researchers and local people to assure appropriateness and relevance
- develop and encourage education and training programs for residents

However, the strategy for ways to accomplish these goals was in the form of suggestions only. Whether or not the strategy will be heeded depends on many factors. The immediate action planned was to:

circulate the MaSTS report;
discuss the Torres Strait Treaty and its role in management;
hold a workshop on marine management and publish the proceedings; write a handbook of advice for planners;
and petition for a Torres Strait environmental centre.

Further suggestions for the longer term marine strategy are as follows:

- interdisciplinary biological monitoring and research
- shared management to maximise Islander involvement in conservation and decision making
- integrated resource planning and management that includes
    - land and marine use planning
    - sustainable development
    - non-renewable resource planning
    - review of environmental impact assessment procedures and development of environmental guidelines
- develop criteria for marine environmental quality standards
- increase public knowledge

Exercise: Individual reflection/group discussion on questions arising from local efforts to influence policy makers.

What are the similarities and differences between the approaches used by the Thai fishing communities and those used by the Torres Strait Islanders?

What are the advantages and disadvantages of each of these strategies?

How could such activities be incorporated into larger management and development schemes?

5.1.5. Tuvalu Fisheries Development Plan

Background

Location	South Pacific
Land area	24 km^2
Population	9000
Political status	independent since 1978
Institutional support for fisheries	Tuvalu Fisheries Division Naficot - government's commercial fishing corporation
Existing fisheries	• 1 pole and line tuna vessel • subsistence fishing from canoes in lagoon or in nearshore areas • artisanal fishing for offshore tuna from trolling skiffs
Special concerns	small land area limited resources

Goals

1. Develop fisheries at the village level for a good, consistent protein supply for the local population

2. Develop small-scale seafood export industry

3. Maximise the returns from foreign fishing vessels

Strategies

1. Village level fisheries
2. Small-scale export industry
3. Maximising the returns from foreign vessels

We will now discuss each of these in more detail.

1. Village level fisheries. The strategy is to promote the use of appropriate technology to increase fuel efficiency and enhance self-sufficiency. Several projects are in progress to achieve this goal. Some of these projects have been introduced to remedy earlier poorly designed projects.

a. All boats introduced to Tuvalu in the last 10 years were unsuccessful because unsuited to local conditions. One project promotes the building of improved low-cost small plywood boats. Four new designs were developed specifically for Tuvalu, including a simple paddling canoe. The new boats have sails for improved fuel efficiency and safety, are strong enough for surf entry, and are seaworthy. The boats were demonstrated to local fishermen and they were encouraged to suggest design changes if they felt they were needed.

b. Emergency sail rigs were made available to the owners of the existing fleet of trolling skiffs to be used in case of engine breakdown.

c. Extension services are being developed to provide training to local fishermen. Training covers both technical and non-technical areas. Technical areas include outboard maintenance and using "innovative fishing methods including bottom fishing, improved trolling methods, vertical longlining" (Gentle 1991:25). Non-technical areas include safety at sea, small business management and record keeping.

d. The village fisheries database is being improved and updated.

e. FADs have been deployed.

f. A master fisherman at the Fisheries Division has been training younger fishermen in traditional fishing methods and marine lore. These were secret and passed from older relatives to the young village men, but the western style school system leaves fewer opportunities for young men to go on fishing trips with their elders.

g. The Fisheries Division is working with the Education Department to include fishing knowledge and skills in the school curricula.

2.Small-scale export industry. Several projects aim to develop products specifically for the export market.

a. The fish market and processing centre was upgraded to facilitate the production of export quality products.

b. The feasibility of a small-scale offshore fishery for deep-water snappers was studied. The feasibility study included resource assessment and habitat mapping.

c. An outer islands development programme emphasised the production of dried fish (tuna jerky) as a cottage industry, because of the difficulties of operating a successful fish collection service to these islands. (Some evidence that this did not do so well)

d. The effective use of five fisheries training launches donated under Japanese aid in 1988 was debated. The boats are not well suited to local conditions, but the Fisheries Division discussed using them in tuna longlining

3. Maximising the returns from foreign vessels

Tuvalu has serious problems enforcing its large EEZ. Distant water fishing nations often claim they are fishing in non-Tuvalu waters and that they rarely, if ever, fish in Tuvalu waters. As a result, they pay minimal access fees.

Tuvalu is working with FFA on regional initiatives to improve the surveillance of EEZs. These include learning how to use a high frequency radio network to exchange regional information on vessel movements and using satellite transponders (?) to track vessels.

