FISHERIES

Management by Communities

A manual on promoting the management of subsistence fisheries by Pacific Island communities

Secretariat of the Pacific Community

Fisheries Management by Communities

A manual on promoting the management
of subsistence fisheries by Pacific Island communities

COMMUNITY FISHERIES SECTION
Secretariat of the Pacific Community
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Secretariat of the Pacific Community
BP D5, 98848 Noumea Cedex, New Caledonia

Telephone: +687 26 20 00, Facsimile: +687 26 38 18
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Preface

It is impossible for government fisheries agencies to properly manage subsistence fisheries without the involvement of fishing communities. Most agencies have limitations on budgets and staff which make it impossible to constantly work in communities which are spread out in many different villages. But, more importantly, community involvement results in the ownership of fisheries management actions and regulations. Under community ownership, fisheries management measures are enforced by the communities themselves.

This manual is about community-based fisheries management. It provides guidelines and suggestions on how communities can be encouraged to take a leading role in the management of their fisheries and the marine environment. The Samoan model of community-based fisheries management, which is referred to in this manual, has stood the test of time. Over a period of about three years, some of the 60 villages in the programme have fallen by the wayside, but most are now successfully managing their own fisheries resources.

I believe that the model used in Samoa is transportable to other island countries in the Pacific, perhaps with some alterations to suit local conditions and culture. I urge agencies in these countries to consider the benefits of community-based fisheries management, and develop a suitable programme of village participation.

I wish you the best of luck with your endeavours.

Ueta Faasili
Assistant Director (Fisheries)
Fisheries Division, MAFFM
Apia, Samoa.

September 1999

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Drawings by Michael King, except where noted in the text.

1. Introduction

This book was written for two reasons. First, there is a concern that catches of seafood in inshore lagoons and reefs are declining in Pacific Islands. Second, there is growing recognition that fishing communities themselves hold the key to preventing this decline.

Fishing and the marine environment have always played an important role in the lifestyle and culture of people in Pacific Island countries. Now, after many years of rapidly changing lifestyles, people are being encouraged to eat more local foods – that is, to eat plants and meat that are traditional and healthy. One of the most traditional and appropriate foods for people living in islands is, of course, seafood. But it is no use encouraging people to eat more seafood if it is becoming increasingly difficult to get and more expensive to buy.

Catches of the most accessible seafood, fish, seaweed and shellfish of the lagoons and reefs, have been declining in several island countries over many years. Reasons for the decline in inshore catches may include overexploitation, the use of overly efficient and destructive fishing methods (including the use of explosives, chemicals and traditional plant-derived poisons), and environmental disturbances. Environmental disturbances have resulted from not only natural events such as cyclones and storms but from human activities.

Even though inshore catches of seafood are decreasing in Pacific Islands, subsistence fishing, the catching of fish to eat rather than to sell, often still results in a total catch that is several times larger than that from commercial fishing. In spite of the obvious importance of subsistence fishing, government authorities usually concentrate their conservation and fisheries management efforts on commercial fish stocks. Governments may be concerned about falling fish catches in villages, but their ability to do something about the problem is limited. Most fisheries agencies have small numbers of staff and limited budgets. Although most Pacific Islands have enacted national laws to protect fish stocks, enforcing such laws in widespread rural areas and villages is often impossible. It is, at least, impossible without community involvement and support.

Fishing communities are often repositories of valuable traditional knowledge concerning fish stocks and have a high level of awareness of the marine environment. In addition, many villages have some degree of control, either legal or traditionally assumed, of adjacent waters. Together, these factors provide an ideal basis on which communities can be encouraged and motivated to manage their own marine resources.

This manual has been written in response to growing regional interest, from fisheries and environmental agencies as well as non-government organisations, in how to provide this motivation.

- How can villages be encouraged to manage their own fisheries?
- What can be done to support village communities in their efforts to conserve fish stocks and protect their marine environment?
- What particular conservation actions can village communities take?
- What can be done by communities and what must be done by governments?

This manual is based on the following premise.

Regardless of national legislation and enforcement, the responsible management of fisheries resources will only be achieved when fishing communities themselves see it as their responsibility rather than that of the government.

This manual is designed to provide some technical background on fisheries and the marine environment, and to be a guide on promoting and encouraging their management by Pacific Island communities. Such management is said to be community based. The community-based methods presented in this manual are not the only ones possible, and, in any case, must be adapted to a greater or lesser extent to suit local situations, culture and customs. Readers interested in pursuing the subject from a more academic viewpoint are directed to the references provided at the end of the manual.

2. Subsistence and artisanal fisheries in the Pacific

Fisheries

In its broadest sense, a fishery includes the marine environment, a resource or target species of seafood, and the people involved in fishing and in handling the catch. The marine environment consists of the living and non-living surroundings of a marine species – thus both corals and seawater are parts of the environment of a reef fish. A fisheries resource is a population of fish, or other marine animal, which is exploited. Some of the different types, or species, fished in Pacific Islands are described later in this chapter.

A fishing operation may be a simple one, such as the collection of shellfish on a reef, or it may be a much more complicated one, such as the catching of tuna by a large fishing vessel. Handling the catch may range from the simple storage of fish on ice to the technologically sophisticated procedure of canning. Methods of fishing and catch handling appropriate to subsistence fishing are described later in this chapter.

Fisheries are often divided into non-commercial and commercial sectors. The non-commercial or subsistence sector involves the catching of fish to eat rather than to sell. The commercial fishery may be divided into an artisanal sector, usually small-scale fishing to supply local markets and an industrial sector, involving large-scale fishing for canneries and export. This manual is concerned with subsistence fishing in coastal communities in the Pacific.

Types of coastal ecosystems

There are many different types of marine environments, or ecosystems, in tropical islands. Some islands have rivers and forests of mangroves. Many coasts have coral reefs fringing the shore while others have a sheltered lagoon between the shore and a barrier reef. Beyond the coral reefs in the open sea, there is usually no continental shelf and the sea-floor rapidly drops away to deep water. Marine animals are specially adapted to living in particular environments. A range of different environments, and some of the species present in each, are shown distributed along a profile of a tropical coastline in Figure 2.1. However, many species migrate between different environments at different stages of their life-cycle; some fish, for example, grow up as juveniles in mangrove areas before migrating out to lagoons as adults.

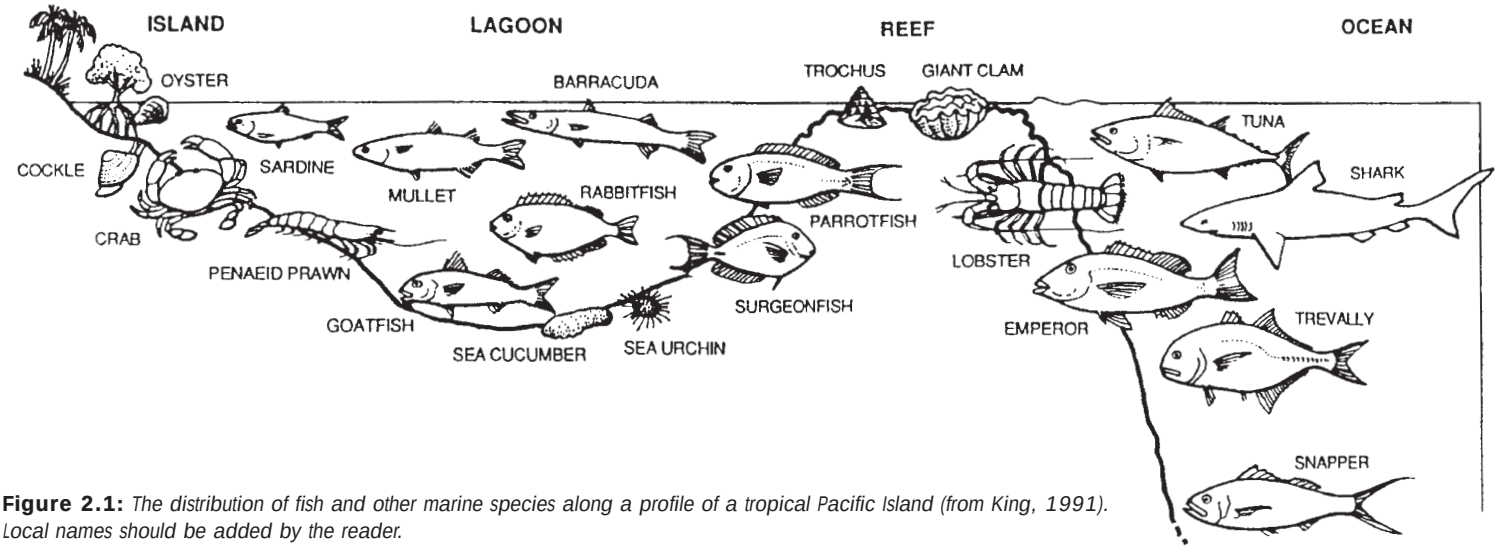

Figure 2.1: *The distribution of fish and other marine species along a profile of a tropical Pacific Island (from King, 1991). Local names should be added by the reader.*

Estuaries – brackish water and mangroves

Estuaries are places where rivers meet the sea. Here, because of the mixing of river water and sea water, the water is of low salinity, and is said to be brackish. Brackish water can also occur where there are freshwater soaks or run-off from the land. In these ecosystems, there are often forests of mangroves – trees which are specially adapted for life at the sea's edge. The common red mangrove, *Rhizophora*, is shown in Figure 2.5.

Mangroves play an important role in providing shelter and food for marine creatures. Plant material decomposes to form detritus which is used as food by crabs, prawns and many fish. The juveniles of many different species use mangroves as areas in which to grow (as nursery areas) before moving out to deeper water. Mangroves are also important in protecting and extending shore-lines.

Mangroves are often cut down during land reclamation, in which land is filled in for housing or other development. Some coastal road construction which interrupts the mixing of fresh and salt water also creates an environment unsuitable for mangroves – usually mangroves die because water on the seaward side of the road becomes too saline and water on the landward side becomes too fresh.

Beaches and seagrass

Beaches are formed by particles of material washed ashore by waves and currents, or, in some cases, particles carried from inland by rivers. In tropical regions, most beaches consist of coral which has been broken up into particles by storms, or has passed through the digestive system of coral-eating fish such as parrotfish (Figure 2.9). In each case, coral skeletons are broken down to small particles which are carried by currents and deposited inshore to form beaches.

Gently sloping beaches of sand prevent waves eroding and washing away the shore, and are, therefore, particularly important in low-lying areas. In coral atolls, beaches protect land which is often only a few metres above sea level. In some shallow sandy areas there may be extensive underwater meadows of seagrass (Figure 2.2) which provide shelter and food for many different animals. Seagrasses are similar to flowering plants on land, and unlike seaweeds (marine algae), they have root systems which are able to gain a foothold in drifting sand. Seagrass beds assist in the formation of sand bars and provide food and shelter for many marine animals.

Sand is often removed from beaches, or dredged from lagoons, to make concrete for the building industry. The mining of sand must be controlled so that there is minimal impact on the coastal environment.

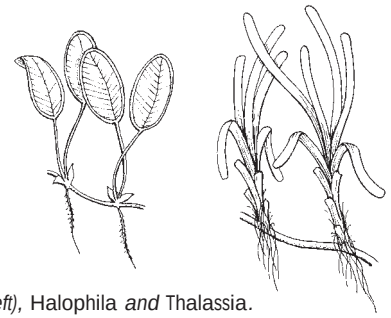

Figure 2.2: *The seagrasses (from left),* Halophila *and* Thalassia.

Coral reefs and lagoons

There are many hundreds of different types of coral. All corals are made up of small animals called polyps, which are usually less than 1 cm in diameter and live side by side in groups or colonies. A few species, such as the mushroom coral (Figure 2.3), have larger solitary polyps up to 20 cm in diameter. Many coral polyps grow together as a colony to build a shared skeleton which has a particular shape depending on the species of coral (Figure 2.3). A large number of coral colonies collectively form a coral reef, consisting of the skeletons of many millions of dead polyps. Living polyps are only found on the thin outer layer of the coral reef which continues to grow outwards and upwards with each generation.

Besides capturing food drifting in the water, coral polyps can obtain food from small plant cells (zooxanthellae) living in their tissue. Through photosynthesis, the zooxanthellae use sunlight and dissolved nutrients to produce food which is shared with the coral. Thus most corals, like plants, require sunlight and can only live in clear, shallow, sunlit waters.

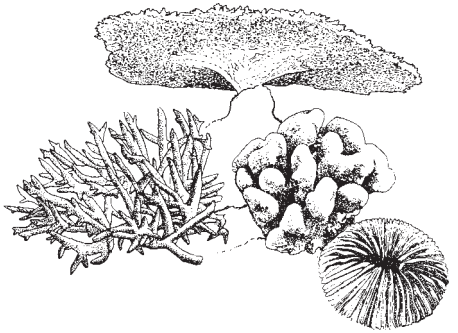

Figure 2.3: *Some common types of hard, reef building corals, including (from left) staghorn coral, table coral (*Acropora *species) and boulder coral (*Porites*); a mushroom coral (*Fungia*), which exists as a single, large polyp is shown on the right (from King, 1988).*

There are three basic types of coral reefs – fringing reefs, barrier reefs and atolls. One explanation of how the different types of reefs evolve is based on the concept of an oceanic island gradually sinking over many thousands of years. As long as a newly formed island in tropical waters is within reach of drifting coral larvae, it soon acquires a fringing reef of coral. As the island slowly subsides or sinks, the fringing reef around the island actively grows upwards. Eventually a lagoon will form between the sinking island and the growing coral which then becomes a barrier reef. When the island sinks beneath the sea, the barrier reef maintains its upwards growth to become a circular atoll. This sequence in reef formation is illustrated in Figure 2.4.

A coral reef is part of a complex ecosystem and includes many animals and plants which are important food items for coastal communities. In addition, coral reefs protect coastlines and villages, particularly from large ocean waves created by cyclones, and are the source of sand for beaches.

Although corals have natural predators, such as the crown-of-thorns sea star and the parrot fish (Figure 2.9), the activities of people present the greatest threat to coral reefs. Corals are collected for sale as souvenirs and coral blocks are used for building. Dredging harbours and coastal building projects often release silt into the water which blocks off sunlight or smothers coral polyps. In some areas, corals are being destroyed by destructive fishing methods (see Chapter 4).

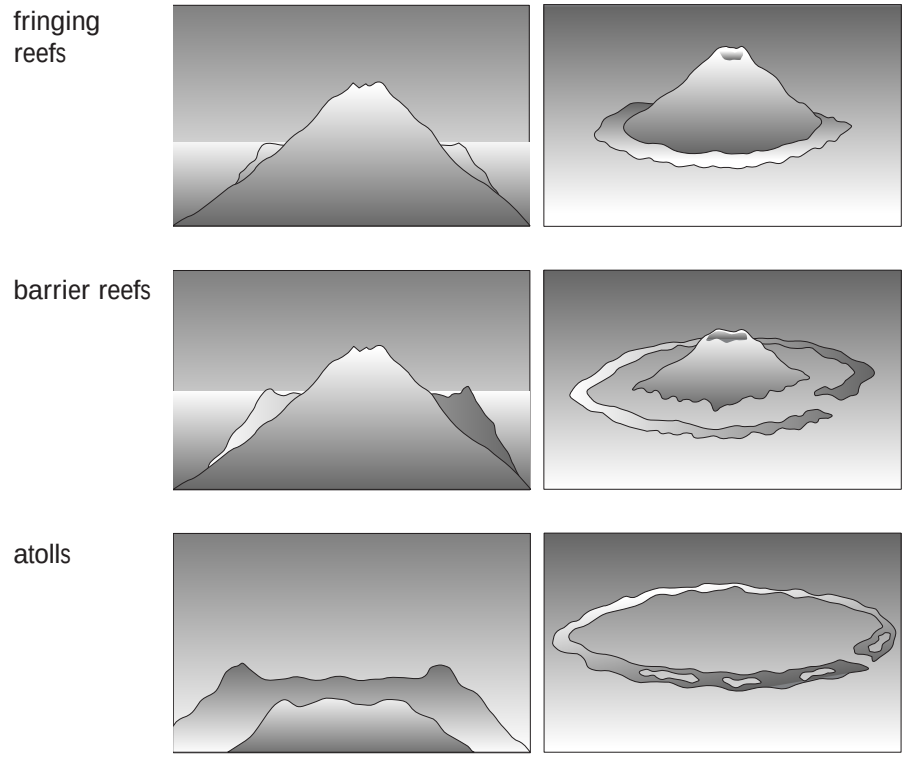

Figure 2.4: *Types of coral reefs (Adapted from Colin & Arneson, 1995).*

Outer reef slopes and the open sea

On the outer edge of coral reefs, the sea floor usually slopes down at a steep angle until the ocean floor is reached at an average depth of about three kilometres. After this the seafloor is relatively flat although it may rise to form seamounts and other island groups. In some areas the sea floor drops away to form very deep trenches (often over 10 km deep) such as the Tonga Trench and the Mariana Trench.

Many seafood species including spiny lobsters and fish such as groupers and snappers are caught on the outer slopes of reefs. But in the open ocean, there are no reefs to provide shelter or large plants to provide food, and only a few specialised types of fish, such as tuna, can live there. These oceanic fish wander over large areas of ocean hunting smaller fish which feed on small drifting animals (zooplankton). The zooplankton, in turn, feed on very small, drifting plants (phytoplankton). Phytoplankton, however, can only grow where there are nutrients, mainly dissolved nitrates and phosphates. Most surface areas of the sea contain only small quantities of nutrients to feed phytoplankton, and can, therefore, support only small numbers of fish. An exception to this is a particular area where water moves up from the deep as an upwelling, bringing with it large quantities of nutrients.

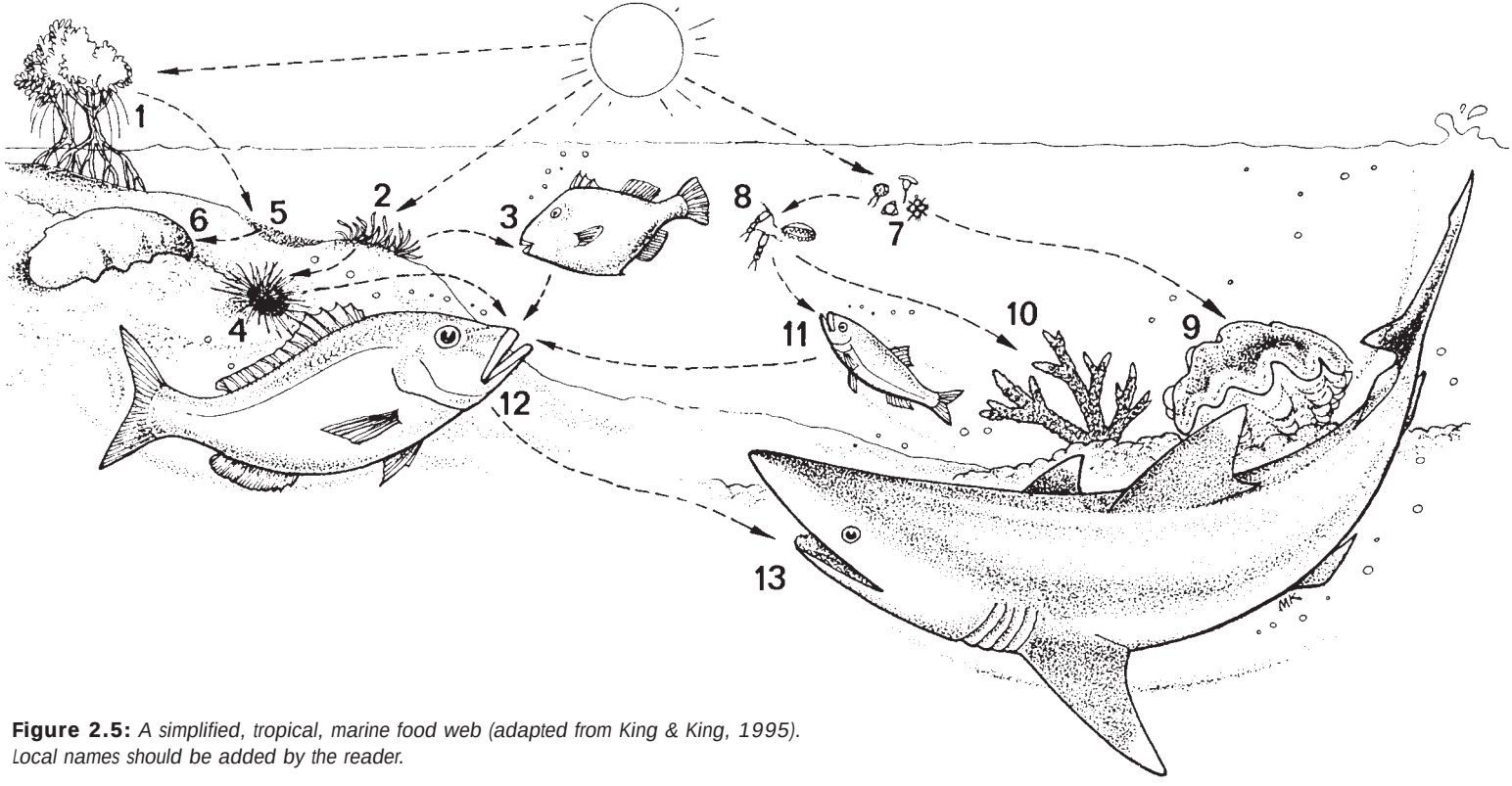

Figure 2.5: *A simplified, tropical, marine food web (adapted from King & King, 1995). Local names should be added by the reader.*

Foodwebs and relationships between ecosystems

Although ecosystems are described under separate headings in this chapter, they are not independent of each other. They are interrelated, and many species migrate between different ecosystems at different stages of their life cycles. Some fish, for example, grow up as juveniles in mangrove areas before migrating out to lagoons as adults. The larvae of other species may drift in the open sea before settling on coral reefs to grow.

Within and between the various ecosystems described in previous sections there is a flow of material and energy. Energy from the sun and dissolved nutrients are used by plants to form tissue through photosynthesis. The plant material is eaten by animals which are eaten by other, usually larger, animals. This complex flow of energy and food material is often referred to as a food web.

A simplified, tropical, marine food web is shown in Figure 2.5. Plants such as mangroves **(1)** and seagrasses **(2)** use sunlight to produce plant material from carbon dioxide and nutrients during photosynthesis. Plant material is eaten by herbivorous animals such as triggerfish **(3)** and sea urchins **(4)**. Plants and wastes from animals are broken down by bacteria to form a pool of organic material called detritus **(5)** which is consumed by a wide range of animals, including the sea cucumber **(6)**. Microscopic plants (phytoplankton – greatly magnified in **(7)** drift near the surface of the sea, and are eaten by small floating animals (zooplankton – magnified in **(8)**. Some small plant cells (zooxanthellae) live in the tissues of giant clams **(9)** and corals **(10)**. Some animals, including the giant clam, actively pump sea water through their shells to filter out phytoplankton for food. Zooplankton are consumed by small carnivores such as sardines **(11)** and corals. Fish, including emperors **(12)**, eat a wide range of smaller fish, and are themselves hunted by larger animals such as sharks **(13)**.

Each living thing is part of a food web in which material or energy accumulated at each step by plants or animals as biomass (weight of living material) is transferred as food to the next level. Hence, reducing the numbers of one marine species by overfishing or by destroying its habitat may affect many other species. Because ecosystems are connected through food webs and migration, human activities that badly affect one ecosystem may affect other types of ecosystems, even those some distance away.

Resource species

In spite of the large diversity of marine species, most exploited species of animals are contained in one of four large scientific groups – three invertebrate groups (animals without backbones) and one vertebrate group (animals with backbones). Species are included in a particular group on the basis of having similar characteristics and larval stages, as well as having what is believed to be a common ancestor, perhaps many millions of years ago.

The following sub-sections briefly describe some members of these groups – the ones that are important in fisheries of Pacific Islands. Seaweeds (marine algae) are included because of their use as food in many islands, and their importance at the base of the food webs described in the previous section. A technical review of the biology and fisheries aspects of many inshore resource species of the South Pacific is given in Wright and Hill, 1991. Details of general biology and fisheries are given in King, 1995. A review of fisheries of Pacific Islands is given in Dalzell et al., 1996.

Echinoderms – sea stars, sea cucumbers and sea urchins

Echinoderms, including sea cucumbers and sea urchins (Figure 2.5), have a covering, or external skeleton, of hard plates. In sea cucumbers, however, these plates are reduced to small spikes embedded in the thick body wall. At least seven different species of sea cucumbers are used as food in the South Pacific; some species are boiled, smoked and dried for export as beche-de-mer to Southeast Asia. Sea urchins are collected as food from shallow-water lagoons and reefs, and the star-shaped reproductive organs are regarded as delicacies in many countries of the world.

Molluscs – clams, sea snails and octopuses

Molluscs number more than 80 000 different species and include creatures as different as the giant clam and the octopus. Although most molluscs are encased in one or two shells, others have no shell at all. The three different classes of molluscs of commercial importance are the bivalves (such as clams), the gastropods (including trochus shells) and cephalopods (such as octopuses and squids).

Bivalve molluscs (clams, cockles and pipis) have two shells. Most obtain food by filtering phytoplankton from the surrounding water. Many species of bivalve molluscs (such as cockles and pipis) live under the sand, and pump seawater through two tubes, or siphons, which stick up through the sand. These are collected in village communities, particularly by women, and are an important source of seafood when the weather is too rough to fish in the open sea. The world's largest bivalves, giant clams, live in clear, shallow water on coral reefs. Giant clams have been overexploited in many islands, and some species have become locally extinct in Micronesia and Melanesia. In South-east Asia the dried muscles of giant clams are regarded as a delicacy. Pearl-oysters, which may form pearls around grains of sand or other material which irritates their soft tissues, are grown commercially in some Pacific Islands.

Most gastropods (sea snails) have a single shell for protection, although some, such as sea hares (sea slugs), have no shell. Several different species, such as the green snail, are collected

from rocky shores or reefs for use as food. Gastropods have remarkable, file-like teeth, called radula. With the radula, some species scrape plant material from rocks, while other carnivorous species bore through the shells of bivalve molluscs. Trochus shells, which have pearly inner-linings, are collected and used in the manufacture of buttons. Figure 2.6 shows two trochus shells, one of which has been drilled to remove the circular pieces of shell used to make the buttons. The sea hare, which grazes on algae and is collected for food, has a shell which is reduced to an internal horny plate.

Because of their attractive shells, many different bivalves and gastropods are collected, mainly by women, for making handicrafts such as necklaces. Selling handicrafts contributes substantially to the incomes of many coastal communities.

The octopus, which is used as food in many islands, usually lives in holes on the coral reef and comes out at night to hunt. Other cephalopods include the squid, cuttlefish and nautilus. The nautilus, the shell of which is sometimes found washed up on reefs, lives in deep waters of the Indo-Pacific.

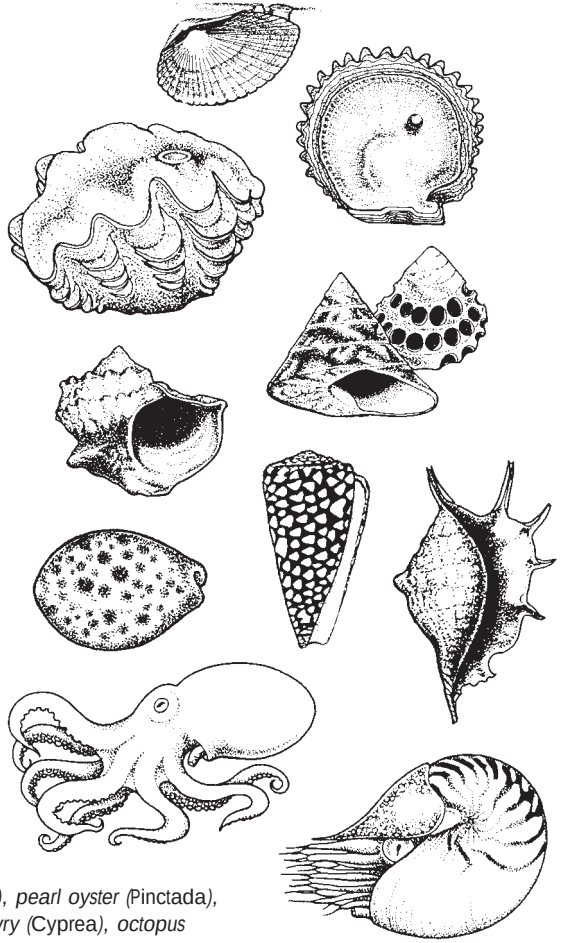

Figure 2.6: *Examples of molluscs in Pacific Islands. From the top these are the ark shell (*Anadara*), pearl oyster (*Pinctada*), giant clam (*Tridacna*), trochus (*Trochus*), green snail (*Turbo*), cone (*Conus*), spider shell (*Lambis*), cowry (*Cyprea*), octopus (*Octopus*) and chambered nautilus (*Nautilus*). Local names should be added by the reader.*

Crustaceans – lobsters, crabs and prawns

Over 30 000 marine animals including prawns, shrimps, lobsters and crabs, together with such animals as barnacles, are crustaceans. Crustaceans typically have a body covered with a hard shell (or exoskeleton) and jointed legs. In order to grow in size, the animal must cast off (or moult) its hard exoskeleton and expand before a newly-formed shell hardens.

Spiny lobsters generally live on coral reefs and outer reef slopes, and are usually caught by divers using spears. After reproduction, the female spiny lobster carries fertilised eggs underneath her abdomen or "tail". The eggs hatch to small larvae which drift with ocean currents before settling on reefs to grow to adults. Related to spiny lobsters are the slipper lobsters, which are usually speared on sandy seafloors.

One of the larger inshore species of crab is the mud crab, which spends the early part of its life-cycle in estuaries and mangrove areas. Many other smaller crabs are caught on rocky shore lines. Like lobsters, female crabs carry eggs beneath their abdomens. The mud crab, for example, carries her eggs out to sea, where they hatch into larvae which drift back to inshore areas. The coconut, or robber crab, is one of the largest of all crabs and spends most of its life on land; its large size (up to 30 cm across the shell) prevents it from living in an empty gastropod shell like other hermit crabs.

Prawns, such as tiger prawns and king prawns, are found in some western Pacific countries, and are the basis of commercial fisheries in Papua New Guinea. Most prawns require areas of brackish water for the juveniles to grow in, and are therefore not found in coral atolls or low islands with insufficient rainfall.

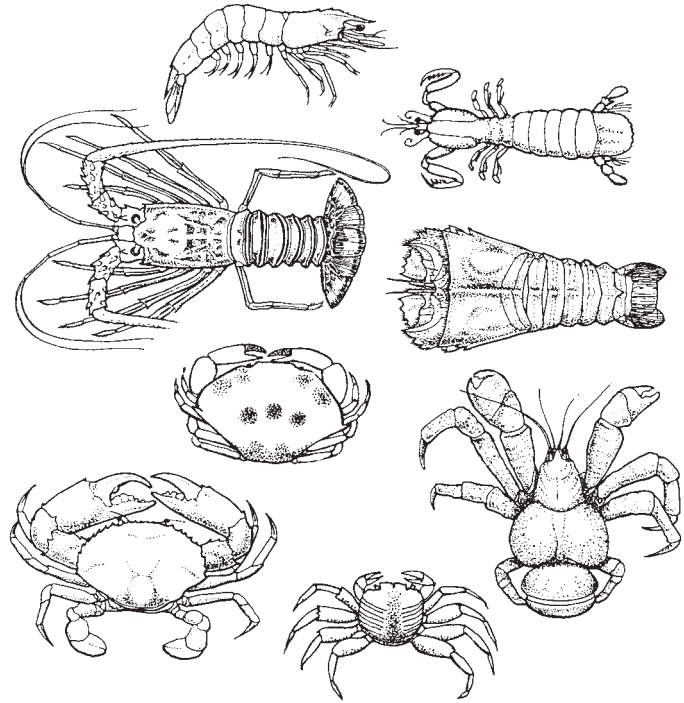

Figure 2.7: *Crustaceans of Pacific Islands. From the top, examples include the tiger prawn (*Penaeus*), mantis shrimp (*Squilla*), spiny lobster (*Panulirus*), slipper lobster (*Parribaccus*), three-spot reef crab (*Carpilius*), coconut crab (*Birgus latro*), mud crab (*Scylla*), and the shore crab (*Grapsus*). Local names of species should be added by the reader.*

Fish

Of all the groups of animals with backbones (vertebrates), fish are the most numerous. There are over 25 000 different species of fish distributed in environments from high mountain pools to the deepest parts of the ocean. In most species of fish, the female releases eggs into the sea before they are fertilised by sperm from males. The fertilised eggs hatch to small larvae which are often planktonic and drift with ocean currents. After a period which varies from species to species, the larvae change to adults which are either demersal (living near the sea floor) or pelagic (living near the sea surface).

Sheltered, inshore areas, particularly estuaries, are rich in food material and are able to support a wide variety of fish species. Some species of fish, including garfish, stay in inshore areas throughout their life-cycle. Other species use sheltered inshore waters only during part of their life-cycle, often as nursery areas in which the young grow up. Examples of common inshore fish are shown in Figure 2.8.

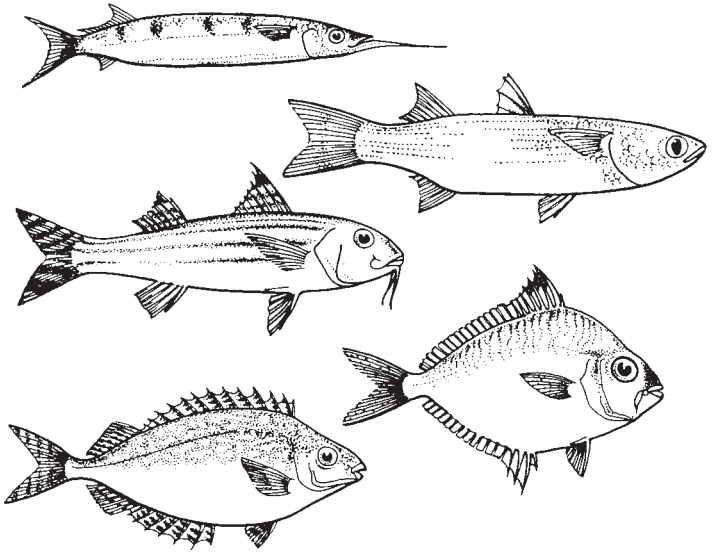

Figure 2.8: *Fish families from sheltered inshore areas of tropical Pacific Islands. From the top, examples include garfish (Hemirhamphidae), mullet (Mugilidae), goatfish (Mullidae), ponyfish (Leiognathidae), and rabbitfish (Siganidae). From King, 1995. Local names should be added by the reader.*

A coral reef ecosystem contains more species of fish than most other environments. Larger fish include the many different species of emperors, groupers and snappers. Smaller species commonly used as food include surgeonfish, parrotfish, wrasse, triggerfish and eels (Figure 2.9). Generally, coral reef fishes have adults which live within a small home range on the reef. They reproduce repeatedly over a lifespan of less than ten years to produce pelagic larvae. Many coral reef fish, particularly trevallies, groupers, and surgeonfish, produce larvae which drift far out in the ocean before returning and settling on coral reefs as adults. The species with longest larval phases, have the greatest potential for dispersal, and are widely distributed on isolated reefs across the Pacific.

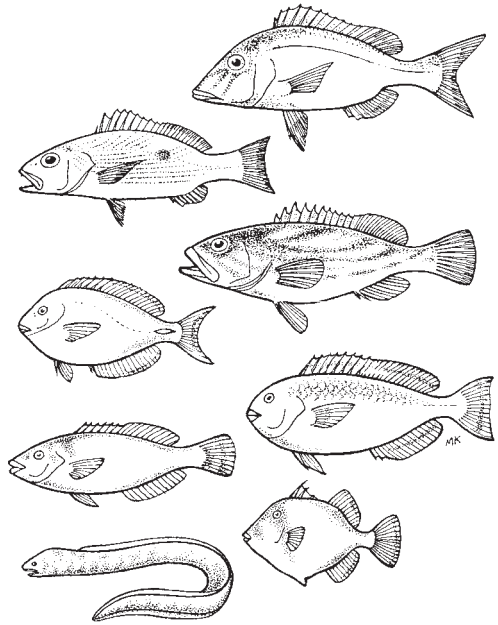

Figure 2.9: *Coral reef fish families of Pacific Islands. From the top, examples include emperor (Lethrinidae), snapper (Lutjanidae), grouper (Serranidae), surgeonfish (Acanthuridae), parrotfish (Scaridae), wrasse (Labridae), triggerfish (Balistidae) and moray eels (Muraenidae). Local names should be added by the reader.*

Beyond the coral reefs, many demersal species are caught on the shallow outer reef slopes. Deep water snappers are caught by hook and line in depths of about 200 m on the steep slopes of islands and seamounts (Figure 2.10). These large deep-water snappers are particularly valuable in tropical areas, as their distance from coral reef ecosystems means that they are unlikely to be affected by ciguatera, the toxic condition that seasonally affects some reef fish in shallower water.

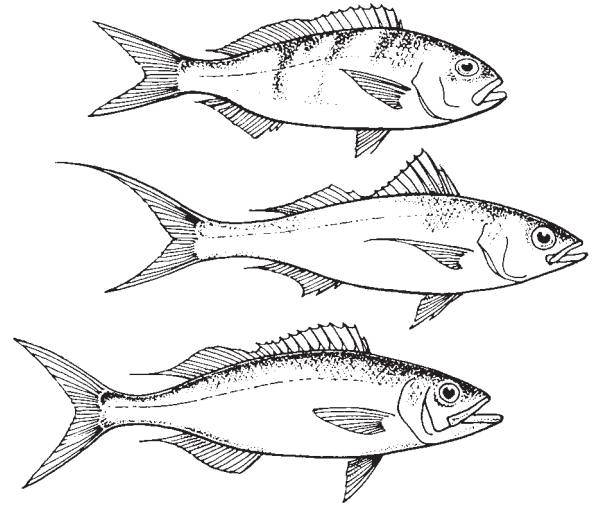

Figure 2.10: *Larger fish of the deeper outer reef slopes. From the top, examples include the oblique-banded snapper (*Pristipomoides zonatus*), the long-tailed snapper (*Etelis coruscans*), and the rusty jobfish (*Aphareus rutilans*). From King, 1995. Local names should be added by the reader.*

Inshore pelagic fish include the jacks or trevallies as well as the smaller horse-mackerels or scads, which form hunting schools on many reefs. In the western Pacific, the Indian mackerel is commonly netted in lagoons, and the Spanish mackerel is trolled off reefs. Barracudas are more widely distributed, and are voracious predators in the vicinity of coral reefs (Figure 2.11).

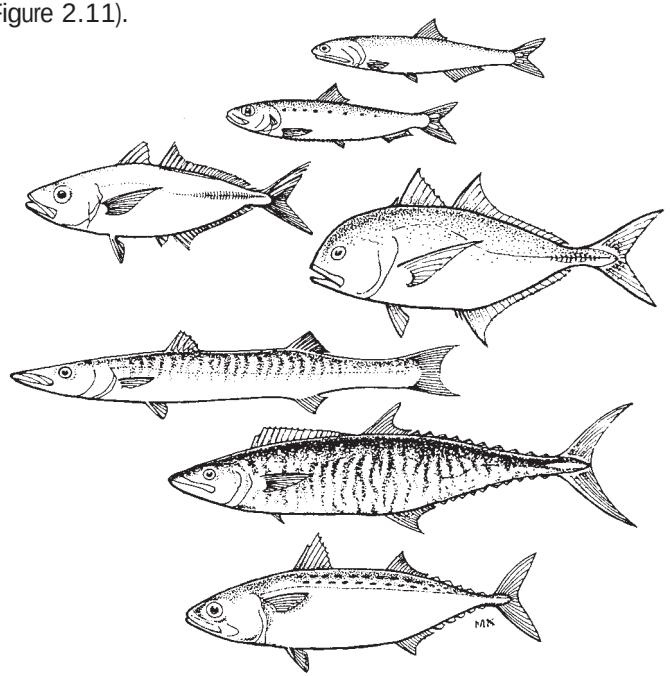

Figure 2.11: *Inshore pelagic fish in Pacific Islands include, from the top, anchovies (Engraulidae), sprats, sardines and herrings (Clupeidae), scads (*Selar, Decapterus*), trevally (*Caranx*), barracuda (*Sphyraena*), Spanish mackerel (*Scomberomorus commerson*), and Indian mackerel (*Rastrelliger kanagurta*). Local names should be added by the reader.*

Further from the coast, in the open sea, the best known pelagic fish are the dolphinfish (dorado or mahi-mahi) and several species of tuna (Figure 2.12). Tunas are fast-swimming pelagic fish related to marlins and sailfish, and are distributed over large areas of the ocean. Tuna are caught by local fishers in many Pacific Islands, often by trolling lures behind small boats. Commercial vessels use longlines and purse-seine nets to catch albacore, big-eye and yellowfin tuna. Approximately 35% of the world catch of tuna is caught in the Pacific Ocean. Some species of tuna, including albacore, move across large areas of the ocean, either to reach new feeding grounds or to reach spawning areas, whereas some species, such as skipjack tuna, may stay in one area for their whole lifespan.

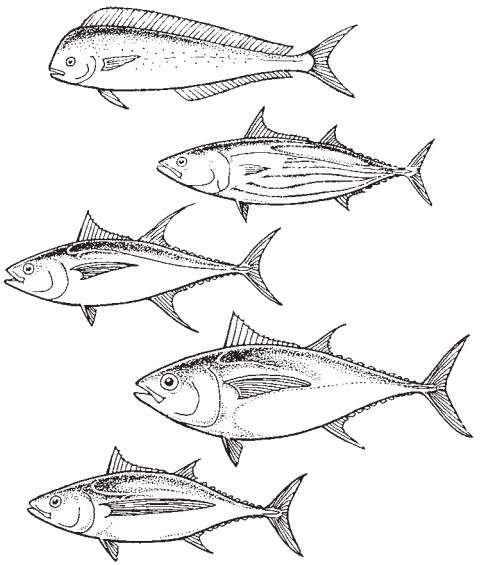

Figure 2.12: *Offshore pelagic fish of Pacific Islands include, from the top, the dorado or mahi-mahi (*Coryphaena*) and tuna such as skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), big-eye (*Thunnus obesus*) and albacore (*Thunnus alalunga*). Local names should be added by the reader.*

Marine algae (seaweed)

Larger seaweeds are grouped, according to their dominant pigment, into either green, red or brown algae. In tropical areas, there are fewer and less striking species of marine algae than there are in cooler waters. However, algae form the basis of many tropical food webs, and, through the remarkable capacity of some species to retain calcium (become calcified), contribute to the coral reef mass. Although seaweeds are an important part of shallow-water marine ecosystems only a few species are commonly eaten in Pacific Islands.

Green algae include the common reef species *Halimeda* with its branched chains of flat segments which are often calcified and therefore greyish in appearance. Green sea grapes, *Caulerpa racemosa*, are commonly collected for food from reef tops at low tide, mostly by women. Examples of red algae include the edible seaweed *Gracilaria* and the fleshy seaweed *Eucheuma*. The latter is farmed on floating ropes before being harvested, dried and processed to extract carrageenan and agar for use as food additives.