Exercise:Evaluation by individual reflection/group discussion:

How well does this plan meet local and national needs?
What are its strengths ?
What are its weaknesses?
How can it be improved?

5.1.6 South Pacific Marine Protected Areas

Chapter 17 of Agenda 21 provides for maintaining biological diversity. Fisheries constitute an important resource for foreign exchange and for food and income. On the other hand it is a resource that simultaneously depends upon both its exploitation and conservation. This creates conflicting needs to exploit resources for immediate again and to conserve them for future growth. Thus the establishment of marine protected areas is designed to balance competing needs through sustainable development.

The conservation of biological diversity through the wise management of living resources such as through the establishment of marine protected areas is an important means for balanced and sustainable approach to economic development and maintaining spiritual and cultural values. This is of particularly important for the South Pacific islands, whose long term economic and social development depend on careful management of its relatively limited resource base and where people live in close symbiosis with their environment.

Marine protected areas can be of varied types having different objectives to reach the same goal. The challenge in conserving biological diversity is to identify and create opportunities so that people may act in their own economic interests and at the time promote the sustainable use of resources. Tapping the economic potential of biological diversity as a renewable resource and to promote its development is a realistic approach to the conservation in small island countries.

To promote ecotourism in coastal areas in Palau, certain reef and lagoon areas are protected. A major source of income is derived by marketing the scenic underwater beauty of reefs and its ecosystems while maintaining fisheries at subsistence levels. By establishing a management plan that sets out guidelines and regulations for the resource use of conservation in these areas, Palau is able to maintain its biological diversity.

Contrary to popular belief, marine protected areas (MPAs) are not, therefore, necessarily closed to human activity. In the South Pacific, these areas fall into five major categories. Most of the MPAs in the region were declared during the colonial or trusteeship time, or during the late 1970s and early 1980s.

The categories are defined by the reasons for which the protected areas were created and by the uses allowed within their borders.

- tourism or recreation oriented MPAs
    - Palolo Deep, Western Samoa
    - Million Dollar Point Reserve, Vanuatu
    - Ha'atafu Beach Reserve, Tonga
- general marine resource and habitat conservation areas near population centres
    - Mare and Amede Islets Nature Reserves, New Caledonia
    - Manuafe Island Park and Reserve, Tonga
- outlying uninhabited atolls or islands
    - Ngerukewid Islands Wildlife Preserve, Palau
    - Suwarrow Atoll National Park, Cook Islands
- MPAs designed to protect harvested species
    - Maza Wildlife Management Area, Papua New Guinea
    - Trochus sanctuaries: Palau; FSM; Cook Islands
    - Giant clam grow-out/spawning areas: Tonga; American Samoa
- fully developed MPAs: these areas are legally protected and can serve as educational centres to obtain the interest of the public in creating other MPAs
    - Fagatele Bay National Marine Sanctuary, American Samoa

Several strategies can be used to promote development of marine protected areas as a conservation and management technique.

- Strengthen existing MPAs.
- Expand, where appropriate the species protected by areas established to protect certain harvested species. For instance, trochus sanctuaries could become giant clam, trochus and lobster sanctuaries.
- Promote MPAs as a fisheries management tool to provide 'seed areas' for other fishing sites. In order to succeed in this, fisheries and conservation personnel must work together.
- Exploit tourist industry interest in MPAs: successful tourism in the region, especially ecotourism, requires healthy natural environments.
- Promote MPAs as a way to protect rare and endangered species
- Develop MPAs when developing coastal management plans, and delineating areas where little or no development is allowed:
- Adapt and include traditional management and ownership systems.
- Expand biodiversity protection efforts to include marine communities

Exercise: Individual reflection/ group discussion:

Are there any areas in your country that would be appropriate as marine protected areas? What are they?
What sort of MPAs do you think they should be?
What obstacles do you foresee in the delineation of these areas as marine protected areas?

5.1.7 Customary Marine Tenure (CMT) systems

5.1.7.1 Introduction to the case study.
There is increased emphasis on people's participation ie. involving local communities in management and development of their resources. Chapter 17 of Agenda 21 makes specific provision to this effect. The value of these traditional systems are now being realised in the face of the threatened marine environment and declining fisheries resources where contemporary management systems do not seem to work.

CMT systems have evolved through history involving years of practice. However most are not documented and have become vulnerable to rapid modern changes. In S. E. Asian countries like Philippines and Thailand, these systems have eroded considerably; most the coastal areas in these countries are heavily exploited and alternative management regimes are urgently needed. In contrast, in some of Pacific Islands like Solomon Islands, Vanuatu, Fiji and some Micronesian states. these systems provide an important means of regulating fishery activities in coastal areas.

Coastal communities have exclusive fishing rights over coastal waters adjacent to their village land. Any outsiders have to seek permission of the chief or headman of the village or tribe. This limits access to the fishing grounds. In many of the countries where CMT systems exists, clear boundaries are delineated and identified by some physical features. Thus, with the current desire to increase economic benefits, there is a danger of people trying to lay claims to larger resource areas often involving boundary overlaps and conflicts.

On the other hand, CMT systems are viewed as part of the culture and tradition with values and norms guiding daily life. The sustainability and applicability of some aspects of the system may be questionable, but many of its features provide a useful base for our understanding in formulating of management plans.

The Fisheries Departments of most Island countries are small with limited budget and personnel to be able to enforce regulations. A community based system like the CMT is able to regulate the activities within the cultural context. The system further provides management and development consistent with the level of development of the community, and a system that is not alien to the community. People are able to relate to the system and have a role within the systems. This therefore gives them a sense of responsibility and commitment.

Several studies have been done on CMT systems, trying to document traditional knowledge to understand its mechanism, its usefulness and adaptability to modern management systems. For example, Hviding has recently done an extensive survey and documentation of the CMT systems in Marovo Lagoon area in the Western Province of the Solomon Islands. Johannes (1984), likewise has documented the CMT systems in Palau. Other local researchers have also been trying to understand the mechanisms and their compatibility with modern management systems.

Many of these studies have been supplied as **Readings** for this course. **Readings** 2.9; 2.13; 5.6; 5.10; 5.19 were presented at an international workshop on CMT and sustainable development was held by the International Ocean Institute (IOI) in early July 1994 at the University of the South Pacific.

Reading 5.6 is about a series of fishing experiments to determine stock sizes, catch, gear and species composition. Based on use of traditional fishing methods to determine this scientific data, it points out that the experiment did prove success in use of traditional methods and knowledge. **Reading 5.9** outlines some of the reasons for using CMT systems in terms today's need for fisheries management, and **Reading 5.10** indicates some of the issues involved in enhancing and advancing the study of CMT and traditional knowledge of fisherfolk. CMT systems also provides a more practical approach in terms of regulating and monitoring of national fisheries regulations in remote areas.

5.1.7.2 Case studies and exercise: individual reflection/group discussion.

Participants working individually or in small groups study a Reading from those listed below. Participants who have selected Reading 5.9 (Fong, Fiji) and 5.18 (Ruddle, Japan) present their findings, and lead a discussion covering,for example, the following points:

1. What are the similarities and differences between the Japanese system and that of Sasa Village in Fiji.

2. What are some of the problems of CMT in today's context for integrated coastal fisheries management?

3. What lessons can be learnt from the experiences and observations described in these Readings?

List of CMT Readings

Reading 2:3
W. C. Clarke. "Learning from the past: traditional knowledge and sustainable development." *Contemporary Pacific*, 2(2)1990:233-253

Reading 2:8
E. Hviding. *The rural context of giant clam mariculture in Solomon Islands: an anthropological study.* Manila: ICLARM/University of Bergen, Norway, 1993 (ICLARM Contribution 953, Tech.Rpt. 39. 93p.)

Reading 2:9
E. Hviding. "Customary marine tenure and fisheries management; some challenges, prospects and experiences." from G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 (pp.89-101)

Reading 2:12
M. Pulea. "An overview of constitutional and legal provisions relevant to customary marine tenure and management systems in the South Pacific." *Forum Fisheries Agency Report* 93/23(1993):61p.

Reading 2:13
K. Ruddle. "Traditional marine tenure in the 90s." from G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 (pp. 6-45)

Reading 2:15
J. Veitayaki. "Village level fishing in the Pacific." from G. R. South (ed.) *Marine resources and development*. Suva: PIMRIS, USP Library, 1993 (pp.73-96)

Reading 4:6
G. David; E. Cillauren. *Traditional village fishing, food security and development of fisheries in Vanuatu.* Port Vila: ORSTOM, 1992 27p.