Brown seaweeds include funnel weed, *Padina*, which grows on dead coral, and the floating brown seaweed, *Sargassum*, which is one of the largest tropical algal species. One of the few edible brown seaweeds is the spiny top, *Turbinaria*, which can be boiled and eaten.

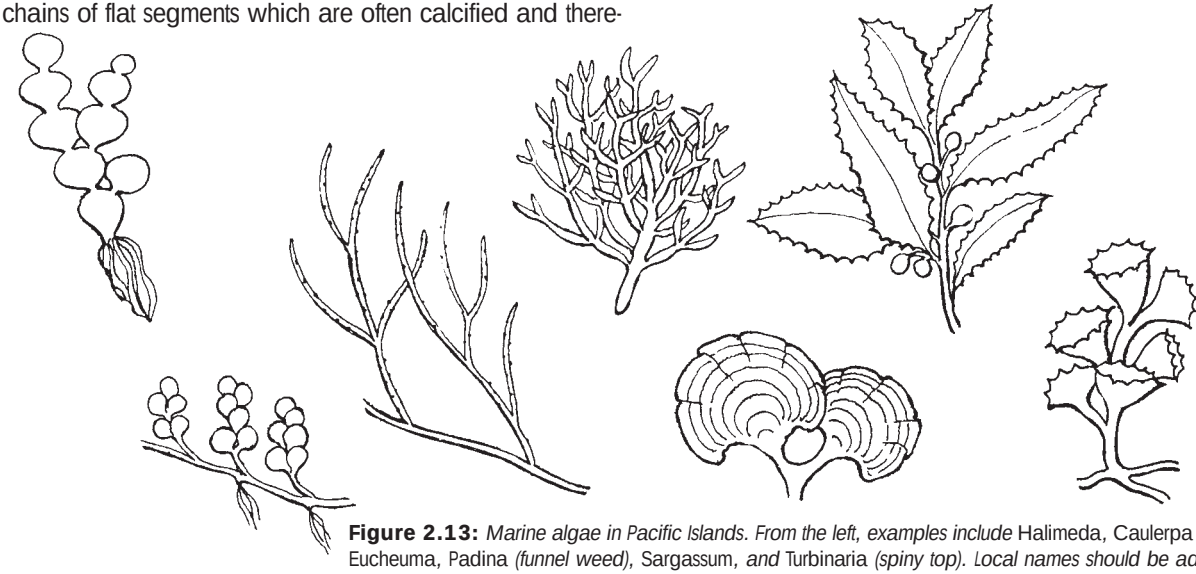

Figure 2.13: *Marine algae in Pacific Islands. From the left, examples include* Halimeda, Caulerpa *(seagrapes),* Gracilaria, Eucheuma, Padina *(funnel weed),* Sargassum, *and* Turbinaria *(spiny top). Local names should be added by the reader.*

Fishing gear and methods

Fishing gear and methods used depend on the species fished. Fishing techniques in the Pacific vary from very simple, such as the hand collection, or gleaning, of shore-line invertebrates, to complex and expensive commercial operations such as purse seining for tuna. The roles of men and women in using different fishing methods and gear is largely dictated by whether they require a boat or canoe, and whether they involve the fisher being away for extended periods. Fishing methods which can be used from the shore, on the reef or within the lagoon and close to the village are usually practised by women. For example, women are often involved in hand-line fishing from the edge of the reef, netting in the lagoon and gathering invertebrates from inshore areas. Although it is becoming more common in some areas for women to accompany men on boat trips, fishing with boats is traditionally a male activity.

A large range of fishing gear is used by commercial and artisanal fishers, and some basic types relevant to subsistence fishing in the Pacific are described in this section.

Reef gleaning

The collection of marine animals and seaweed in lagoons or on the reef flat at low tide is a common activity usually practised by women and children. A variety of species is collected in this way, including sea cucumbers, sea urchins, crabs, shellfish, seaweed, eels, small fish, worms, jellyfish and octopus. Collection can be done by hand, by digging in the sand or mud with the feet for bivalves, by overturning or breaking corals and rocks, and by using sticks and metal hooks to draw octopus, crabs or fish from holes in the reef. Although the volume of food collected by one person in this manner may be quite small, the impact on the reef and marine life can be substantial.

Traps

Traps are devices designed to encourage the entry of particular animals, which are then prevented from escaping either by particular aspects of their behaviour, or by the design of the trap itself.

Portable traps are regularly used in Micronesia and parts of French Polynesia, although in the past, cane, bamboo and mangrove wood traps were used throughout the South Pacific. Portable traps may be either baited or unbaited. The principle of baited traps is that animals, attracted to the bait, enter the trap through tapered openings from which it is difficult to escape. Baited traps or pots are used to catch various carnivorous species of crustaceans, molluscs and fish. Only two species of lobster, *Panulirus penicillatus* and *P. longipes*, will enter traps. Traditional traps made of wicker or cane and baited with sea urchins or chitons have been used to catch lobsters in Samoa, Vanuatu and Tonga, but at present, most are caught by spear or hand.

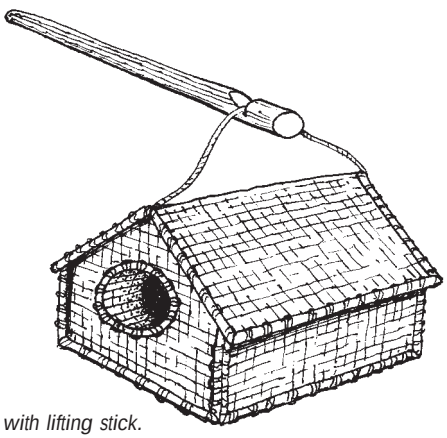

Figure 2.14: *Kiribati eel trap with lifting stick.*

Barrier and fence traps represent perhaps one of the oldest ways of communal fishing. The simplest traditional traps use the ebbing tide to strand fish in hollowed-out areas on reefs and sandbanks, and are contained by v-shaped or semi-circular walls of stone or coral. Fence traps include a wall built at right-angles from shore-lines and reefs to guide migrating coastal fish such as mullet into a large retaining area. Fish that have been feeding on the reef flat will follow the receding tide into deeper water. When they encounter the fence they will swim along it until they reach the retaining area. Fish may be either isolated in the retaining area by the retreating tide, or prevented from escaping by a complicated design or maze. Men, women and children may be involved in collecting the fish from the trap by spear, hand or net. Designs are often traditional, and vary between regions. Although originally made from stone or coral blocks, such traps are now usually made from modern materials such as wire-mesh netting (Figure 2.15). Traps may be owned by a single family or by a whole community. Their ease of construction, and their use by increasing populations, have resulted in authorities limiting the number of fence traps in some areas.

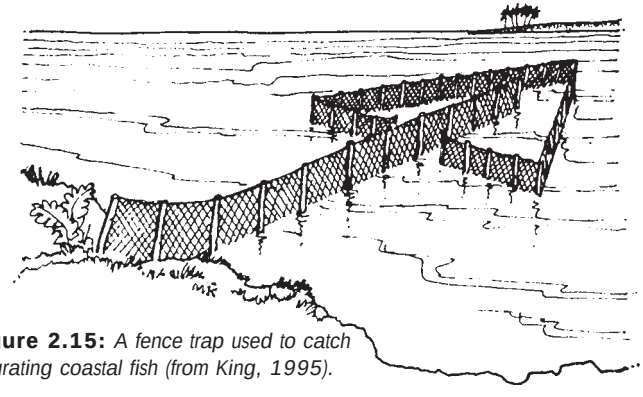

Figure 2.15: *A fence trap used to catch migrating coastal fish (from King, 1995).*

Hooks and lines

Hook and line gear is used in a wide range of configurations, the simplest being hand-held lines with one or more baited hooks. The most familiar type of manufactured steel hook is J-shaped, with the pointed part of the hook more or less parallel to the shank (Figure 2.16). In many commercial fisheries, however, the hooks are more circular in shape. Circle hooks are similar in design to the bone or shell hooks which have been used since prehistoric times in Pacific Islands. When a fish strikes a circle hook, the point rotates around the jawbone, ensuring that the fish remains caught without the fisher having to maintain pressure on the line. Steel circle hooks are now used to catch tuna, sharks and deepwater snappers.

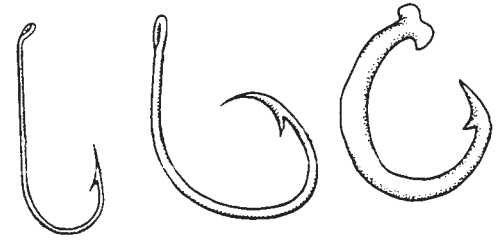

Figure 2.16: *Fish hooks, including, from left, a common J-shaped hook, a modern circle hook, and a Pacific Island traditional bone hook (from King, 1995).*

Handlining gear consists simply of one or more baited hooks attached to a line, which is weighted at the bottom in the case of demersal target species. If more than one hook is used, these are connected to the main fishing line by short side-lines or snoods. Handline fishing in shallow coastal waters is a popular subsistence and recreational fishing method and is commonly practised by women and children. When handlines (or droplines) are used to catch demersal fish in deep water, mechanical means may be used to haul in the line. Small artisanal vessels catch deepwater snappers beyond coral reefs using simple wooden hand reels to retrieve lines from depths of about 200m (Figure 2.17).

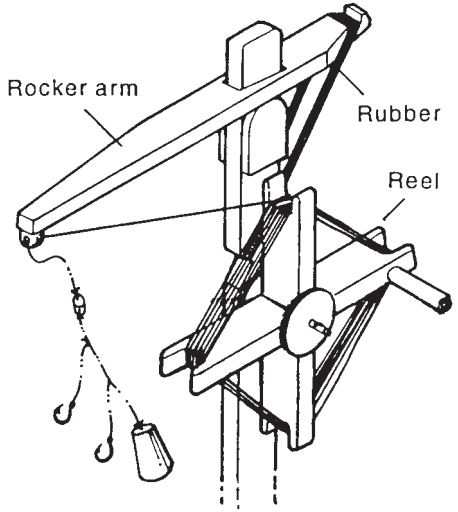

Figure 2.17: *A FAO-sponsored, Samoan hand-reel used to retrieve droplines set to catch deepwater snappers in depths of about 200m (from King, 1995).*

Longlines

A longline consists of a mainline with hooks set on short side-lines or snoods. A horizontal longline may be set near the surface for pelagic fish such as tuna (Figure 2.18), or on the sea-floor for demersal species such as sharks. A vertical longline, with hooks set from snoods along its lower section, can be set perpendicularly in the water column in areas where the sea floor is steep or rugged. Horizontal longlines set by fishermen in the Samoan tuna fishery are generally 8 to 40 km in length. This rapidly expanding commercial fishery targets albacore, yellowfin and bigeye tuna.

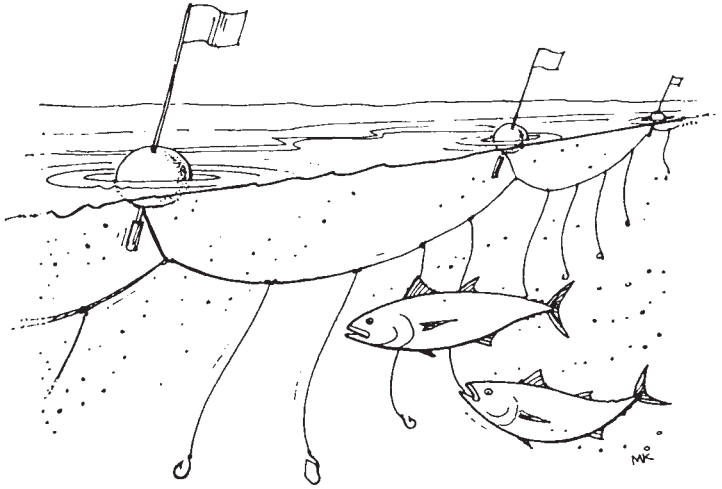

Figure 2.18: *A tuna longline (from King, 1995).*

Trolling and lures

Natural or artificial lures attached to lines may be towed (or trolled) behind boats to catch pelagic species, such as spanish mackerel, dolphinfish and tuna. In general, lures are designed to attract fish by having one or more of the following characteristics – an erratic movement when towed through the water (to resemble an injured prey), a bright or reflective surface, and fluttering appendages of feather, plastic, rubber or cloth. Instead of artificial lures, small, silver fish such as garfish and flying fish, or pieces of larger fish, may be threaded onto one or a series of hooks (Figure 2.19). Details of trolling rigs are given in Preston et al., 1987.

Tuna may be caught commercially by pole-and-lining, involving the use of barbless, unbaited wire hooks, or pearl-shell lures with a barbless hook, on short lines attached to poles. The tuna are often encouraged to strike the bright metal hooks by "chumming" the water with live baitfish to induce a feeding frenzy. Traditionally, pole-and-line fishing was an important communal fishery using live bait and mother-of-pearl lures to catch skipjack tuna. The fishery in French Polynesia is now a highly developed and competitive local industry, supplying fresh tuna to the local markets.

Squid are also caught commercially on barbless lures, or jigs (Figure 2.19) attached either to handlines, or to automatic jigging machines. The machine automatically lowers the line to a set depth, and an elliptical drum retrieves the line with a jerking or jigging movement. During night fishing, bright lights are used to attract squid into the fishing area.

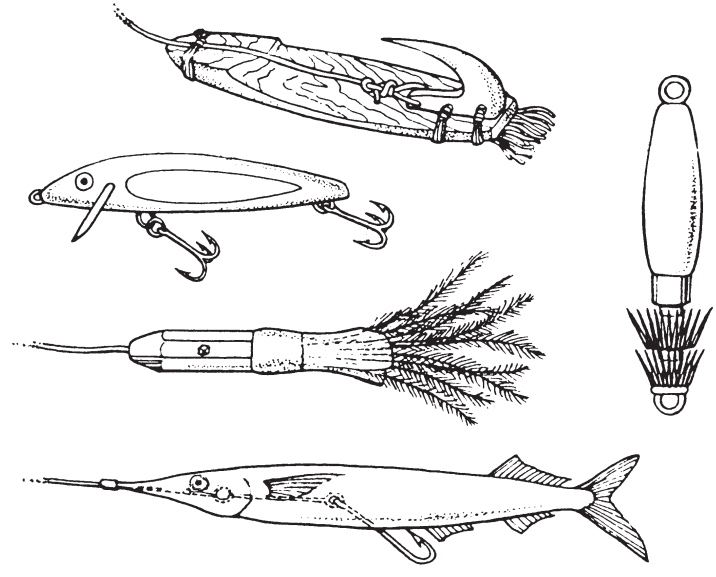

Figure 2.19: *Fish lures including (from top left down) a traditional pearl-shell lure from Kiribati, a manufactured "hard" fish lure, a manufactured "soft" fish lure, and a lure baited with a garfish. A squid jig is shown on the right (from King, 1995).*

Gill nets, tangle nets and barrier nets

Gill nets are panels of netting held vertically in the water column by a series of floats attached to their upper edge (the floatline, or corkline), and weights attached to their lower edge (the footrope, or leadline). These nets may be either anchored in shallow water, or set to drift in the open ocean. As passive gear, their catching ability relies on the movement or migration of fish through the area where the nets are set. Gill nets (Figure 2.20) are used in shallow water to catch species such as mullet and mackerel. In deeper water they may be set on the seafloor for demersal species such as sharks, or near the surface for pelagic fish such as tuna. The nets are often made from almost invisible monofilament nylon strands, which lock behind the gill covers of bony fish or the gill slits of sharks.

The main advantage of gillnets is that they are highly selective; that is they usually have a mesh size designed to catch fish of a specific size range, and very small and very large fish are not caught. The main determinant of the range of lengths of fish caught by gill nets is the hanging ratio, which is defined as the ratio of the length of the headline to the length of the stretched net. If the hanging ratio is low, say less than 0.5, the net will hang slack in the water rather than taut. In this case the net becomes less selective, as it will entangle fish as well as gill them. Some nets, referred to as tangle nets, are deliberately made this way.

Barrier nets can be set across reef passages and channels to trap fish as they try to return to deeper water on a falling tide. Often the barrier net is set in a V-shape with the point of the V lying in deeper water than the mouth of the V. As the tide falls the fish move towards the deeper water of the point. Eventually the mouth of the V is in very shallow water or on the dry reef flat and the fish are trapped in the point of the V.

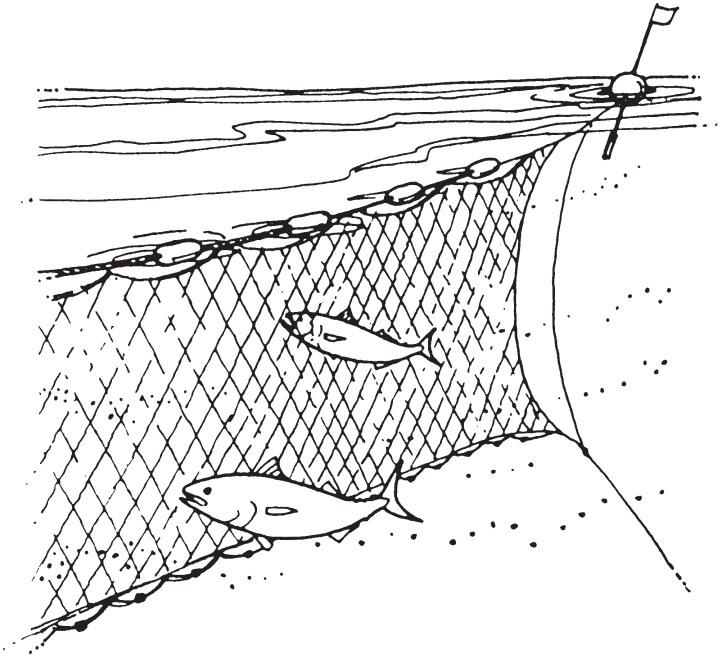

Figure 2.20: *A gill net (from King, 1995).*

Seine nets and drive-in netting

A beach seine in its simplest configuration consists of a long panel of netting which is dragged around shore-line schools of fish. The net is weighted to keep the lower side of the panel in contact with the sea-floor, and has floats to keep its upper side at the sea's surface. Some beach seines have a central panel of loose netting which forms a bunt or codend to retain fish. Ways of employing beach seines vary, although in many cases, one end of the net is anchored on the shore, and a boat is used to drag the other end seawards in a large arc and back to the shore before hauling.

Drive-in net fishing is a group activity that often involves the whole community. Nets are set in a shallow part of the water on a reef plateau or lagoon and fish are driven into the net by swimmers and scare lines. Fish may be herded with coconut leaves tied to a rope or scared by splashing the water surface with sticks and throwing rocks. The fish may then be concentrated in one part of the net for hauling, or are speared by swimmers. Fish may also be herded and scared without nets; fish are driven into an area where they can be easily speared, or they may be herded into a large trap or woven basket.

Cast nets and scoop nets

Cast nets are used in shallow water by men and women to catch schooling species such as mullet, rabbitfishes and scad. Fish are stalked in shallow water and a circular, weighted net is thrown so it spreads horizontally over the school like a parachute, entangling the fish in the net.

Flying-fish are caught in Polynesia by fishermen at night, using hand-held scoop nets and lanterns or torches. Flying-fish are located using canoes or dinghies and caught in the scoop nets while lying on the surface, dazed from the light.

Spears

Spears are used by men, women and children in a variety of ways, from both above and below the water. The spear may be used from land or a boat, or by diving beneath the water with sling-type spears and spear guns. Men and women often use torches and spears at night to catch fish at low tide. The use of modern, underwater flashlights has had a large impact on inshore marine life. Larger fish from the reef edge come in at night to sleep among the corals for protection from predators, making them an easy target for fishers with a flashlight and spear. Masks, fins, SCUBA gear, steel spears and spear guns have also increased the effectiveness of spearfishing.

Fish aggregating devices (FADs)

Many species of fish that inhabit the open sea are attracted to floating objects; some tunas, for example, congregate around drifting logs. This behaviour has been used in the deployment of fish aggregating devices (FADs), floating rafts anchored offshore to attract pelagic fish (Figure 2.21). A range of materials, including coconut logs, bamboo, and aluminium pontoons have been used in the construction of rafts. Material such as old fish nets, palm leaves, and car tyres are suspended beneath the rafts in the belief that this increases the raft's effectiveness as a habitat for fish.

The benefits of FADs are that they reduce the search time involved in a fishing trip, and therefore reduce fuel costs, as well as increase fish catches. However the costs of building and setting FADs are high, and, because of storms, wear and vandalism, their average life span is less than two years. Data on any increase in fish production where FADs have been deployed are generally not available.

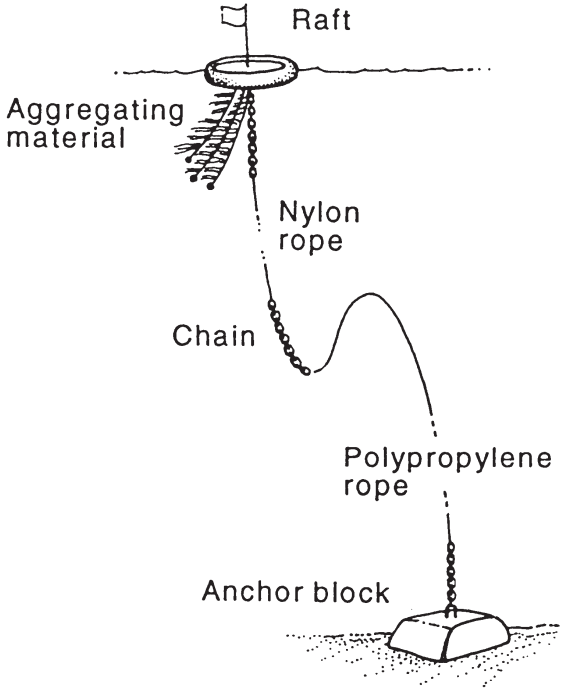

Figure 2.21: *A Fish Aggregating Device or FAD (from King, 1995).*

Processing and marketing of seafood

Processing of seafood in the Pacific ranges from simple primary processing (gilling and gutting, scaling, filleting) to secondary processing such as salting, drying or smoking of fish. Marketing may involve selling from a central market, small shops, from the side of the road or from the home.