Reading 5:6
P. Dalzell; A. Smith. "Something old, something new: an approach to obtaining fisheries management information from a remote Pacific atoll." From G. R. South et al. (eds) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 pp. 103-125

Reading 5:9
G. Fong. *Case study of a traditional marine management system: Sasa Village, Macuata Province, Fiji.* Honiara: Forum Fisheries Agency/Rome: FAO, 1994 (Field Report 94/1; Project RAS/92/TOS) pp.i, 66-70

Reading 5:10
T. Graham. "Examining traditional marine resource management in the context of today's objectives." From G. R. South et al.(eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 pp.261-268

Reading 5:12
E. Hviding; G. B. K. Baines. "Community-based fisheries management: tradition and the challenges of development in Marovo, Solomon Islands." *Development and Change*, 25(1994):13-38

Reading 5:18
K. Ruddle. "Solving the common-property dilemma: village fisheries rights in Japanese coastal waters." From F.Berkes (ed.) *Common property resources: ecology and community-based sustainable development*. London: Belhaven Pr., 1989 pp.168-134

Reading 5:19
A. Smith. "Strategies for acquiring and using traditional marine knowledge." From G. R. South et al.(eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 pp.240-251

6. FORMULATION OF MANAGEMENT PLANS FOR COASTAL FISHERIES DEVELOPMENT:EXERCISE

Purpose: The purpose of this section is to develop a national management plan for coastal fisheries development.

Objectives: On completion of this section, participants will have produced a document containing the elements described below.

Method: Participants, in common interest groups ie. country and sub-regional, work together using their lectures, discussions, reading materials, knowledge & experience to produce a draft plan. Appendices 6.5 and 6.6 of this module provide checklists of policy instruments and resource materials.

6.1 Background analysis: factors to be taken into account in the design of fisheries management and development plans.

6.2 Plan design and formulation
6.3 Presentation
6.4 General discussion

6.5 Appendices
6.5.1 Checklist of policy instruments for fisheries management and development in the South Pacific Region
6.5.2 Draft plan outline

6.5.3 List of Readings, Module 5

Reading 5:1
S. C. Bacani. "Coastal resources management: the Philippine Department of Agriculture's Fisheries Sector program for 1990-1994". From T. E. Chua & L. F. Scura (eds.) Managing ASEAN's coastal resources for sustainable development: roles of policymakers, donors, scientists, media and communities. *ICLARM Conference Proceedings*, 30(1991):107-109

Reading 5:2
Bay of Bengal Programme for Fisheries Development. "Defining people's participation; Understanding people's participation; Securing people's participation; Participation:end or means?" From its *Helping fisherfolk to help themselves: a study in people's participation*. Madras: Affiliated East-West Pr., 1990 pp.7-9; 10-13; 14-17; 18-27

Reading 5:3
P. W. Birnie. "The Law of the Sea and the United Nations Conference on Environment and Development." From E. M. Bergese et al. (eds.) *Ocean Yearbook*, 10(1993):13-39

Reading 5:4
W. V. Branan. "The University of Rhode Island's international coastal resources management project." From L. M. Chou et al.(eds.) Towards an integrated management of tropical coastal resources. *ICLARM Conference Proceedings*, 22(1991):419-422

Reading 5:5
"Coastal and marine resources." From *Programme of action for the sustainable development of small island developing states, advance unedited text, 4 May 1994*. [np: np], 1994
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Reading 5:6
P. Dalzell; A. Smith. "Something old, something new: an approach to obtaining fisheries management information from a remote Pacific atoll." From G. R. South et al. (eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific* Suva: International Ocean Institute, 1994 pp. 103-125

ESCAP. "National and regional maritime policies." From its *The Law of the Sea in the South Pacific: a study on the integration of marine affairs activities within government concerns.* NY: UN, 1991 (pp.5-14) [See Reading 2:4]

Reading 5:7
FAO. "Coastal fisheries development in small island countries: constraints and strategies for sustainable use."[for] *Inter-regional Conference of Small Island Countries on Sustainable Development and Environment in Agriculture, Forestry and Fisheries, Christ Church, Barbados, 7-10 April 1992.* [np:np, 1992?] i,9p

Reading 5:8
FAO. "Fisheries resources." From its *Sustainable development and the environment: FAO policies and action, Stockholm 1972-Rio 1992.* Rome, FAO, 1992 pp. 54-58

FAO. *Strategy for fisheries management and development.* Rome: FAO, 1986 (pp.[5],1-26) [See Reading 2:5]

Reading 5:9
G. Fong. *Case study of a traditional marine management system: Sasa Village, Macuata Province, Fiji.* Honiara: Forum Fisheries Agency/Rome: FAO, 1994 (Field Report 94/1; Project RAS/92/TOS) pp.i, 66-70

Reading 5:10
T. Graham. "Examining traditional marine resource management in the context of today's objectives." From G. R. South et al.(eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific.* Suva: International Ocean Institute, 1994 pp.261-268