In many parts of the Pacific men go fishing with boats and bring the fish back for the women to share or sell. Often no processing is involved from capture to sale. Women will also market their own inshore catch, and bottles of sea cucumbers, piles of shellfish and banana-leaf packages of seaweed are a common sight in many markets. Most Pacific people prefer fresh, whole fish and this is the most common way fish are sold. Small fish are often threaded onto a length of twine and sold by women or children at the side of the road. In other areas, handcarts with small ice chests may be used to sell the catch. The use of ice to keep the fish fresh before selling is still uncommon for fish intended for the local market. In many cases the quality, shelf life and subsequent value of the catch could be improved by some simple handling and storage methods.

Many markets lack facilities such as easy-to-clean display shelves, ice, cold storage facilities or, in some cases, even running water for cleaning the selling and display areas. Interest in seafood handling and processing is often high in fishing communities wanting to start or improve a small business. Many communities simply want to learn more about handling fish for family use. Many of the people catching, marketing and buying seafood are not fully aware of the effects of temperature control and hygiene in preventing poor quality or spoiled fish.

Learning new preservation techniques is of particular concern to isolated communities with limited refrigeration facilities. Workshops on seafood handling and processing, with some small business training, are good ways for government and non-government agencies to establish positive links and give technical assistance to fishing communities. However, it is important that training is directed at the right people. For example, if women are involved in fishing, processing or marketing, they must be included in any training programme. If training is given for correct seafood handling at sea, then it should be directed at boat crews and skippers, not just boat owners.

Seafood quality and handling

In most cases "quality" refers to the freshness of seafood. Quality is important for a successful seafood selling business – customers will return if they think the quality of the seafood is good. To seafood buyers, quality is important for reasons of taste (bad quality means bad taste), health (poor quality may mean loss of nutritive value and food poisoning) and value for money. Quality is also just as important to the subsistence fisher providing food for the family or community. Quality is judged on sight, touch, smell and taste. The longer a fish has been kept, the more likely it is to be of lower quality and "off" or spoiled. The way a fish has been treated after capture will also have an effect on quality and the rapidity of spoilage.

In the following discussion, the term “fish” is used to include all types of marine animals caught for food, including fish, shellfish, crabs, lobster, sea cucumbers, and eels. In all of these, quality will decrease due to incorrect handling and subsequent spoilage. Spoilage is brought about by three destructive processes:

- enzyme activity (proteins in the fish attack the flesh),
- bacterial action (bacteria feed and multiply on the flesh), and,
- oxidation (the fat or oil in the flesh becomes stale or rancid on contact with the air).

To minimise fish spoilage and maintain quality there are some simple things that should be controlled between the time the fish is caught and when it is eaten.

Quick recovery of the fish after capture reduces stress and struggling before death. This results in a slower onset of rigor mortis and minimal quality loss. Rigor mortis is when the body goes rigid sometime after death. If the onset of rigor is slow and gentle, loss of quality is minimal. If rigor commences rapidly and violently, quality loss can be severe. Muscles in the flesh contract during fast rigor, causing the flesh to fall apart, or gape. This makes the fish unattractive and difficult to cook.

Any bruises or cuts spoil appearance and reduce the amount of edible fish as well as hasten spoilage. The bacteria that cause spoilage are already present in the seafood (on the skin, in the gills and in the intestines) and will easily enter the flesh if the fish has been damaged. The boat or area where the fish is landed should be kept clean. Fish should be handled with care; for example, fish should be gaffed only in the head, and not thrown, kicked or stacked with too many on top of each other.

Bleeding the fish avoids blood clots and darkening of the flesh. Correct gutting minimises bacterial and enzymatic spoilage. The gut contains bacteria and enzymes,

and correct gutting removes and isolates a large proportion of these. However, cutting and opening the usually sterile flesh, exposes it to direct bacterial attack. There is also an additional risk from contaminated knives and dirty work areas. But if working conditions are of a high standard, gutting can be beneficial. Guts should be removed completely and cleanly, unless whole fish are required for the market. Most Pacific Island countries prefer to sell fish whole. Thus, although the fish contain bacteria-laden guts and gills which can accelerate spoilage, they have not been subjected to incorrect gutting and gilling.

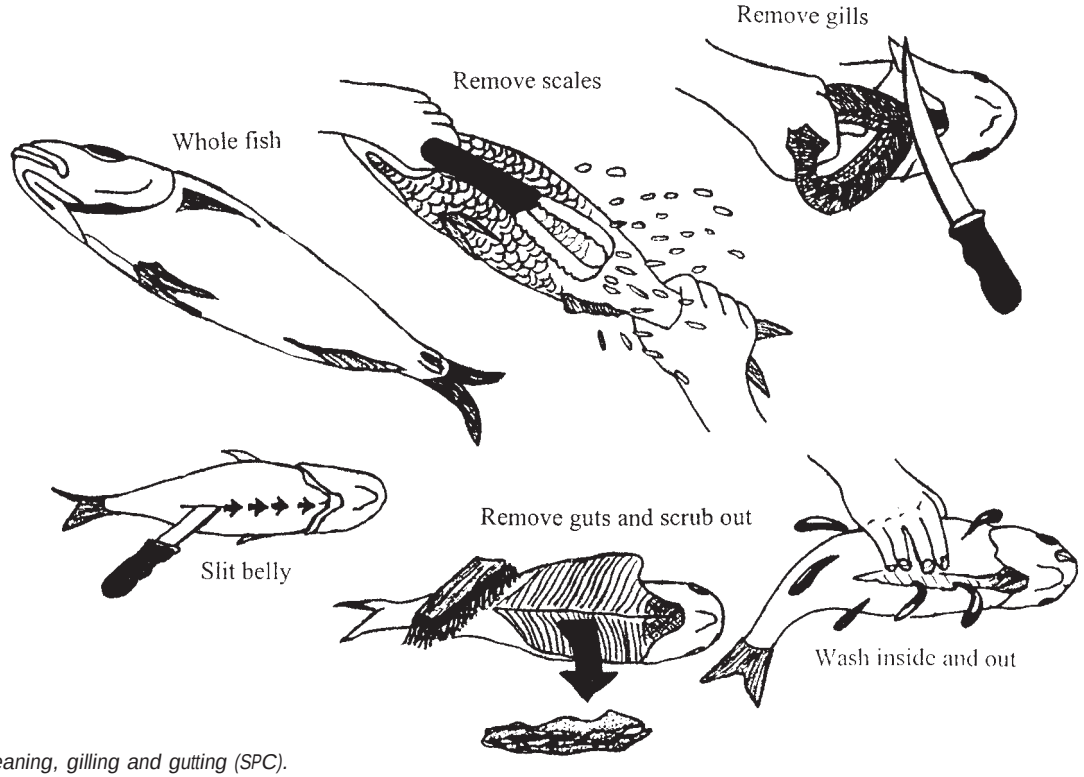

Figure 2.22: *Cleaning, gilling and gutting (SPC).*

Washing the fish or shellfish with clean water. Washing fish or shellfish with clean salt or fresh water prevents cross-contamination and lowers the rate of spoilage.

Low temperatures minimise bacterial spoilage and enzyme activity. Chilling lowers the rate of bacterial spoilage and helps achieve the slow and gentle onset of rigor. Cooling the fish as quickly as possible reduces deterioration and spoilage, reduces post-harvest losses, and produces a better quality end product. If no ice is available, all fish must be kept out of the sun and wind, and covered with a sack kept wet with seawater to keep the fish cool.

The use of ice is one of the most effective and cheapest ways to lower the temperature of fish to 0°C, the ideal temperature for storing fresh fish, especially where refrigeration and freezing facilities are not readily available. It minimises the activity of bacteria and enzymes, maintains quality and maximises shelf life (ie. the length of time a caught fish can be stored before becoming inedible). If the temperature is higher than 0° C, the shelf life is considerably reduced. For example, a fish that sits at room temperature for four hours before being chilled may already have lost four days of shelf life at 0° C.

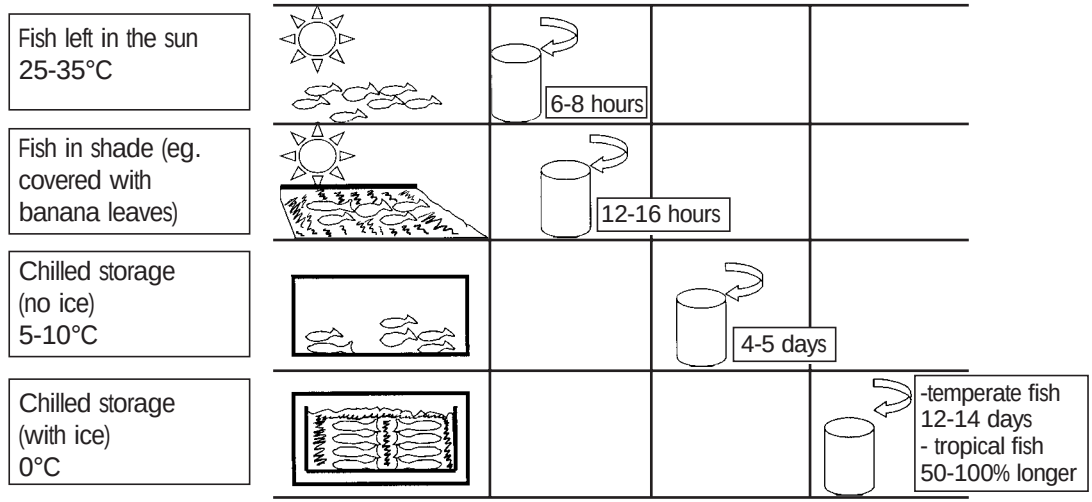

Figure 2.23: *The storage life of fresh fish (SPC).*

Ice works best if it is allowed to melt slowly and is continuously replaced when necessary. The "melt water" also improves contact of the chilling medium with the fish, keeps fish moist and removes blood and slime. The use of fish bins is the most common method of storing fish in ice by local fishers. Fish bins should have drainage holes and a smooth, hygienic and easily cleaned inner surface. *Coolers* or *eskies* (insulated boxes) are often relatively cheap and readily available.

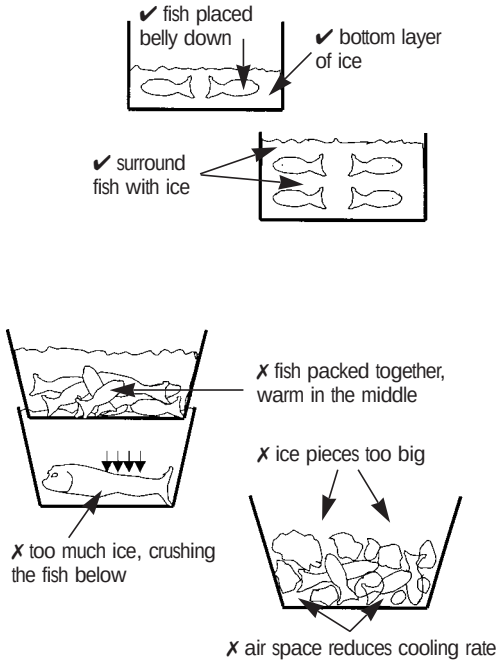

Figure 2.24: *Correct and incorrect methods of packing fish in ice (SPC).*

Hygiene. It is important that anyone handling fish works with a high level of cleanliness or "hygiene". Fishers at sea, people in the market and anyone involved in preparing and cooking fish must adopt good hygienic practices. On a personal level this includes clean hands and nails, and hair tied back. In relation to work areas and equipment, this includes a clean vessel deck, work bench, fish bins, and filleting knives.

Preservation of fish

One of the reasons fish and shellfish are processed is to preserve seafood for a longer time. Food quality and nutritional value can be maintained over a long period by preventing spoilage. Preservation, however, cannot improve a fish that is spoiled to start with.

Bacteria and enzymes survive well at ambient temperatures and in wet conditions (ambient temperature refers to the usual surrounding temperature which bacteria are accustomed to). As bacteria do not multiply well at low temperatures, chilling and freezing can be used to extend the shelf-life of fish. Also, bacteria and enzymes do not survive well in very high temperatures or in dry conditions. High temperatures will kill bacteria and destroy enzymes. Processes such as cooking, (e.g. boiling, frying, baking), hot smoking, canning, and pasteurising, extend the keeping time of food by creating conditions that destroy bacteria and enzymes.

The processes of salting and drying have been practised for centuries as an effective way to preserve meats. Salting inhibits bacterial and enzymatic spoilage due to its drying properties (dehydration) and because of the high salt concentration used in the processing.

Smoking has also been used to extend the storage life of seafood. The preservative effect of the smoking process results from the combined effects of salting, heating, smoking and drying. However, as the smoke penetrates the flesh slowly, the potential anti-bacterial effect of wood-smoke is confined to the surface of the fish. Certain parts and types of wood smoke also protect the fish against oxidation or rancidity. A smouldering fire will preserve flesh better than a hot, flaming fire due to the higher levels of smoke and anti-oxidative substances.

The keeping quality and storage life (how well the fish keeps and for how long) depends on the type of fish used, its initial quality, the actual smoking process and the use of other preservation and storage techniques after smoking. Fatty (oily) fish generally have a shorter storage life than lean (less fatty) fish. The quality of the smoked fish during and after storage is highly dependent on the quality of the fish before it is smoked. A fish that has started to spoil cannot be improved by any amount of salt or smoke. A fresh fish that is in good condition and has been handled well (kept on ice), will have a better taste and longer storage life after smoking than a fish that was of lower quality before smoking.

A simple effective smoker is easily made from an old 44-gallon drum (Figure 2.25). More complex smokers for semi-commercial and commercial operations can be built to smoke larger quantities of fish at one time.

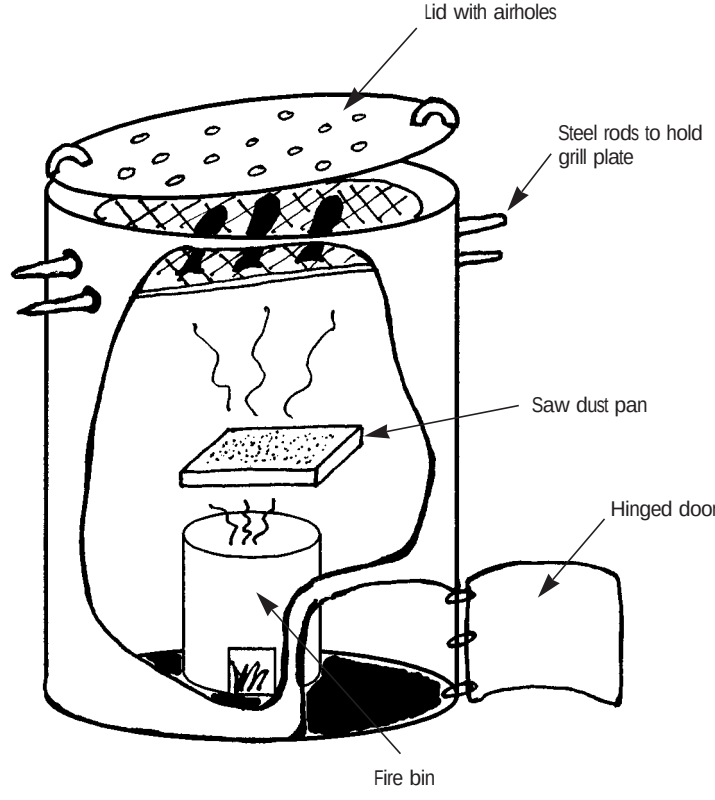

Figure 2.25: *A simple drum smoker (SPC).*

Fisheries management

A group of fish of the same type, or species, living in one area is referred to as a fish stock. A fish stock, and the forces acting on it and controlling its numbers, is shown in Figure 2.26. The number of fish is being increased by the reproduction of adult fish, which eventually results in small fish being added, or recruited, into the stock. In addition, the weight, or biomass, of the fish stock is increased by the growth of individuals – in the figure, three consecutive age groups, or different year classes, are shown. Concurrent with these increases, the stock is being reduced in numbers and biomass by natural mortality and, in exploited species, by fishing mortality as well. Fishing mortality refers to fish caught by fishers, and natural mortality refers to fish which die by other means, most commonly by predation (being eaten by another animal).

If a fish stock is unexploited or is fished at a low level, losses due to mortality are balanced, on the average, by gains through the recruitment of young fish or juveniles. The number of fish in the stock will therefore fluctuate around an average level as long as not too many fish are caught. It is for this reason that fish are referred to as a renewable resource. That is, fish can continue to be caught and used as food forever, as long as the numbers caught are replaced by more young fish being produced.

If exploitation is high, however, the number of adult fish may be reduced to a level where reproduction is unable to replace the numbers lost. In this case the numbers of fish in the stock will decrease. In severe cases of overfishing, the stock may even disappear altogether (become extinct). In Pacific Islands, many fish stocks have been overfished. Some species of giant clams are now extinct in Micronesia and one species has disappeared from Vanuatu, Fiji and Tonga since the 1970s. Stocks of mullet, which have been caught in large numbers in fence traps, are very low in some islands. The renewability of fisheries resources depends on our ability to ensure that not too many fish are caught. This implies that fisheries, and particularly the amount or types of fishing, have to be controlled or managed.

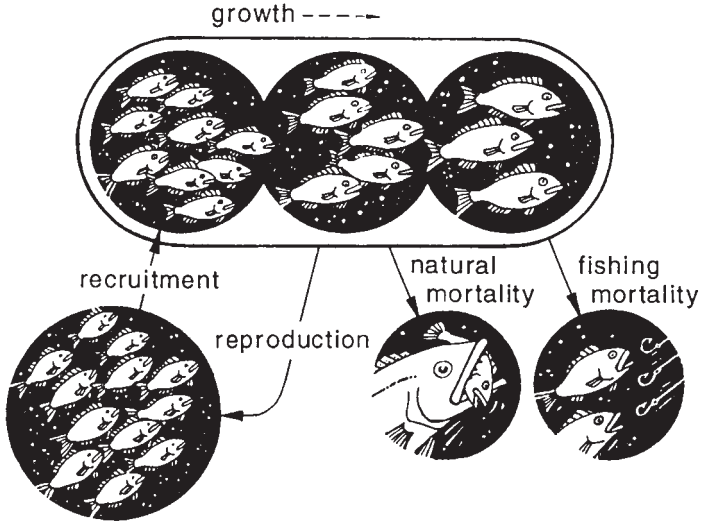

Figure 2.26: *The weight (or biomass) of an exploited fish stock (top elongate shape) is increased by reproduction which results in the recruitment of young fish (lower left circle) back into the stock. At the same time, the stock is being reduced by natural mortality and, in exploited species, by fishing mortality as well (from King, 1995).*

Fisheries scientists in various Pacific Islands, and in regional organisations such as SPC and the University of the South Pacific, are studying the basic biology and distribution of resource species. Many are attempting to determine how much of a particular species can be caught on a sustainable basis - this quantity is sometimes referred to as the Maximum Sustainable Yield (MSY).

In order to manage fisheries, that is, to ensure that fishing is done on a sustainable basis, it is usually necessary to apply one or more regulations. National governments in Pacific Islands have imposed a variety of regulations that either restrict fishing (input controls), restrict the catch (output controls) or protect the marine environment.

3. The importance of subsistence fishing

The role of subsistence fishing

Fishing has always played a very important role in Pacific Island communities, for cultural, nutritional and, more recently, economic reasons. Many coastal communities developed a strong cultural identity based on fishing and the marine environment as a result of their dependence on the sea and its resources. For many countries with limited productive land and a lack of potential for agriculture, the sea has provided the major source of protein. Subsistence activities and informal employment are recognised for the contribution they make to the economic and social well-being of Pacific island communities.

Traditional culture and the division of labour

In most countries fishing offshore with boats has been the domain of men while women have concentrated their activities on the inshore areas, collecting a wide variety of species from the reef and inshore area. Separate fishing roles and areas for men and women reflect community and family obligations of both. Women and children collect from the inshore areas, often as a way of supplementing the diet when the weather is too rough for the men to go out in their boats. By gleaning the reef, they can stay close to the village and not neglect other necessary tasks such as gardening and the preparation of food. Men on the other hand often fish from boats or canoes and are away from the village for much longer time periods. Community fishing methods such as fish drives and palm frond sweeps may involve men, women and children.

Women seldom collect or fish alone. They are often accompanied by friends, relatives and children. Reef gleaning can be a way family and friends can enjoy a communal activity. The social values of such enjoyment are difficult to quantify.

Figure 3.1: *Fishing is often a social activity in the Pacific (drawing courtesy of AusAID).*

A number of customs and traditions have developed as a result of the intimate relationship of coastal communities with the sea, both to protect the resource and to ensure harmony within the village. In many cultures throughout the Pacific the distribution of excess catch throughout the community is based on customary obligation towards certain family and community members. Women are often the ones responsible for this customary distribution of the catch.

Some fishing cultures developed specialised roles dictating exactly what form of fishing a fisherman was entitled to pursue given his social standing. In Palau offshore fishing for several species of shark was practised only by a few prestigious specialists – with the prestige being related to the danger of the fishing method rather than an appreciation of the shark as food. In some societies there existed a professional class of men whose occupation in the community was fishing. Other cultures placed restrictions on who can catch, cook or consume certain species—such as turtles in some parts of Polynesia. Before the introduction of Christianity to the Pacific, religious taboos and magic were often associated with fishing. In Kiribati, the significance and ritual associated with fishing tied the fisherman to the sea spiritually and gave him a feeling of respect for the marine environment (Mollica, 1999).