Reading 5:11
A. M. S. Halidi et al."Some considerations in the development and management of the coastal fisheries resources of Brunei Darussalam." From L. M. Chou et al.(eds.) Towards an integrated management of tropical coastal resources. *ICLARM Conference Proceedings,* 22(1991):375-380

Reading 5:12
E. Hviding; G. B. K. Baines. "Community-based fisheries management: tradition and the challenges of development in Marovo, Solomon Islands." *Development and Change,* 25(1994):13-38

Reading 5:13
B. N. Lohani. "The Asian Development Bank's efforts in sustainable development of coastal resources." From T. E. Chua & L. F. Scura (eds.) Managing ASEAN's coastal resources for sustainable development: roles of policymakers, donors, scientists, media and communities. *ICLARM Conference Proceedings,* 30(1991):73-82

Reading 5:14
P. McCully. "FAO and fisheries development." *The Ecologist*, 21(March-April 1991):77-80

Reading 5:15
W. Meynen. "Fisheries development, resources depletion and political mobilization in Kerala: the problem of alternatives." *Development and Change*, 20(1989):735-770

Reading 5:16
R. Miclat & E. Miclat. "Artificial reefs: a fisheries management tool for Lingayen Gulf." From G. Sylvestre et al.(eds.) Towards sustainable development of the coastal resources of Lingayen Gulf. *ICLARM Conference Proceedings*, 17(1989): 109-117

Reading 5:17
B. Nietschmann. "Indigenous island peoples, living resources and protected areas." From J. A. McNeely & K. R. Miller (eds.) *National parks, conservation and development: the role of protected areas in sustaining society*. [np]: IUCN/Smithsonian Inst. Pr., 1984 pp. 333-343

Reading 5:18
K. Ruddle. "Solving the common-property dilemma: village fisheries rights in Japanese coastal waters." From F.Berkes (ed.) *Common property resources: ecology and community-based sustainable development*. London: Belhaven Pr., 1989 pp.168-184

Reading 5:19
A. Smith. "Strategies for acquiring and using traditional marine knowledge." From G. R. South et al.(eds.) *Traditional marine tenure and sustainable management of marine resources in Asia and the Pacific*. Suva: International Ocean Institute, 1994 pp.240-251

Reading 5:20
SPC. "Coastal fisheries programme." *SPC Regional Technical Meeting on Fisheries*, 25 (Working Paper 1, 1994):1

Reading 5:21
SPC. *Coastal fisheries programme*. Noumea: SPC, 1994. [8p.]

Reading 5:22
SPREP. "Programme 4: Coastal management and planning." From its *1991-1995 Action Plan for managing the environment of the South Pacific region*. Apia: SPREP, 1993 pp.14-15

Reading 5:23
"Unesco activities relevan[illegible] management of coastal areas and resources." [Presented at] *World Coast Conference, The Hague, 1-5 November 1993*. [?Paris: Unesco], Sept.1993 10p

Reading 5:24
United Nations. *The Law of the Sea. official text of the United Nations Conference on the Law of the Sea with annexes and index. Final Act of the third United Nations Conference on the Law of the Sea: introductory material on the Convention and the Conference*. NY:UN, 1983. pp.1-17;70-105.

Reading 5:25
United Nations. "Programme areas" [A: Coastal and marine areas; B: Marine environmental protection; C: Marine living resources, high seas; D: Marine living resources, national jurisdiction; E: Critical uncertainties, marine environment and climate change; F: Strengthening cooperation and coordination; G: Sustainable development of small islands] From its *Report of the UN Conference on Environment and Development, Rio de Janiero, 3-14 June 1992*. NY: UN, 1992? (A/Conf.151/26,vol. II, pp. 131-166)

Reading 5:26
United Nations. "Protection of the oceans, all kind of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources. From its *Programme of action for sustainable development: the final text of Agreements negotiated by Governments at the United Nations Conference on Environment and Development, 3-14 June 1992, Brazil* NY:UN, 1992 pp. 147-165

Reading 5:27
F. J. Vande Vusse. " A community-based resource management approach to address Philippine coastal resource degradation and overfishing." From L. M. Chou et al.(eds.) Towards an integrated management of tropical coastal resources. *ICLARM Conference Proceedings*, 22(1991):387-393

Additional Reading
M. T. Kalaw. "The role and involvement of nongovernmental organizations in the sustainable development of coastal resources." From T. E. Chua & L. F. Scura (eds.) Managing ASEAN's coastal resources for sustainable development: roles of policymakers, donors, scientists, media and communities. *ICLARM Conference Proceedings*, 30(1991):103-106

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