Although many customs, traditions, taboos and rituals have been eroded in Pacific Island fishing communities, the importance of fishing to the cultural identity of the community remains very strong.

Nutrition

In the past a traditional Pacific meal included a variety of starchy root and tree staples (taro, tapioca, breadfruit) along with a side dish of green leaves and seafood either boiled or cooked in coconut cream. Wild fruits and bush nuts provided snacks between meals. This diet was not only nutritious but the physical work involved in obtaining the food (hunting, fishing, gardening and collecting bush foods) kept people active and fit. Today people have changed their food habits and their lifestyles. They rely more on imported foods and do less physical work.

Since the 1970s there has been increasing concern at the appearance of non-communicable diseases such as diabetes, hypertension, stroke and heart disease in many countries in the Pacific (English et al., 1996; Coyne, in press.). Dietary deficiencies, particularly of vitamin A and iron, are affecting mothers and infants. These diseases and conditions often result from the increased consumption of refined and processed foods as well as cheaper meat cuts. Many of these foods are imported into Pacific countries, and are high in energy levels but low in essential nutrients. Imported meats, such as frozen lamb ribs (lamb-flaps) and turkey tails, as well as canned corned beef and lamb contain very high quantities of fat. The consumption of fat is directly related to the incidence of heart disease.

Besides the personal tragedies of poor health caused by poor diets, there are considerable economic implications. Pacific communities spend millions of dollars each year not only on importing low-quality food, but on solving / counteracting the long-term health and medical problems caused by the consumption of food which is high in fat and poor in nutrition.

Because of the health and economic problems related to imported foods, people are now being encouraged to eat more local foods – that is to eat plants and meat that are traditional and indigenous. One of the most traditional and appropriate foods for people living on islands is, of course, seafood. Fish meat contains very little damaging fat and is regarded as high-quality protein. Seafoods contain health-giving nutrients and many, particularly seaweeds and shellfish, contain essential minerals including iron. Fish flesh, fish liver oil and even fish eyes contain vitamin A.

But it is no use encouraging people to eat more seafood if it is difficult to get and expensive to buy. The most accessible seafood, the fish, seaweed and shellfish of the lagoons and reefs, is now in short supply. Subsistence fisheries based on inshore species need to be managed just as much as commercial fisheries do.

Informal Employment

Informal and subsistence employment has traditionally formed the basis of Pacific Island economic and social structure. The informal sector includes the production, home consumption, trade and marketing of surplus agriculture and marine products, handicrafts and services. A significant proportion of people's livelihood in the Pacific is still derived from informal production. This is especially the case in islands and villages away from the main population centres where the cash economy and formal job opportunities are limited.

The low levels of unemployment and poverty in Pacific Island countries are largely due to the subsistence sector, which provides a livelihood to people who might otherwise be destitute. Pacific Island governments recognise the importance of supporting the subsistence sector and enhancing its productivity, as it supports the majority of Pacific people.

Measuring the non-market output of subsistence activities is very difficult. Collecting catch data from numerous and widely distributed fishing communities is time consuming and impracticable for the often understaffed fisheries agencies. Dalzell et al. (1996) estimated that 80% of the catch from inshore fisheries in the South Pacific, whether from reefs, estuaries or fresh water, is taken for subsistence purposes with the remainder going to commercial markets.

Lack of information on inshore fisheries

Most Pacific countries have some estimate of commercial fisheries production but there is usually very little information collected on subsistence fisheries production. The development of the commercial fishing industry, and the collection of information to support commercial fisheries management, has been the main priority of both national governments and outside funding agencies.

In the early stages of the development of a fishery, whether it be subsistence, artisanal or commercial, each increase in the amount of fishing effort produces a corresponding increase in the annual catch or yield. At this stage catch rates (catch per unit of fishing effort, or CPUE) will be high, encouraging more people to enter the fishery. As the amount of fishing effort grows the resulting increase in yield will not be as great and mean catch rates will decrease. If fishing effort continues to increase then the adult stock may be reduced to the extent that insufficient young fish are produced to maintain the fish stock. Continued excessive fishing will cause fish yields to decrease, on the average, year after year.

Reductions in fish stocks are therefore indicated by lower catches per unit of effort. Catch and effort information are the basic data requirements for monitoring the "health" of a fishery. Other indications of overfishing can include changes in the size structure of catches, changes in the catch composition and a shift of fishing effort to more distant grounds.

In most temperate-zone, developed-country fisheries, mathematical models are used by a centralised administrative authority to make decisions about management strategies and the regulation of fishing pressure. The collection and use of this type of information can be extremely difficult and costly for Pacific Island countries and territories with limited budgets and fisheries staff. This is compounded by the difficulty in dealing with a fishery that can involve a wide range of fish stocks and species, a variety of different harvest methods, many fishers per unit of catch and a large number of distribution channels.

If government fisheries agencies recognise that the key to the successful management of inshore marine resources lies in the hands of the fishing communities who harvest those resources, they can take the first step of encouraging and motivating those communities. A side benefit of fisheries staff working closely with village fishing communities is that the collection of scientific data on subsistence fisheries is greatly facilitated by community involvement. Fishing communities can also provide much local or indigenous knowledge to supplement scientific information.

A trial run in Samoa involved village high-school students keeping a "weekly fishing log" of all fishing activities (fishing methods, effort and catches) in their own household or extended family. A surprising amount of information, and even estimates of sustainable yield by area, may be gained from such extensive surveys on subsistence fisheries. Where data are collected from different areas with similar ecological characteristics it may be possible to apply a surplus yield model (over area rather than time) not only to provide an approximate estimate of the average sustainable catch, but also to indicate villages where resources are presently under pressure (King, 1995).

Declining fish catches

Despite a lack of hard data in most Pacific Island countries, it is agreed that the coastal inshore and reef areas are heavily exploited and, in many cases, overexploited. This is especially the case in or near the main urban communities. Surveys from some Pacific countries and territories indicate a reduction in landings of inshore species (Horsman & Mulipola, 1995; Saucerman & Kinsolving, 1995; Dalzell et al., 1996).

Reductions in total inshore fish landings in a country may be caused by less people going fishing, or by there being less fish to catch. Lifestyle changes may mean that in some areas less people are going fishing, due to loss of traditional culture, increased involvement in the formal employment sector and the availability of cheap, convenient sources of protein such as tinned fish and mutton flaps. However, most fisheries agencies and fishing communities acknowledge that catch rates of fish and shellfish from the lagoons and inshore reefs of many areas have been declining for a number of years.

Reasons for the decline in fish stocks can include overexploitation, the use of destructive fishing methods and environmental disturbances. Overexploitation has resulted from a combination of factors including increasing population sizes, and the use of overly efficient, and sometimes destructive, fishing methods. The use of modern materials such as chicken wire for fence traps and monofilament nylon for gill nets, for example, has made fishing effort more effective. In some cases, modest developments such as the availability of underwater torches, which allow the spearing of fish resting under corals at night, have resulted in a dramatic increase in fishing efficiency.

Some fishing methods are considered to be destructive because they damage the environment or are non-selective in what they kill. Damaging the environment in which a fish or animal lives reduces the quality of the marine environment and makes it unavailable for further life, or reproduction, for a long time. Destructive fishing methods also tend to kill everything, including coral polyps, very small fish and shellfish, as well as the food of the target species.

Destructive fishing methods include the use of explosives and chemicals such as bleaching agents, as well as traditional plant and animal poisons. Fish drives and some collecting activities may involve damage to corals, either directly as a result of breaking or overturning coral to catch sheltering fish, or indirectly through the impact of many people moving over the reef. Some traditional destructive fishing practices have only become problematical as a result of increasing population sizes; in the past the marine environment was able to sustain occasional, localised damage because the frequency of the activity was low and fewer people were involved.

In some countries, the use of explosives and poisons to disable and capture fish represents a serious threat to marine ecosystems and the long-term viability of fisheries. These destructive fishing methods include the use of toxic plants, commercially available poisons such as bleaches (Sodium hypochlorite), insecticides, and explosives. Poisonous plant material may be derived from the roots of the climbing vine, *Derris elliptica*, and the nut of the coastal tree, *Barringtonia asiatica*, which are ground into a paste and wrapped in small parcels made of leaves; fishers drive fish into the shelter of a preselected coral head where two or three parcels of poisonous material are placed. More seriously, commercial poisons, including bleaches,

are poured into pools isolated at low tide to capture small coral fish. Explosives are either thrown from a canoe into a school of fish such as mullet, or set on coral where fish have been encouraged to gather by setting bait. Explosives and severe poisons are many times more damaging to small animals, such as fish larvae and coral polyps, than they are to large fish. Destroyed coral reefs result in low fish production, and may not recover for over 20 years.

Environmental disturbances have resulted from not only natural events such as cyclones and storms but also from human activities. These activities include the destruction of nursery areas (including mangrove areas) by road construction and land reclamation. Corals are collected for sale as souvenirs and coral blocks are used for building. Harbour dredging and coastal building projects often release silt into the water, and this blocks off sunlight or smothers coral. Poor land management practices have resulted in erosion and the siltation of lagoons. Environmental disturbances and habitat destruction have been linked to an increased incidence of ciguatera, a form of poisoning caused by eating affected fish, and an increase in outbreaks of the crown-of-thorns starfish.

Lack of government support

In many countries subsistence and artisanal fisheries have been seen as steps on the way to the development of a commercial fisheries sector rather than important contributors to the economy and the well being of the community in themselves. There has been a lack of government support for small-scale fishing communities and the problems they face.

Government responses to falling subsistence catches usually involve setting up public awareness programmes and enacting national laws to protect fish stocks. For a number of reasons these actions are rarely successful. National regulations rely on government enforcement and if that enforcement is poorly funded or stopped, then compliance with the regulation also stops. Enforcement from the national government level is also very difficult in communities that operate under their own traditional governing structure. A lack of community "ownership" is another reason government-imposed actions often fail – the community is given no ownership of either the resource or the problem and therefore feels no responsibility or accountability.

Government fisheries agencies have traditionally assumed responsibility for directing community actions and they may be reluctant to encourage village communities to take over that responsibility. However, experience suggests that a government agency promoting community management gains both public support and respect (see Chapter 6).

5. Raising community awareness

The need for awareness

The knowledge of island and coastal people regarding the marine environment has often been underestimated. Most coastal communities have an acute awareness of, and concern for, their marine environment.

Pacific Island fisheries have been managed within a framework of traditional knowledge which has accumulated over many hundreds of years. Many communities have had, and in some cases still have, traditional rules and regulations to protect fish stocks. These may include taboos on destructive fishing such as catching small fish and fish at particular times of the year when they are spawning. Many communities have had traditional rights to fish in adjacent coastal areas under customary marine tenure. Fishers were small in number and were mindful of customary methods of conserving fish stocks, and communities which cared for their fish stocks were highly regarded. In parts of the Fiji, for example, the word "kaiwai" is used to describe coastal or sea people who keep and use the marine environment wisely.

In many islands, however, customary rights have been eroded with increased local population sizes and a trend towards a money-based economy and commercial fishing. In centres of high population, commercial fishing to supply local markets provides an important source of employment. In some cases, fishermen now travel great distances from their home bases to catch fish in areas which were previously exploited and controlled by local communities. Younger people in villages may not hold the same conservation values as their grandparents did.

This manual is concerned with encouraging communities to take actions necessary to manage their marine resources and make fisheries sustainable. A precursor to these actions is that there must be a community awareness of the marine environment, and a concern for existing problems. The process of community involvement can be illustrated by the following sequence.

AWARENESS >>> CONCERN >>> ACTION

In previous chapters, a case has been made that fisheries have to be managed, and that, in order for fisheries to be sustainable, regulations will have to be imposed. If the majority of fishers are aware of the need for conservation and the aims of fisheries regulations, compliance is likely to be high and fisheries management will be more effective. This chapter discusses ways of raising community awareness.

Environmental education in schools

In the longer term, education of the young is the best way to ensure protection of the marine environment and the sustainability of fisheries resources. It is education that provides an increased awareness of environmental issues and produces future citizens who are more environmentally responsible individuals. Introducing students to environmental subjects at an early age is most important, as young people are particularly receptive to learning environmental values and behaviour. In addition, information and values communicated to the young can be a way of raising the awareness of parents and the general community.

Education gives people the knowledge and skills to make informed decisions, and the ability to act on them. Such people will recognise the importance of the marine environment, have an awareness of environmental issues, and be able to discuss technical and social solutions to problems. Managing and protecting the marine environment and its resources will be more effective if environmentally aware and educated people in the community, rather than governments and scientists, take part in expressing environmental concerns and in suggesting solutions.

All relevant government and non-government agencies should be actively encouraging and assisting educational authorities to include aspects of the marine environment and conservation into school curricula. When developing annual work plans it may be useful to include objectives such as the following.

- to encourage and assist educational authorities to include marine environmental studies in school curricula;
- to provide scientific and technical staff to give talks on marine conservation topics to classes in local schools; and
- to produce information sheets and other educational material on marine environmental issues for the use of teachers and students.

Ways of introducing studies on the marine environment into high schools are outlined in the following box. The use of public awareness raising materials, such as information sheets, is discussed later in this chapter.

Information for teachers – marine environmental studies in high school curricula

There are two ways to introduce studies on the marine environment into high school curricula. The first is a multidisciplinary approach and the second an interdisciplinary (single subject) approach.

- **Multidisciplinary approach** – aspects of marine environmental studies are introduced into subjects that students are currently studying, such as general science, social science, ecology, biology, and geography. This multidisciplinary approach may be the most convenient way to provide students with exposure to environmental topics in the short term.

- **Interdisciplinary (single subject) approach** – marine environmental studies are included in high school curricula as a separate subject. This is the better long-term choice as it provides environmental education with the status that it deserves.

Whichever approach is used to introduce environmental education, it should eventually aim to take students beyond a study of ecology, to include relationships between ecological concepts and environmental issues, as well as environmental problem solving. These sequential stages are listed below.

1) **Ecological concepts.** Students must be provided with a background knowledge of ecological concepts based on biological, chemical and physical properties of the environment.

2) **Awareness of environmental issues.** Students should be exposed to broader issues including sociology, economics and human behaviour, including personal, political and cultural activities and how these interrelate.

3) **Problem solving in relation to environmental issues.** Students should be encouraged to discuss community-focussed solutions to real local problems. The balance between the need for development and protection of the marine environment, for example, is of real concern in many Pacific Islands.

Details of possible curriculum design and content are included in King & King, 1996.

Radio and television

Radio can be an effective way of increasing environmental awareness in rural communities in Pacific Islands. Radio presentations can range from brief environmental messages to talks by, or interviews with, extension officers.

Brief environmental messages are often read by a professional announcer at the radio station. However, longer talks or interviews may involve presentations by an extension officer. When preparing a talk for radio, it is best to arrange for the talk to be pre-recorded; this gives an opportunity to re-record the talk, or parts of it, if necessary. The talk should be entertaining, brief and to the point. When being interviewed, ask to discuss the questions in advance; this gives an opportunity to check facts and ensure that the answers given are correct.

Advantages of using radio as a method of raising public awareness are:

- **Low cost** – radio stations, particularly if government owned, may broadcast messages of public interest at no cost;
- **Speed** – delivers messages quickly;
- **Reaches remote areas** – in many islands, even remote villages have the use of radios;
- **Reaches a large audience** – the audience will include people who cannot read.

Disadvantages include:

- **Usually a one-off event** – programmes are not repeated unless special arrangements are made to repeat short messages.
- **Not useful for complicated messages or concepts** – broadcasted messages cannot be studied or easily questioned by the audience.

The advantages and disadvantages of using television are similar to those given for radio, except that television presentations involve audiences more closely (as sight as well as sound are involved) even though purchasing time on television is often more expensive.

With television, a talk is often more effective if it given as a "voice over" while some relevant and interesting film clips are shown (a range of film clips are often kept on file at television stations). Alternatively, an extension officer can be video-taped demonstrating or pointing out some aspects related to the message being given. As television audiences expect movement and action, long segments with the presenter talking directly to the camera, particularly in a studio, should be avoided. Some regional organisations, including SPREP and SPC, produce videos which may be used to give or support some messages.

Printed material

Printed material, including newspaper advertisements and articles, newsletters, leaflets, information sheets and posters, are commonly used in extension and awareness-raising programmes. The advantages of printed material are listed below.

- **relative permanence** – written material can be kept, studied and referred to;
- **ability to be directed** – the distribution of written material (other than in newspapers) can often be directed to specific audiences.

The main disadvantage of printed material is often the cost, although this varies according to the medium. Colour posters, for example, are very expensive to produce, whereas some printed material, such as leaflets, can be photocopied to save printing costs.

Local newspapers are produced in many island countries, and these may be used for short advertisements, press releases, and regular columns.

Short advertisements containing simple messages (such as the one shown in Figure 5.1) can be used on a repeated basis to maximise impact. Although some newspapers will print small public-interest advertisements without charge, most will charge a fee which depends on the size of the advertisement. A short hard-hitting message in bold print with a supporting graphic is the most suitable format.

Media releases, as long as they raise topical, newsworthy and interesting items, will often be used by newspapers without charge. Editors often like to receive photographs to illustrate a media release, but these have to be clear and high-contrast to allow printing in black and white. Writing media releases requires special writing skills, which are quite different from those required to write a report or scientific paper. An attention-grabbing headline should be used, followed by key information in the first paragraph. The least important part of a media release should be placed at the end. One technique is to write the article in the form of an interview with an authority on the subject – for example, a good fisher, a community leader, or a research worker. Checking the local newspaper will provide a guide to the preferred style.

Sometimes arrangements can be made with a newspaper to print a regular column on a single theme; for example, a weekly column on environmental facts or issues such as mangroves, destructive fishing, fish farming, and the biology of important resource species. However, a large degree of commitment is required to produce a weekly column as the preparation is time consuming, and over a long period it becomes harder to create new ideas for articles. It is best to produce a list of prospective topics and committed specialist authors. The responsibility to submit the article to the newspaper each week should rest with one person, preferably a dedicated Information Coordinator.

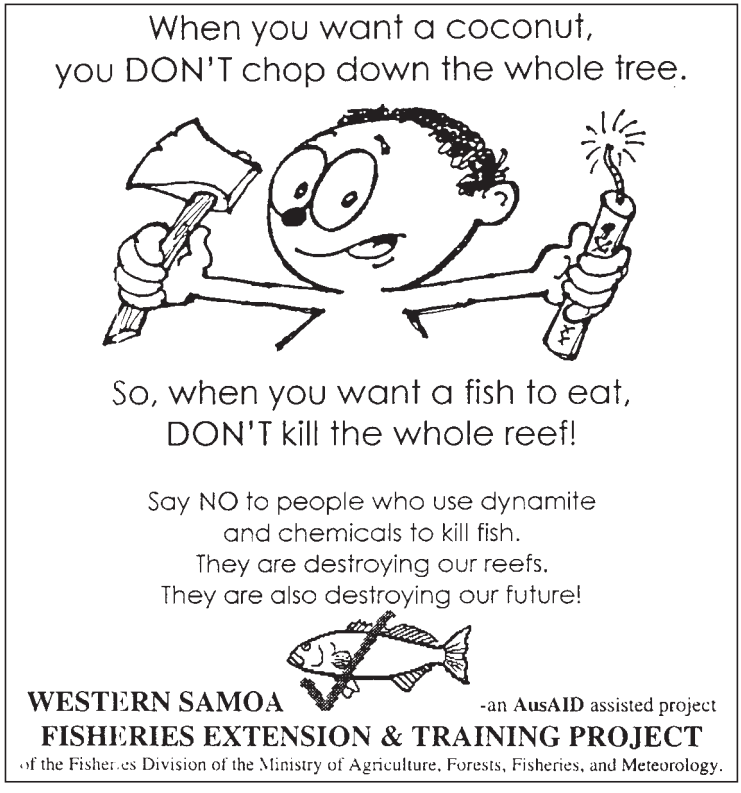

Figure 5.1: *Advertisement using a cartoon character in Samoa (wording based on a poster produced by the Department of Marine and Wildlife Resources, American Samoan Government).*

Newsletters, of a single sheet or more, are suitable for targeting particular groups such as commercial fishers, members of organisations, and other interest groups. They are usually produced and distributed on a regular basis, often monthly or quarterly, and contain articles of current interest to the specific target group. Newsletters are sometimes made more interesting by the inclusion of cartoons, jokes and recipes to break up the more serious information. An example of a regional newsletter is shown in Figure 5.2, but the cost of preparing and producing a similar newsletter would be beyond the resources of most individual countries. Locally produced newsletters can be photocopied to save on printing costs, but these are likely to fade in a short time.

Leaflets and information sheets are generally directed to a wider audience than newsletters, and usually contain factual information on a single topic. They often have a longer lifespan than newsletters because the information contained in them is less likely to become outdated in the short term. Leaflets containing information on the value of mangroves, for example, may remain current for many years. Like newsletters, information sheets can be photocopied, but printing is a better option for a document designed to be used over a long period. Information sheets on marine resources and environmental topics are often sought after by students completing projects at local schools.

Posters are like leaflets but in a large format, and are effective only if they are sufficiently attractive to encourage people to display them in places such as shops, offices and markets. For this reason, posters are often large and colourful, which makes them very costly to produce and print. A poster can be designed to contain either a brief, bold message to be seen from a distance, or to contain a large amount of factual information displayed in such a way to encourage people to study them

more closely. An example of the latter is the fisheries regulations poster shown in Figure 5.2.

Colourful adhesive labels containing brief environmental messages are popular, particularly with children. Although the message may get widely distributed, its impact decreases with familiarity, and the labels are often costly to produce. The use of adhesive labels printed with warning messages is discussed in the final paragraphs of this chapter.

The use of a cartoon character, slogan or logo can enhance many of the above printed materials. The repeated use of any, or all, of these devices aids the public to recognise the type of message and the sponsor. The cartoon character in the newspaper advertisement shown in Figure 5.1 was used to promote environmental messages in Samoa. If such a cartoon character is used repeatedly with a range of similar messages, it becomes comfortably familiar to the public – in this case, as a recognisable character who provides sensible environmental advice. Similarly, a slogan, particularly if it is brief and memorable, becomes publicly familiar – the World Wildlife Fund's use of "save our seas" is an example. A logo is an emblem or a device that is used to identify the sponsor or organisation giving the message – an example of a logo that is easily recognisable in the Pacific region is the SPC logo on the front cover of this manual.

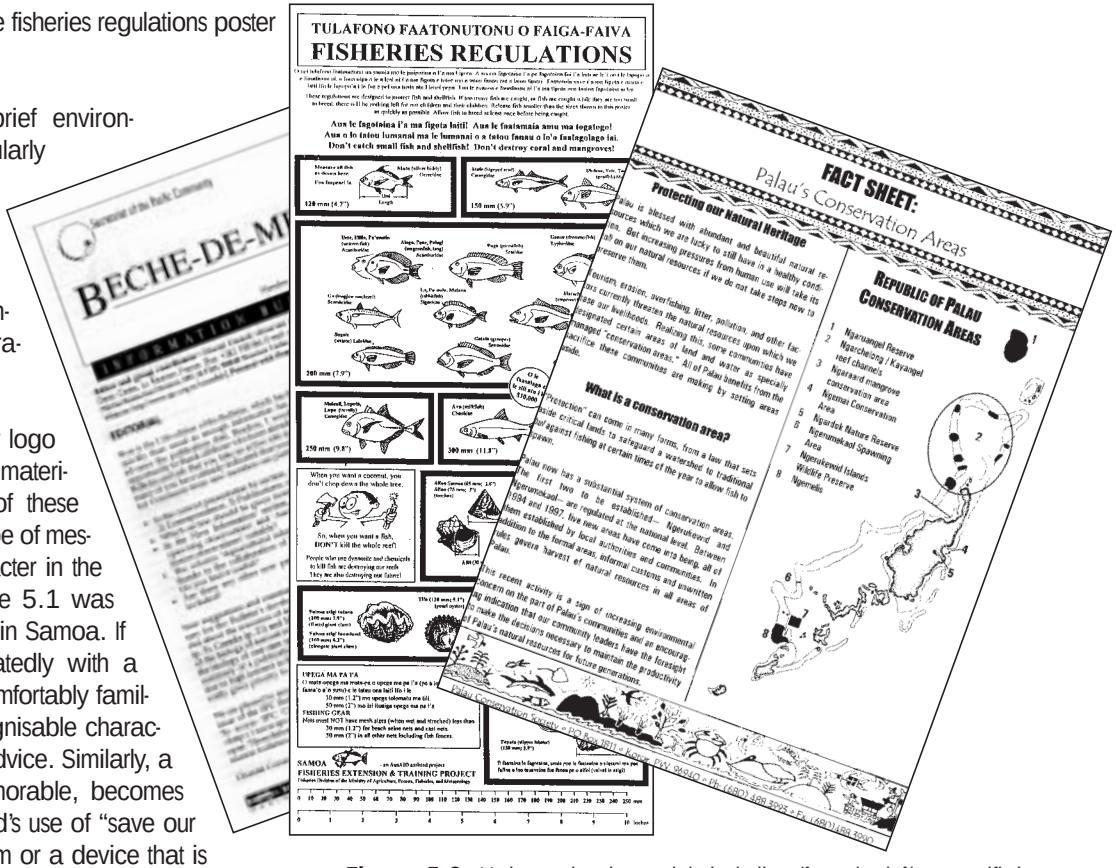

Figure 5.2: *Various printed materials including (from the left) a specific-interest newsletter produced by the SPC, a Samoan poster on fish minimum size limits, and a fact sheet produced by the Palau Conservation Society on Palau's conservation areas. The originals are much larger, and in the case of the poster, printed in colour.*

Direct contact

Direct contact, face-to-face interactions with people, is part of most awareness raising programmes. This can include meetings and public talks, activities and displays. As will be discussed in Chapter 6, meetings and interactions with people in villages play a vital part in any community-based programme. For less localised issues, there are other existing forums for raising public awareness. Scheduled meetings of rural teachers, church leaders, and village mayors can be used to introduce and publicise many topics such as a community-based programme, a new fisheries development, or to give messages that counter widespread, environmentally destructive practices. Seeking the assistance of community leaders is a good way of maximising the spread of messages. Asking church leaders to include environmental messages in their church sermons, is an example. As women are often receptive to messages regarding care of the environment, there is a good case for involving women's groups at both the national and community level. Interactions with schools have been discussed previously, and may include the provision of professional people to give talks to school children.

Open days and public displays are useful to familiarise the public with the work and aims of a government or non-government agency. This may involve having an annual open day, at which the public is invited to view displays, posters, and demonstrations. An open day can be publicised by running school competitions (perhaps involving students producing a hand-painted poster with a marine environmental theme) which are scheduled to be judged at the open day. Local businesses will often agree to provide prizes for these competitions.

In some cases, public education is the only practical way to change attitudes towards overexploitation and environmentally damaging practices. An extreme example is where explosives and commercial poisons (such as bleach) are used by members of coastal communities. Fishers using such destructive fishing methods are often tolerated, and sometimes highly regarded, in the community as the catches are usually shared. Because of the isolated fishing locations, as well as lack of public sympathy, fisheries enforcement staff have difficulty in apprehending offenders. Public education may be the only method of ensuring that the use of such methods is seen as contrary to the long-term interests of the community.

Planning an awareness-raising campaign

This chapter contains an overview of methods which can be used to publicise issues and to raise public awareness in relation to the marine environment and fisheries. However, before embarking on a publicity campaign, an annual work programme should be prepared, listing objectives, target audiences, outputs, activities and associated inputs (time and costs). This will enable the production of a directed campaign that is achievable within the budget and time constraints of the agency.

A publicity campaign should first consider its target audiences. Which people in the community is the message aimed at? How can the message be delivered in the most cost-effective way? In this respect it is worth noting that women are often very receptive to campaigns promoting conservation. Not only do they have influence on the attitudes and behaviour of members of their family, especially their children, but they are also likely to take a longer-term (inter-generational) view.

A public education campaign to counter the use of explosives and industrial chemicals for fishing, for example, could include both short-term and long-term measures. Short-term measures could include a series of talks given to community groups, and the distribution of posters emphasising the environmental dangers of using such damaging fishing methods. Actions could include asking for government regulations to enforce the inclusion of warning labels on certain chemicals sold. All bleaching agents, for instance, could include an adhesive label with a message warning against its use in fishing and emphasising the long-term damaging effects to the environment and fish production. Longer-term methods could include teachers being encouraged to discuss the issue in schools.

Extension work

Extension can be broadly defined as working with people to provide, or to build on, skills and knowledge, or to promote community action, to achieve particular goals. Fisheries extension, therefore, could mean working to provide communities with the skills necessary to increase seafood production. Equally it could mean working to provide communities with the means and motivation to conserve fish stocks and protect the marine environment.

One type of extension involves an agency deciding what skills and knowledge are needed to achieve a particular goal, and then providing these to the community. This method has been referred to as "top-down" – that is, one in which an agency (say a Fisheries Department) believes it has the knowledge to achieve a goal, and proceeds to either provide instruction and skills to, or to impose regulations on, the community. An example of this is the setting of minimum size limits for fish by government agencies. Fish size limits are usually set without reference to the community (they are usually set by fisheries biologists) and rules are imposed on fishers by the government agency on the understanding that it is for the public good.

Another type of extension involves an agency working to encourage and assist communities to achieve their own particular goals. In this case, the community is encouraged to define its needs and propose solutions to problems. As the agenda are set and actions are taken by communities with government agencies playing a supportive role, this type of extension has been referred to as "bottom-up". In this case, the community would set its own conservation rules, and it (rather than the government) has ownership of the rules and a responsibility to enforce them. Because communities play the key role, this type of management is referred to as **community-based resource management**, which can be defined as arrangements under which a community takes prime responsibility for managing resources.

There are many other arrangements under which resources can be managed. One which can be regarded as falling somewhere between the above two methods, is co-management, in which government representatives, communities and other user groups manage fisheries resources on a cooperative or shared basis. This manual is particularly concerned with establishment of community-based fisheries management in which the community is the major partner.

Government attitudes to fisheries management by communities

When embarking on a community-based programme, it may be necessary to overcome an initial government reluctance. Government authorities may have concerns regarding a programme which encourages village communities to take actions for which they see themselves responsible.

Fisheries agencies, as repositories of technical and scientific expertise, have historically assumed responsibility for taking actions and setting national laws to protect fish stocks and the marine environment. Consequently, a government fisheries agency may feel a loss of power, or that it is avoiding its own responsibility, by placing the initiative for marine conservation in the hands of fishing communities. However,

experience suggests that a government agency promoting community management gains in many ways:

- **the agency is seen to be active in rural areas**
  – because of the presence of its extension staff working in villages.
- **the agency gains both public support and respect**
  – because community-based activities often attract favourable attention from the media and government.
- **the agency gets credit for reducing enforcement costs**
  – because communities assume responsibility for enforcing their own regulations.

However, the main reason for encouraging community-based fisheries management is that it may represent the only chance for subsistence fisheries to be exploited on a sustainable basis. National laws and regulations to protect fish stocks are unlikely to be complied with in rural areas and villages without communities themselves being involved.

Extension staff skills

Historically, extension staff are required to have appropriate technical knowledge and an ability to train people and transfer skills. However, if community-based management is the goal, facilitating skills are more important. The word facilitate means "to make easy" – in other words, the extension officer as facilitator "makes it easier" for a meeting or a community to achieve its own objectives by its own actions. In this role, the extension officer is more of a listener than a teacher. Facilitation refers to the process of encouraging other people to give their views and take their own actions.

Ideally, a community-based extension officer should have a balance of both basic scientific knowledge and community facilitating and motivating skills. An understanding of biology, ecology, conservation, fishing techniques, seafood handling, and resource management practices is undoubtedly valuable. However, most government agencies have scientific staff available to provide more specialised technical advice to communities.

In the process of encouraging communities to take conservation actions, extension staff are required to facilitate meetings. A facilitator needs to unobtrusively encourage groups to define problems and to propose their own solutions, without imposing his or her own views on the proceedings. Previous experience with problem-solving techniques would be an advantage. One particular problem-solving technique, which is easily-learned and suitable for working with groups, involves the use of a problem / solution tree (described later in this Chapter).

Some of the most successful community-based extension officers are extroverted people, both men and women, who like people and are good at encouraging all individuals in a group to give their opinions. This may (depending on local custom) involve joking and friendly cajoling. However, what is not required, is an egotistical bully who is likely to embarrass people, and impose his or her own opinions on the group. Many younger people require training in cultural skills in order to address community groups which include village elders.

Whether existing staff are to be used or new staff are to be employed to develop community-based fisheries management, selection of good extension officers is a difficult task. Interviews with prospective candidates can often establish whether or not the person is likely to have the

people-skills discussed above. Using experienced extension staff is not always the best option if their experience is based on "top-down" rather than "bottom-up" methods. A guide to position requirements is given in the box below.

It should also be taken into account that having female fisheries extension staff often makes it easier, or culturally more acceptable, to facilitate community meetings involving women. Women not only make up an important and influential part of the community, but they are also very involved in subsistence fisheries. In Fiji, for example, over 50% of the rural subsistence catch is believed to be taken by women (Rawlinson et al., 1995). In the Pacific, women play a large role in the capture, post-harvest and marketing sectors, but still fail to be well-represented in most fisheries agencies. Fisheries agencies should aim to increase the number of active female staff members. Currently, many of the women employed in government fisheries agencies have clerical or secretarial positions when they might be more profitably employed in the field.

Position requirements Community-based Fisheries Extension Officer

Minimum skills and qualifications

- Successful completion of final year of secondary (high) school;
- High level of verbal and written skills;
- Knowledge of local culture in relation to holding village meetings;
- Confidence in meetings and in working with community groups;
- Ability and desire to work with isolated communities;
- Ability to work as part of a team;
- Ability to drive a vehicle.

Desirable qualifications

- Experience in working with communities;
- Experience in using problem solving techniques;
- Degree in science or social science;
- Training, knowledge or experience in one or more of the following areas: biology, ecology, conservation, fishing, seafood handling, fisheries management;
- Ability to use word processing.

Extension goal and strategies

Setting up a community-based fisheries management programme involves defining a goal and a strategy. The goal refers to the expected result and the strategy defines the principles or overall plan under which the goal is to be achieved. For example, the goal may be for a particular number of villages to effectively manage their own fisheries resources. One of the possible strategies to achieve this goal would be to encourage each participating village to develop its own Village Fisheries Management Plan.

In this manual, the above goal and strategy is used as an example of the development of community-based fisheries management. Under the example strategy, each village would be encouraged to analyse its fishing practices and problems, and suggest solutions. Community undertakings and actions to solve these problems may include introducing fisheries regulations and pursuing other conservation measures. These undertakings and actions would be listed in the community-owned Village Fisheries Management Plan. The strategy should address questions such as the following.

- Which villages should participate in the programme?
- How can community ownership of the plan be assured?
- How can participating villages be supported?

Participating villages. Villages must be made aware of the programme, but for reasons of efficiency and sustainability, the programme should focus on villages in which communities have a concern for the marine environment and are prepared to take action in finding solutions to problems. Although it is tempting to concentrate on villages where the need is greatest (say a village where destructive fishing methods are known to be used), community-based management will not work unless the community has a strong desire to address its own problems. The strategy involves working selectively with village communities eager to participate in the programme. As the programme progresses more villages may develop the desire to participate.

Community ownership. Community ownership will be optimised if as many people as possible are allowed to contribute to the process of developing the Village Fisheries Management Plan. This will require involving all groups, including women and untitled men, to ensure the widest community participation and eventual ownership of the plan. The length of the extension process in each village has to be sufficiently extended to allow the community time to establish ownership of their plan and undertakings. Ownership by the community requires sufficient time for people to consider their own problems and causes, and think of their own solutions. It may take many months of facilitated discussions by community groups before the plan can be regarded as owned by the community.

Support for villages. As many subsistence fishers require seafood for their families on a daily basis, it is unreasonable to expect communities to readily take conservation measures, which, at least initially, will reduce present catches of seafood even further. Whether community-based or not, most conservation measures, including preventing destructive fishing methods and imposing fish size limits, will cause a short-term decrease in catches. Accordingly, a community-based extension programme which does not provide support by way of promoting alternative means of obtaining seafood is unlikely to be sustainable. Developing alternative sources of seafood is discussed in Chapter 8.

Extension process

In order for communities to manage their fisheries resources, they must have:

- an awareness of problems with the marine environment and fisheries resources;
- a concern for these problems and their effects on the community;
- a desire and willingness to take actions to address these problems;
- some traditional, legal or assumed control over their adjacent fishing areas;
- the traditional power or organisation to make and enforce their own regulations.

Before embarking on a community-based fisheries management programme, the level of community awareness must be assessed. If community awareness is considered to be low, greater efforts will be needed to raise it. However, care should be taken not to underestimate community knowledge. The use of damaging fishing methods such as dynamiting, for example, does not necessarily indicate community ignorance; it may mean that such methods are used and condoned for economic reasons. The use of dynamite may result in large fish catches in the short term, even if the long-term result is destroyed coral reefs and reduced fish stocks. A range of awareness-raising methods has been discussed in Chapter 5.

Although it may be decided that public awareness-raising activities should be part of the fisheries extension programme, it may be that the most important need in communities is not for education, but for motivation and support. The key extension tasks, therefore, are to provide this motivation and technical advice, and, most importantly, to enable communities to realise that they, not the government, have the primary responsibility to manage their fisheries and marine environment.

Preparation for a fisheries extension programme consists of designing a culturally appropriate extension process and training extension staff to facilitate the process effectively. The extension process has to be designed specifically to encourage communities to discuss problems and propose solutions relating to fisheries and the marine environment.

In most countries, the extension process will involve recognising village leaders as the prime instigators of change, while still allowing ample opportunities for other community groups to participate. In the early stages of the programme, it will be necessary to contact communities to explain the programme. Later, and if the programme is successful, this will become less necessary as village leaders will approach the agency to express interest in joining the programme. The process is summarised in Figure 6.1 and described below.

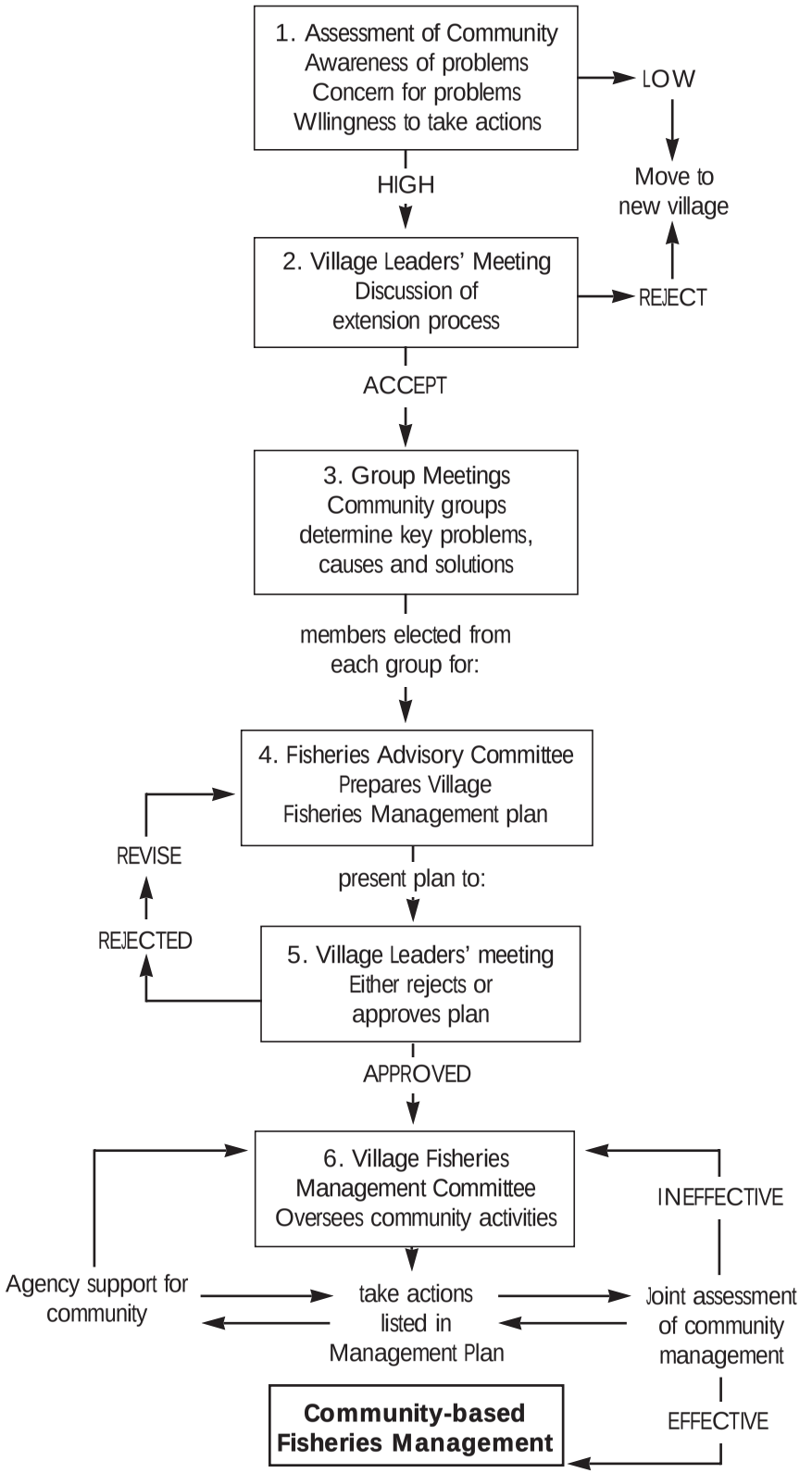

Figure 6.1: *The Fisheries Extension Process. Activities are described by number in the text.*

1) Assessment of community awareness, concern and willingness to act

Following an initial expression of interest by members of a community, extension officers must assess whether the community as a whole is ready to commit to the process. The three key components are an awareness of problems with fisheries and the marine environment, a concern for these problems, and willingness to take actions to solve these problems. If this assessment is positive, it is usually culturally appropriate to arrange a meeting with community leaders.

2) Meeting with community leaders – acceptance or rejection of the programme

At this meeting, community leaders are provided with information to allow them to either accept or reject participation in the extension programme. Villages may decide to reject the programme, at least initially, for many reasons. Some village leaders may have the mistaken belief that a government agency is attempting to take away their authority, or some may be involved in local political disputes. If the community declines to participate, extension staff should not try to "sell" the programme or otherwise persuade the community to change its mind.

If the meeting decides to accept the process, it must agree to arrange for separate meetings of several different village groups. This separation is necessary to allow particular sectors of the community to express opinions which they otherwise may not do in large groups dominated by community leaders. The village should be encouraged to nominate its own groups (e.g. fisher groups, church groups), but extension staff may need to ask that women and, if applicable, untitled men have their own groups. Each of the nominated groups should then arrange to hold village Group Meetings (GMs) at some time in the near future.

3) Community Group Meetings (GMs) – problem/solution trees

Each group meeting requires a facilitator and, if possible, a second person to act as a recorder of the discussions. As there may be three or more different community groups in a particular village, it is most convenient to arrange for the individual Group Meetings to be held on the same day. A portable white board should be taken to each of the separate meetings and used by the facilitator to record the results of discussions. Recording results in a large format, visible to all, emphasises the ownership of the written words by the group.

At the first series of Group Meetings, each group should be encouraged to analyse the condition of the marine environment and fish stocks adjacent to the village. This could include making an assessment of changes in fishing, seafood catches and the marine environment over recent years. Traditional management methods and customary marine tenure should also be discussed. Notes on these should be kept for eventual inclusion in the Village Fisheries Management Plan.

At a second series of Group Meetings, each group should discuss problems relating to fisheries and the marine environment as the first step in the construction of a problem/solution tree. In most cases several problems can be resolved into a single key problem which the facilitator could write on the white board a little way down from the top (as shown in the example in Figure 6.2). Once the key problem is agreed upon, the group could list the effects of this key problem on the

community. The facilitator writes down these effects on the white board in a row above the key problem. The group is then asked to think about the causes of the key problem and these are written by the facilitator on row 3 of the white board. After this, the group is asked to think about these causes, and about possible solutions, before coming to the next meeting (perhaps arranged for one or two weeks later).

At a third series of Group Meetings, each group is encouraged to discuss the causes of the key problem, and to propose possible solutions. The solutions are written by the facilitator on row 4 of the white board. Finally (and perhaps at a fourth series of meetings) each group is encouraged to discuss practical remedial actions to put the solutions into effect. These should be written by the facilitator on row 5 of the white board.

These community actions will eventually be listed as community undertakings in the Village Fisheries Management Plan. At the final series of Group Meetings, each group should be asked to nominate two or three of its most active members to form a village Fisheries Advisory Committee (FAC).

The above facilitated group meetings may be held over a period of one or two months, and should not be completed in less than a month. If the period is too short, people will not have time to think about the problems and will have less ownership of the results. However, if the period is too long the community may become impatient with the slow rate of progress.

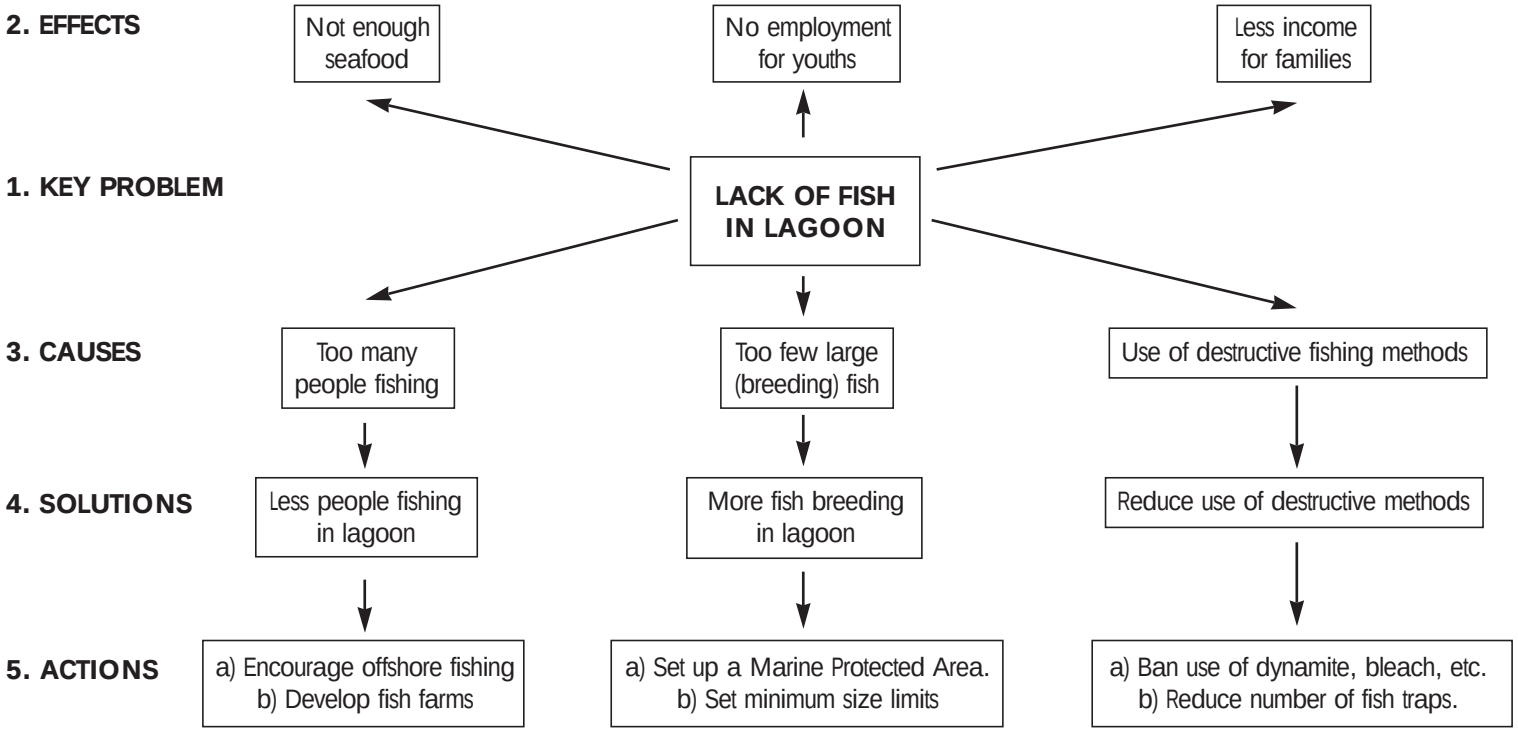

Figure 6.2: *A simplified example of a problem/solution tree as constructed by a village community (from King & Faasili, 1999). The process begins with step 1 (Key Problem) before proceeding in the numerical order shown. All information is provided by the community, with a facilitator recording information on a white board.*

4) The village Fisheries Advisory Committee (FAC)

The village Fisheries Advisory Committee FAC holds a series of meetings (say two to three) to further consider the problems and solutions identified by each group, and combines these into a single problem / solution tree (Figure 6.2). The committee then decides how the solutions could be made to work, which actions are required from the village community, and what type of support will be required from the promoting agency.

At the first FAC meeting, committee members and extension staff should conduct a village "stroll-through environmental assessment". This involves walking through the village examining and noting the environmental features which had been either discussed in meetings, or which should receive community attention. The purpose of the assessment is to prompt community discussions of environmentally-critical areas and to avoid wasting time on unrealistic community undertakings. For example, if the village wants to create a marine reserve in a particular area of bare coral rubble, then extension staff could point out that there may be more suitable areas.

At this stage, extension staff may have to diplomatically suggest alternatives to some community plans. In Samoa, for example, some villages initially elected to ban fishing in their entire lagoon area. In such cases, extension staff were obliged to curb over-enthusiasm, and ask the community to balance the perceived fish production advantages of a large reserve against the sociological disadvantages of banning fishing in a large proportion of the village's fishing area. In the latter case, although young men would still be able to go fishing beyond the reef, women (who traditionally collect echinoderms and molluscs in subtidal areas) and the elderly would be particularly disadvantaged in losing access to shallow-water fishing areas. A large reserve may also force people to fish in the waters of neighbouring villages, thereby increasing the potential for inter-village conflict (King & Faasili, 1998a).

At the FAC meetings, members (assisted by extension staff) prepare a draft Village Fisheries Management Plan which should include:

- the names of all members of the groups and committee;
- the names of all extension staff involved;
- a background of the village's marine environment and fisheries;
- a map of the village and fishing areas (completed by community members);
- details of tradition-based controls on fishing;
- undertakings and actions to be taken by the community;
- support to be provided by the promoting agency.

Although the draft Village Fisheries Management Plan may be typed at the agency office, it must be returned to members of the village Fisheries Advisory Committee for checking. As the plan is an important community document, its appearance and presentation should reflect this. The final draft of the plan should be bound in a printed cover for committee members to present to village leaders.

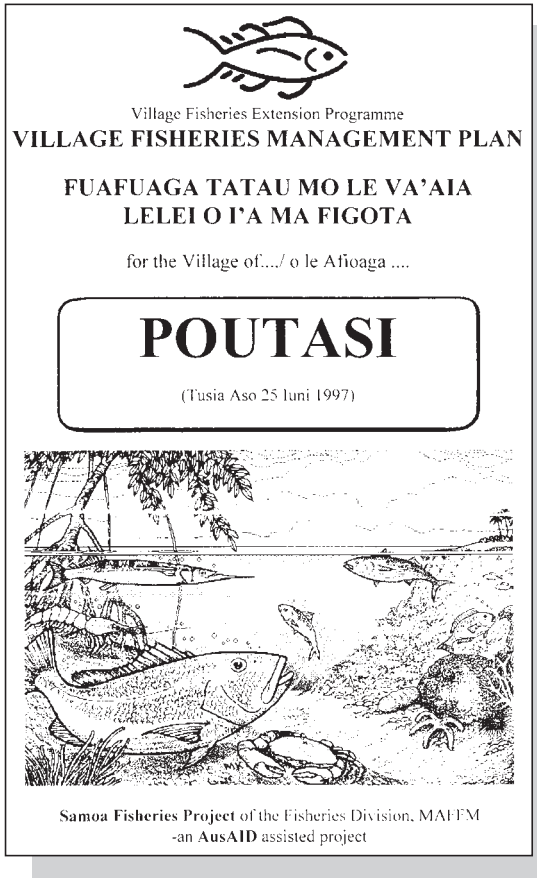

Figure 6.3: *A Village Fisheries Management Plan from Samoa. The cover is printed on coloured cardboard with a cutout through which the particular village name can be seen.*

5) Village leaders' meeting to consider the Village Fisheries Management Plan

The Village Fisheries Management Plan lists the resource management and conservation undertakings of the community, and the servicing and technical support required from the agency. The plan should be presented to village leaders by the Fisheries Advisory Committee at a formal and culturally appropriate meeting. Extension staff should attend this meeting as observers (to signify the meeting's importance), but all questions relating to the plan should be answered by the committee wherever possible. If the village leaders accept the plan they should be asked to appoint a village Fisheries Management Committee to oversee the working of the plan.

6) The community Fisheries Management Committee (FMC)

The FMC is appointed by the village leaders to administer the conservation undertakings of the community. Members of the previous Fisheries Advisory Committee are most likely to be appointed to the Fisheries Management Committee, but this remains a village decision. Once the Village Fisheries Management Plan is formally agreed to, the agency must agree to make regular contact with the FMC and provided the technical support agreed to under the plan.

Ensuring continuing community commitment

Once a community has prepared its Village Fisheries Management Plan, it is responsible for taking actions and enforcing regulations that are listed in their plan. However, it is unlikely that a community will sustain these actions without some support, at least in the short-to-medium term. In particular, post-management plan activities must include regular contact with villages and support for the village Fisheries Management Committees. Types of support will include:

- **Regular contact between communities and extension staff;**
- **Exchange of information between communities;**
- **Support for developing alternative sources of seafood;**
- **Support for producing food and income;**
- **Technical advice and training;**
- **Review of fisheries management in participating communities.**

Regular contact between communities and extension staff. Extension staff must maintain regular contact with communities once they have a Village Fisheries Management Plan. Communities having recently completed management plans may feel disappointed and "let down" if extension staff stop visits once their plans have been completed.

Exchange of information between communities. Opportunities should be provided for the Fisheries Management Committees from different villages to exchange information. For example, a national workshop for members of the committees, or exchange visits between communities could be arranged. Such a workshop will allow people from different villages to compare types of conservation activities in their respective management plans.

Support for developing alternative sources of seafood. Communities imposing fisheries regulations and conservation measures will experience short-term decreases in fish catches. Support for participating communities should, therefore, include promoting the development of alternative means of obtaining seafood (see Chapter 8).

Support for producing food and income. Government agencies and NGOs should be asked to give preference in development projects for those villages involved in community-based fisheries management. Such support could include assistance and advice in agriculture and livestock production as well as with craftwork and curio production.

Technical advice and training. Scientific advice may be required for several proposed community activities. Examples include the positioning of a community-owned Marine Protected Area and the development of new fishing methods. Training could include fish handling and marketing. It should be noted that the agency must target the most appropriate community group which may be women in the case of fish handling.

Review of fisheries management in participating communities. Extension staff will need to assist communities in reviewing their conservation and fisheries management efforts after a period of time (say, after six or twelve months). Reviews should seek to measure how well:

- communities are carrying out the activities listed in their management plan;
- community regulations are being enforced;
- communities are taking advantage of fisheries development support; and,
- communities feel that the agency is supporting their management plans.

Reviews are important in that an agency with limited resources will have to rationalise its work if there are a large number of villages with management plans. Options may include dropping poor performing communities from the programme (Kallie, Taua & Faasili, 1999). An example review form is given as an appendix.

To coordinate the support for, and visits to, rural communities, the extension programme has to be well managed. This should include monthly meetings for extension staff to review the management plans of all villages in the programme, and to ensure that the undertakings of both the village and the agency are progressing.

Things a community extension officer should NEVER do

Never give your own opinions when you are trying to encourage people to give theirs. Do not prompt them with opinions of your own.

Never ask a leading question such as "You have a boat, don't you?" Even the neutral question "Do you have a boat?" may encourage a positive (yes) answer out of politeness because the person may think that a negative (no) answer would be disappointing. It is better to ask "Do you have a boat, or not?" which suggests that either a yes or no answer is equally acceptable.

Never pretend that you know more than you do. Never make up an answer to a question. If you do not know the answer to a question, reply like this – "I don't know the answer to that question. But I'll find out and let you know." In the end, this gains more respect.

Never exaggerate. Never say, for example, that if people stopped fishing with dynamite then numbers and catches of fish would quickly increase (when, in fact, catches would continue to be low for a long time and only increase slowly). Tell people the hard truth.

Never make promises that you cannot keep. Never promise advice, involvement, or assistance if you know that it cannot be given or done.

Never break appointments. Never fail to go to a scheduled meeting with a community or individuals. If it is impossible to attend an arranged meeting, inform those involved ahead of time. Keep a diary with a list of appointments and contacts.

7. Community-based management measures

Community versus national fisheries regulations

In previous chapters, a case has been made that fisheries have to be managed, and that in order for fisheries to be sustainable, regulations which control fishing and fish catches will have to be imposed. To be effective, fisheries regulations must be enforced. In the case of national fisheries regulations, government staff, often fisheries or police officers, have the task of enforcing fisheries laws. In the case of community-based fisheries management, communities themselves enforce their own fisheries regulations.

This manual is concerned with encouraging communities to take conservation actions necessary to exploit seafood resources on a sustainable basis. Under such community-based management, fisheries regulations are more likely to be effective as they are enforced by communities with a direct interest in their continuation and success.

However, it must be recognised that there are many things that a local community cannot do. Some environmental problems are complex and involve activities and areas beyond the control of a local community. For example, fish catches may be falling in a particular village because silt from a nearby river is killing the corals in its lagoon. Mangroves may be dying because a sea-front road has been built without proper planning. These effects may be caused by decisions and actions taken some distance from the village. Siltation, for example, may be the result of poor farming techniques or the logging of timber in hills many kilometres away from the village.

Such problems can only be addressed by an integrated effort by government agencies and community groups working together. Integrated Coastal Zone Management (ICZM) takes into account the inter-dependence of ecosystems, and the involvement of many different agencies (for example, those responsible for agriculture, forestry, fisheries, public works and water supply) and other stakeholders. This is beyond the scope of this manual, but it may be possible for extension staff to provide the necessary link between communities and government to begin to address these issues.

Community conservation measures

In many respects, conservation measures and regulations that a village can impose on its own community will reflect and support those imposed by the government. The difference is that the measures and regulations are owned, imposed and enforced by the community. Communities must be allowed to take actions and to impose regulations that they have developed themselves (as long as these do not contradict national laws). Many communities have tradition-based controls on fishing. The following sections describe some types of fisheries regulations and controls in the Pacific, and discuss where these are applicable to village communities.

Limiting the number of fishers

In commercial fisheries, the numbers of fishers are often controlled. Often this is done by issuing a limited number of fishing licences. In the Cook Islands, for example, a set number of licences is issued for people to collect trochus. In subsistence fisheries, the method has little application.

However, some village communities in Samoa have limited the number of fishers permitted to use fence traps (see Chapter 2).

Numbers of fishers in the past were also controlled, in effect, by restrictions in access to a community fishing area. Trespassers who fished without permission in an area not controlled by their own group, would be stopped and punished by clan leaders. Some communities with strong traditional control over the marine resources are still able to practise this, but public ownership of the sea up to the high tide mark has made it legally unenforceable under the national government law. The increasing mobility and range of fishers has also made it difficult to maintain village control over who fishes in its waters.

Limiting the efficiency and types of fishing gear

The use of some highly efficient fishing methods may be restricted in the interests of conserving fish stocks and allowing more people to use the resource. Limitations on gear types may include banning a specific fishing method in particular areas, or on a particular species. For example, the use of gill nets may be banned in lagoons, or the use of scuba diving to catch lobsters may be banned. These regulations are more appropriate in subsistence fisheries (where the resource provides food for a large number of fishers) than in commercial fisheries where efficiency is more important. In Samoa, for example, some communities have placed restrictions on the use of underwater torches for spearfishing at night. In some subsistence fisheries, the survival of the resource depends on inefficient exploitation!

Commercial gillnetting has been banned by communities in parts of Fiji and this is supported by the government – in order to obtain the necessary government-issued licence for commercial fishing the applicant must first produce a district administration permit which is only given with the permission of the customary fishing rights holder. So, in effect, control over the fishing area and method rests with the local community. In Tuvalu, net fishing in the lagoons is also banned or strictly controlled by chiefs in some of the outer islands.

Banning destructive fishing

Highly destructive methods of fishing, such as those involving the use of chemicals, bleaches or explosives are illegal in most Pacific Island countries. Village communities may wish to support and enforce these laws, and add others of their own. Some village communities may ban the use of traditional plant-based fish poisons (*Derris*) even though this is not banned under national law. Some communities in Samoa have banned the traditional smashing of coral to catch small sheltering fish. Local clans of Marovo lagoon in the Solomon Islands enforce prohibitions on the use of dynamite and plant poisons.

Closed areas and seasons

Closed areas can be used to protect juveniles and the spawning stock. Shallow water mangrove habitats, for instance, are known to be nursery areas for many species and are permanently closed to fishing in some coastal areas. In some countries, for example, known breeding areas for trochus are permanently closed to fishing. Fishing can be banned either during particular seasons, or in particular areas, or both. If the spawning season of a particular species is known from traditional community knowledge, for example, a closed season at the time of spawning may allow adults to breed without interference. Turtles, for

example, are protected in some countries during the egg-laying months of November to February. Closures can also be used to prevent stocks being overfished.

Villages in Vanuatu have periodically closed their fishing areas for the collection of trochus and green snails. Following a radio advertisement by a government fisheries biologist, offering to provide advice to villages interested in managing their trochus stocks, a number of villages in Vanuatu implemented harvesting closure periods (Johannes, 1998). The closures were similar to customary taboos in design and enforcement but were also based on basic biological principles explained to them by the government fisheries team.

In response to concern about the high level of exploitation of sea cucumbers for the export market in the atoll of Ontong Java in the Solomon Islands, village leaders have closed the waters for fishing for the animals during alternate years. During the closed year the lagoon is open to trochus diving (Gillet & Lam, 1999).

In Samoa, a large number of villages have chosen to establish small areas closed to fishing in part of their traditional fishing areas. By social necessity, many of these community-owned MPAs are small. In terms of total fisheries production, a small reserve is unlikely to be as effective as a large one. Larger reserves are more likely to provide suitable breeding areas for small inshore pelagic fish such as mullets and scads, but even small reserves may be beneficial for non-migratory species. For non-migratory species, the combined larval production from many small reserves is likely to be greater than that from a smaller number of large ones. Although the community-owned MPAs are small, they are large in number, often with small separating distances, and form a network of fish refuges around the coast. Such a network may maximise linking of larval sources and suitable settlement areas and provide the means by which adjacent fishing areas are eventually replenished with marine species through reproduction and migration (King & Faasili, 1998a).

Minimum mesh sizes

Minimum mesh sizes in nets, and escape gaps in traps are applied in many fisheries to allow small individuals to escape and grow to a size at which they can reproduce at least once before capture. In many island countries, governments have imposed mesh size regulations, and rules set by local fishing communities can support and enforce these regulations. Some communities may set their own larger mesh sizes, to further reduce the catch of small fish.

Size limits (minimum legal lengths)

Limiting the size of individuals caught involves returning captured individuals smaller than a prescribed minimum size to the sea. Traditionally, size limits have been to applied to allow individual fish to spawn at least once before capture. Minimum legal size limits have been applied by national governments in Pacific Islands to many species including sea cucumbers, trochus, pearl oysters, giant clams, spiny lobsters, mangrove crabs and many species of fish. Size limits are only useful in fisheries where individuals are not harmed by the catching method, such as molluscs gathered by hand, or crustaceans caught in traps. Although some shallow-water fish caught on hooks may survive well if returned to the water immediately, this type of regulation has little application to spear-caught and deepwater fish species. Fish caught

in deep water are unlikely to survive after being hauled to the surface and released. Village communities may decide to support and enforce national regulations on minimum sizes. Some villages in Samoa have set their own minimum size limits, which are larger than those set under national regulations.

Rejection of females, or spawning females

Regulations making it illegal to retain females, or females bearing eggs, can only be applied sensibly to species in which the sexes can be distinguished easily by fishers, and where the catching method does not harm the individuals caught. The sex of most fish cannot be determined by external examination. In most crustaceans the sexes are readily distinguished, and regulations making it illegal to retain egg-bearing, or "berried", lobsters and crabs are commonly used in Pacific Islands. In subsistence fisheries, the regulation may have application in certain cases. One example is where crabs are caught in traps, and females bearing eggs can be returned to the sea. However, in cases where lobsters are caught by spearing, the regulation would be of no use.

Catch quotas

Fisheries agencies may determine that, in order to protect fish stocks, total catches should not exceed a certain amount called a quota. In the trochus fishery in the Cook Islands, for example, fisheries scientists have estimated that fishermen should be allowed to catch about 30% (or about 40 tonnes) of the total trochus stock each year. Once this quota has been reached the fishery is closed. In subsistence fisheries, catch quotas have little application. However applying a daily quota, or bag limit, for particularly desirable species is a possibility.

Protecting the marine environment

Different government organisations are responsible for, and make laws to protect, the marine environment. Community actions can often complement and extend these actions. Such actions can include protecting corals and mangroves, organising the collection of crown-of-thorns starfish, controlling the removal of beach sand, and banning the dumping of rubbish in lagoon waters. Some have, or can re-vitalise, customary controls on environmentally damaging practices. In a community-based project in Samoa, over 60 villages produced their own Village Fisheries Management Plans with a range of community undertakings which differed from village to village. The most common undertaking are summarised in Table 7.1.

Table 7.1: *Community actions and regulations in villages in Samoa. Figures in the right-hand column indicate the percentage of all villages using the particular action or regulation (from King & Faasili, 1999).*

ACTION / REGULATION	PERCENTAGE
Banning the use of chemicals and dynamite to kill fish.	100%
Banning the use of traditional plant-derived fish poisons.	100%
Establishing small protected areas in which fishing is banned.	86%
Banning other traditional destructive fishing methods (eg smashing coral).	80%
Organising collections of crown-of-thorns starfish.	80%
Enforcing (national) mesh size limits on nets.	75%
Banning the dumping of rubbish in lagoon waters.	71%
Banning the commercial collection of sea cucumbers (Holothuroidea).	41%
Banning the capture of fish less than a minimum size.	41%
Banning removal of mangroves (in villages with mangroves).	27%
Restricting the use of underwater torches for spearfishing at night.	21%
Banning the removal of beach sand.	14%
Placing controls or limits on the number of fish fences or traps.	<10%
Prohibiting the collection of live corals for the overseas aquarium trade.	<10%
Banning the coral-damaging collection of edible anemones (*Actinaria*).	<10%
Protecting areas in which palolo worms, *Eunice* spp., are traditionally gathered.	<10%
Offering prayers for the safe-keeping of the marine environment.	<10%

Community compliance and enforcement of regulations

Under community-based fisheries management, the rules and regulations described in the previous section are enforced by village communities. Under such community-based management, fisheries regulations are more likely to be effective as they are enforced by communities with a direct interest in their continuation and success.

Village rules and regulations are set by members of a community, and are therefore usually only applicable to members of that community. In cases where people from outside a village come into local waters to fish, the community may be powerless to insist that the visitors obey local rules. However, there may be customary ways of dealing with this problem, including negotiations with the home villages of offenders. Samoa has an infrastructure which allows rural communities to make their village rules into by-laws which, after government approval, apply to all people and become enforceable under national law (Faasili, 1997).

Some villages may decide to include the fines associated with breaches of various community regulations in their Village Fisheries Management Plan. Other communities may want to have village leaders or councils set fines, or apply them on a case-by-case basis. Although it is best left for the community to decide on appropriate fines, extension staff may be asked for advice.

The first and most important aspect of enforcement is education, and prosecution should be regarded as a measure of last resort. Each Fisheries Management Committee should be encouraged to make all

members of the community familiar with any regulations, and the reasons for their imposition. However, necessary regulations must be rigorously enforced to be effective and fair. If regulations are unenforced, benefits will accrue to those who ignore the regulations at the expense of those who fish according to the rules. Penalties applied should be significant to the offender, and relevant to the offence. For example, although a small fine may be appropriate in the case of a young person catching undersized fish, the use of explosives to catch fish should attract a large fine to act as an effective deterrent. Depending on local custom, village leaders can impose fines of cash, pigs, or food on offenders.

Supporting community-based fisheries management

Community-based fisheries management depends on the availability of professional technical support for the communities involved. Scientific input is required to assist communities with finding alternative sources of seafood and to advise on and monitor community actions.

Whether community-based or not, most fisheries conservation measures, including the prevention of destructive fishing and the imposition of fish size limits, will cause a short-term decrease in catches. The same is so for marine reserves as they reduce the area available for fishing. As most subsistence fishers require seafood for their families on a daily basis, it is unreasonable to expect fishing communities to adopt conservation measures which will initially reduce present catches of seafood even further without offering alternatives. Accordingly, an extension programme should include the promotion and development of alternative sources of seafood to those resulting from the present heavy and destructive exploitation of near-shore reefs and lagoons.

Alternatives could include the introduction of medium-sized, low-cost boats (to divert fishing pressure to areas immediately beyond the reefs), assistance and training in fishing beyond the reef, the promotion of village-level aquaculture and the restocking of depleted species of molluscs in village areas. Support could also include government assistance with non-fisheries development, particularly in livestock and agriculture. This would need the support of government departments other than those involved with fishing and the marine environment.

The overall aim is to compensate communities for the short-term decrease in availability of seafood which inevitably accompanies the imposition of fisheries regulations, whether community-based or not. A community-based extension programme which does not promote alternative means of obtaining seafood is unlikely to be sustainable.

The extension process outlined in Chapter 6 describes a joint effort with both the community and the government making certain commitments to help find solutions to problems. In this process the community agrees to certain actions, while the government agrees to reciprocal actions necessary to support the community's undertakings. These may involve the national fisheries agency providing technical advice on how to care for the marine environment, and on the development of alternative sources of seafood to those resulting from the present heavy exploitation of lagoons and damaged near-shore reefs. Non-government agencies may assist both the government and the community in this work, both in the area of information as well as training.

Village-level aquaculture

Village-level aquaculture is one way of ensuring the community continues to have a source of seafood. It can also be used to restock species that have been overfished; this is especially important for sedentary species such as sea cucumber, giant clam, trochus and green snail (Figures 2.5 and 2.6). The aquaculture and restocking potential of some species are still being assessed (e.g. sea cucumber) while other species are being farmed successfully at present (e.g. giant clam and green snail). Aquaculture of food or non-food species can also be used to provide a small-scale business for a community. In Palau several farms have

been set up growing sponges for export and research is being conducted on growing hard and soft corals for the aquarium trade.

Several questions should be asked, and the advice of fisheries agencies sought, before deciding which species would be appropriate for aquaculture. Is there a possibility that the farmed fish could have a detrimental effect on the environment? If being farmed for food for the community, is the fish acceptable to the local tastes? Is it easy and cheap to farm? How soon and how often will it be able to be harvested?

If appropriate research is not carried out, aquaculture may produce poor results. In Kiribati, *Tilapia mossambica* were introduced into milkfish ponds in the 1960s, to provide cheap protein. It was later found that the tilapia were eating milkfish fry and competing with the milkfish for food and space, resulting in poor growth of the milkfish. Tilapia, introduced as a food source to ponds in Tuvalu, are despised as a food fish locally. In Samoa, however, a fast-growing species of tilapia, *Tilapia niloticus*, has proven to be popular, easy to look after and cheap to feed.

Sometimes the long-term success of a project is affected by whether or not the whole community is involved. For instance, an aquaculture project in Palau, aimed at farming milkfish, rabbitfish and shrimp, provided training for the men in the communities where the farms were located. However, the traditional role of the men is to go fishing in boats while the main role of the women is to daily tend the crops. As the aquaculture project had more similarities with farming than with fishing, providing training for women would have been preferable (Lambeth, 1999). It may have been better to involve women in the day-to-day tasks of the fish farm while the men could have been responsible for the large and irregular tasks such as building the ponds and harvesting the fish. Not involving the whole community may have partially contributed to the failure of the project.

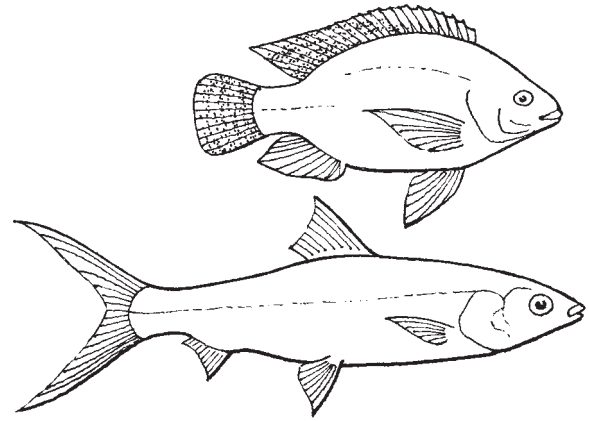

Figure 8.1: *Commonly farmed fish species include (from the top) tilapia (*Tilapia niloticus*) and milkfish (*Chanos chanos*).*

Fishing for less exploited species, and in less exploited areas

Fishing for offshore species is one alternative to overfishing in inshore areas which has the most potential for quickly providing seafood to the community. The introduction of low-cost boats and new fishing techniques into a community has the potential to reduce fishing pressure on inshore fish stocks while providing fishers with access to less-exploited areas and stocks. Tuna and other offshore resources are targeted by commercial and foreign fishing vessels in most Pacific Island countries, but their potential for subsistence fisheries should also be considered.

In Tuvalu the introduction of the outboard motor in the 1980s changed the fishing patterns of fishing communities. The men now find it easier and quicker to go trolling for tuna outside the lagoons to provide enough fish for the family, and subsequently, women do less inshore fishing. Although outboard motors were not initially introduced as a means of getting people to fish offshore, and the reasons for changes in fishing patterns are complex, the example shows the potential for moving fishing pressure to offshore areas. In Fiji and PNG attempts were made to introduce local fishermen to trolling for Spanish mackerel, *Scomberomorus commerson*, a popular food species which was not heavily exploited.

In Samoa low-cost boats with outboard engines for outer reef fishing were promoted in villages participating in the Fisheries Division's extension programme. This was combined with training in fishing gear and methods, fish handling and processing, sea safety, small-boat handling and outboard engine maintenance. A catch and effort data collection programme was also introduced with three-monthly summaries of the information being given to the fishermen to encourage continued interest. The relationship built up between the village fishers and the fisheries extension officers during the long process of developing the village fisheries management plan made it much easier to introduce a data collection programme. The catch and effort data are valuable in monitoring the long-term health of the species targeted, but it should be noted that the collection and analysis of data is a labour-intensive and difficult task for any fisheries agency.

The potential for fishing alternative inshore species is much more limited and care should be taken not to contribute to existing problems. There are species which are utilised in some parts of the Pacific and not in others, especially sea urchins, seaweeds and some types of sea cucumbers, but these are all very vulnerable to overexploitation. Any encouragement to fish for an alternative species should be combined with training and information on sustainable harvesting techniques. For instance, *Caulerpa* or sea grapes, are harvested in Fiji but not traditionally in Palau. In Fiji the women harvest carefully, leaving part of the plant behind to regrow and even replanting sections of the seaweed. In Palau, an increasing immigrant population, largely from the Philippines, is now starting to harvest sea grapes, and Fijian harvesting techniques could be used to conserve the resource (Lambeth, 1999).

Whichever alternative is promoted, the fisheries agency and the community should have an ongoing commitment to achieving and maintaining a healthy marine environment.

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Glossary of terms

Artisanal fishery: A small-scale, low-cost, and labour-intensive fishery in which the catch is consumed locally.

Bilateral and multilateral agreements: An arrangement whereby foreign fishers pay a fee for access to fish stocks not fully utilised by national fishers.

Biodiversity (biological diversity): The variety of living material in terms of genes, species and ecosystems within a given area.

Biomass: The total weight of a stock of a marine species.

Brackish water: A mixture of sea water and fresh water (as occurs near the mouths of rivers).

Carnivore: An animal which eats another animal.

Catch quota: The maximum catch permitted to be taken from a fishery; such a limit applied to the total catch from a fishery is often referred to as a global quota (as distinct from an individual quota).

Closures: The banning of fishing either during particular times or seasons (temporal closures), or in particular areas (spatial closures), or a combination of both.

Co-management (cooperative management): Either informal or legal arrangements between government representatives, community groups and other user groups, to take responsibility for, and manage, a fishery resource and / or its environment on a cooperative basis.

Community-based resource management: Arrangements under which a community takes, or is encouraged to take, responsibility for managing resources.

Coral polyp: A small individual coral animal with a tube-shaped body and a mouth surrounded by tentacles.

Critical habitats: Habitats which are crucial in the life-cycle of marine species; typically, nurseries and spawning areas, such as estuaries, mangroves, seagrass meadows and reefs.

Customary Marine Tenure (CMT): Legal, traditional or de facto control of areas of water by indigenous people.

Demersal: Living on, or near, the sea floor.

Ecologically Sustainable Development (ESD): Use of the environment which aims to meet present needs without compromising the ability of future generations to have the same privilege; development based on the sustainable use both of species and ecosystems, the maintenance of essential ecological processes, and the preservation of biological diversity.

Environmental Impact Assessment (EIA): The assessment of the effects of a development or activity on the environment and people.

Exclusive Economic Zone (EEZ): An area of sea out to 200 nautical miles from coastlines or outer reefs, in which an adjacent country has control and responsibilities.

Extinction: The total disappearance of a species.

Fisheries extension: Working with the community to provide, or to build on, skills and knowledge to achieve particular goals, such as an increase in seafood production, or the conservation of fish stocks and the environment.

Fisheries regulations: Controls designed to either restrict the amount, or efficiency, of fishing (input controls), or to restrict the total catch (output controls) to predefined limits in a fishery.

Herbivore: An animal which eats plant material.

Integrated Coastal Zone Management (ICZM): Coastal management which takes into account the inter-dependence of ecosystems, with the involvement of many different agencies (for example, those responsible for agriculture, forestry, fisheries, public works and water supply) and other stakeholders.

Joint ventures: A partnership between foreign and local fishers.

Larvae: The young stages of many marine animals including corals. Most larvae are small and drift in the sea before becoming adults.

Marine Protected Area (MPA): A marine reserve, park, or other area protected from uncontrolled human access and use by the application of various restrictions on activities, development and exploitation

Maximum Sustainable Yield (MSY): The largest annual catch that may be taken from a stock continuously without affecting the catch of future years; a constant long-term MSY is not a reality in most fisheries, where stock sizes vary with the strength of year classes moving through the fishery.

Minimum legal size: A regulation in which captured individuals smaller than a prescribed minimum size must be returned to the sea; usually justified on the grounds that growth of smaller individuals produces a greater harvestable biomass, and that the size of the spawning stock is increased.

Minimum mesh size: The smallest size of mesh permitted in nets and traps; imposed on the basis that smaller individuals will escape unharmed.

Nutrients: In the context of the marine environment, dissolved food material (mainly nitrates and phosphates) used by plants.

Overexploitation: The situation where so many fish are removed from a stock that reproduction cannot replace the numbers lost.

Pelagic: Living in the surface layers of the sea.

Photosynthesis: the process by which plant material is formed from water, nutrients and carbon dioxide using energy absorbed from sunlight.

Phytoplankton: Small (microscopic) plants, which drift in the sunlit surface layers of the sea.

Predator: An animal which hunts another (prey) species.

Primary producers: Plants, including algae and phytoplankton, which use sunlight and nutrients.

Property rights: A degree of resource ownership by an individual fisher, group or community.

Quota: A limit on the weight / number of fish which may be caught in a particular stock or area; a bag limit is a quota (usually in numbers of fish caught) applied to recreational fishers.

Recruitment: The addition of young or juveniles to an adult fishable stock.

Species: A distinct group of animals or plants able to breed amongst themselves but unable to breed with other groups.

Stakeholders: The different people, groups, communities and organisations that have an interest in a particular activity, resource or area.

Subsistence fishery: A fishery in which indigenous peoples catch fish for their own consumption.

Symbiosis: A relationship between two different creatures which live together for the benefit of both; zooxanthellae have a symbiotic relationship with coral polyps.

Target species: The resource species at which a fishing operation is directed.

Total Allowable Catch (TAC): The maximum catch allowed from a fishery in accordance with a specified management plan.

Zooplankton: Small animals, or the larvae of larger animals, which drift in the sea.

Zooxanthellae: Small plant cells living within coral polyps and the mantle of giant clams.

Joint review of Community-Based Management: form

The following review form is based on one used in Samoa. The purpose of the review is to assist the Fisheries Management Committee (FMC) to review its performance and to make any improvements necessary. The review aims to measure how effectively the Village Fisheries Management Plan has been used by the village, and how well the community has carried out its own undertakings.

The Joint Review should take place about 6 months after the Village Fisheries Management Plan has been approved, and at a time proposed by the community (and recorded in the plan). Because the village must consider this review as their own, extension staff must be very open in their investigation and avoid being seen as policemen. No investigation should be made by extension staff without the full knowledge of the FMC.

Before going to the village ***a) collect all relevant information from records.*** Then go to the village to interview FMC members as a group on ***b) their performance*** and ***c) the undertakings of the community.*** While in the village, ***d) interview 10 other people from the community.*** The following form should be used to record the information collected and calculate a total score for the village.

VILLAGE: ..... STAFF: ..... DATE(S): .....

A) INFORMATION FROM RECORDS

Staff should use information from their work and findings in the village concerned to circle either very good (score = 4), good (score 3), average (score 2), poor (score 1) or very poor (score 0)

If the village has a Fish Reserve, do records show that the community has shown good care by:

Cooperating / participating in surveys? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
Marking the reserve boundaries? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
Enforce rules banning fishing? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
SUBSECTION SCORE = ... *out of 12*

If the village has giant clams, do records show that the community has shown good care by:

Removing predators regularly? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
Cleaning cages regularly? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
Preventing loss by theft? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4

SUBSECTION SCORE = ... *out of 12*

If the village has tilapia, do records show that the community has shown good care by:

Feeding the fish regularly? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
Maintaining the pond? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
Making regular catches? [very good] [good] [average] [poor] [very poor] SCORE ..... / 4
SUBSECTION SCORE = ... *out of 12*

ACTUAL SCORE = ... out of ..... possible marks. ***CORRECT TO*** ..... out of 20
(*if out of 12 then times by 20 / 12; if out of 24 then times by 20 / 24; if out of 36 then times by 20 / 36*)

B) INTERVIEW WITH FMC MEMBERS

On the day of the Review, meet with the FMC members to discuss the review. Suggest that the process should be as honest / unbiased and thorough as possible and that it would be desirable, for example, to interview a range of villagers not involved in the FMC.

How many people were on the FMC originally? ..... people.
How many people are on the FMC now? ..... people.
If people have left the FMC, why is this? .....

If no decrease in people score 2; if decrease of 1-3 score 1; if more than 3 score 0 >> SCORE =..... / 2

What additional relevant activities has the FMC undertaken other than those in the management plan?
.....

If activities undertaken score 1; if no activities undertaken score 0 >>> SCORE =..... / 1

In the last three months;

How many times has the FMC held meetings?..... times.
If 3 or more meetings score 3; if 2 score 2; if 1 score 1, if 0 score 0 >>> *SCORE =..... out of 3*

On average, how many people attend each FMC meeting?.....people.
If more than 8 people score = 3; if 6 to 8 =2; if 3 to 5 =1, if less than 3 = 0 >>> *SCORE =..... out of 3*

How many times have meetings been held with other people in the village? ..... times
If 3 or more meetings score 3; if 2 score 2; if 1 score 1, if 0 score 0 >>> *SCORE =..... out of 3*

How many times has the FMC reported to the village leaders? .....times
If 3 or more meetings score 3; if 2 score 2; if 1 score 1, if 0 score 0 >>> *SCORE =..... out of 3*

ACTUAL SCORE = ...out of 15.

C) INTERVIEW WITH FMC MEMBERS ON UNDERTAKINGS

Examine each undertaking one by one and consider the following

If the undertaking involves a conservation activity, has this been carried out?

If the undertaking involves a rule or regulation, is the rule being enforced, how many people are breaking the rule, and how many people have had to pay a penalty for breaking this law?

UNDERTAKING .....

How well has the undertaking been carried out? [very well] [well] [not well] [very poorly]
(Score 3 for very well; 2 for well; 1 for not well; 0 for very poorly) >>>> *SCORE = ... / 3*

(Repeat the above for all of the village undertakings. Obtain the total score the following way:)

TOTAL NUMBER OF UNDERTAKINGS (U) = ...
TOTAL SCORE (S) =.....out of a maximum possible score (3 times U) of.....
CORRECT TO ..... out of 50 (by calculating S X 50 / (3 X U)

Example - If the community has 6 undertakings the maximum possible score (3 times U) is 18
If the village scored 12, multiply this by 50 / 18 to give 33

What more could the village / FMC / agency be doing to protect its fish stock and its marine environment?

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.....

D) INTERVIEW WITH OTHER VILLAGERS

Choose 10 adults (not FMC members) at random. Out of the ten people you interviewed:

How many know that this village has a Fisheries Management Plan?	SCORE = *people* ..... *out of 10*
How many have seen the Fisheries Management Plan?	SCORE = *people* ..... *out of 10*
How many know the name of at least one of the FMC members?	SCORE = *people* ..... *out of 10*
How many think that having a Fisheries Management Plan is good?	SCORE = *people* ..... *out of 10*

What more could the village / FMC / agency be doing to protect fish stocks and the marine environment?

.....

.....

TOTAL SCORE = ... out of 40. **CORRECT TO** .....out of 15 (times total score by 15 / 40)

TOTAL SCORE FOR THE REVIEW

Section A = ... out of 20
Section B = ... out of 15
Section C = ... out of 50
Section D = ... out of 15
TOTAL = ... **out of 100**

ASSESSMENT OF FISHERIES DIVISION PERFORMANCE

Explain that this is a joint review, and FMC members must have the right to comment on the performance of extension staff. Encourage members to be honest in their comments, and to highlight any areas where support should be improved.

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COMMUNITY FISHERIES SECTION
Secretariat of the Pacific Community
Noumea, New Caledonia

NZODA

AusAID

Design and Layout : Patricia Martin