

# Guide to **information sheets** on fisheries management for communities



Pacific  
Community  
Communauté  
du Pacifique

The Locally-Managed Marine Area (LMMA) Network



Improving the practice of marine conservation



EUROPEAN UNION





# Guide to information sheets on fisheries management for communities

This guide introduces a series of information sheets on important groups of marine species used for food in the Pacific Islands. The series has been produced by the Pacific Community (SPC – [www.spc.int](http://www.spc.int)) in collaboration with the Locally-Managed Marine Area (LMMA) Network ([www.lmmanetwork.org](http://www.lmmanetwork.org)).

The purpose of the information sheets is to assist fishing communities, and people working with them, by providing information on species of interest and advice on **appropriate fisheries management options** for them. Community-based fisheries management involves fishing communities taking a key role in managing the fisheries resources on which they rely for both food security and livelihoods. To do this, communities require technical information and advice on the resource species involved.

## THIS GUIDE CONTAINS THE FOLLOWING SECTIONS:

1. Information sheets and leaflets available
2. Fish in Pacific Island coastal fisheries
3. Inshore fishing methods and gear
4. Fisheries management by communities
5. Fisheries management measures
6. Community-managed marine reserves or no-take areas
7. Discussions in fishing communities
8. Glossary of useful terms





# 1 Information sheets and leaflets available

The sheets and leaflets listed below, provide:

1. Information on important marine species that are common in Pacific Islands. Each sheet provides information on the species, distribution, habitats and feeding, lifecycle and reproduction, fishing methods and fisheries management options.
2. Information on important marine environments, group of species or natural events, and fishing techniques that often require careful management.

The 29 information sheets and three leaflets are available from the Pacific Community and others may be produced based on demand. **This guide should be kept for future use and reference when using the information sheets and leaflets.**

The information sheets are not designed to enable the identification of various species; a number of national, FAO and SPC publications are available for this purpose.

## Information sheets

1. **Groupers** (Epinephelidae)

2. **Rabbitfish** (Siganidae)

3. **Emperors** (Lethrinidae)

4. **Parrotfish** (Scaridae)

5. **Reef snappers** (Lutjanidae)

6. **Trevallies** (Carangidae)

7. **Mulletts** (Mugilidae)

8. **Surgeonfish** (Acanthuridae)

9. **Sea cucumbers** (Holothurians)

10. **Giant clams** (Tridacnidae)

11. **Trochus** (*Tectus niloticus*)

12. **Mangrove crab** (*Scylla serrata*)

13. **Spiny lobsters** (Palinuridae)

14. **Coconut crab** (*Birgus latro*)

15. **Octopuses**

16. **Green snail** (*Turbo marmoratus*)

17. **Reef sharks**

18. **Rays & Skates**

19. **Sea urchins**

20. **Crown-of-thorns** (*Acanthaster planci*)

21. **Slipper lobsters** (Scyllaridae)

22. **Ark clams** (*Anadara* sp.)

23. **Edible seaweeds**

24. **Spawning aggregations**

25. **Mangroves**

26. **Seagrasses**

27. **Nutrients and sediments**

28. **Harmful algal blooms**

29. **Plant-eating fish**

## Information leaflets

- **Community resource management**
- **Community-managed no-take areas in fisheries management**
- **Destructive fishing**



## 2 Fish in Pacific Island coastal fisheries

Between 200 and 300 species of fish are caught in coastal fisheries in the Pacific Islands. The following table (from Dalzell and Schug, 2002<sup>1</sup>) shows the average composition of landings from

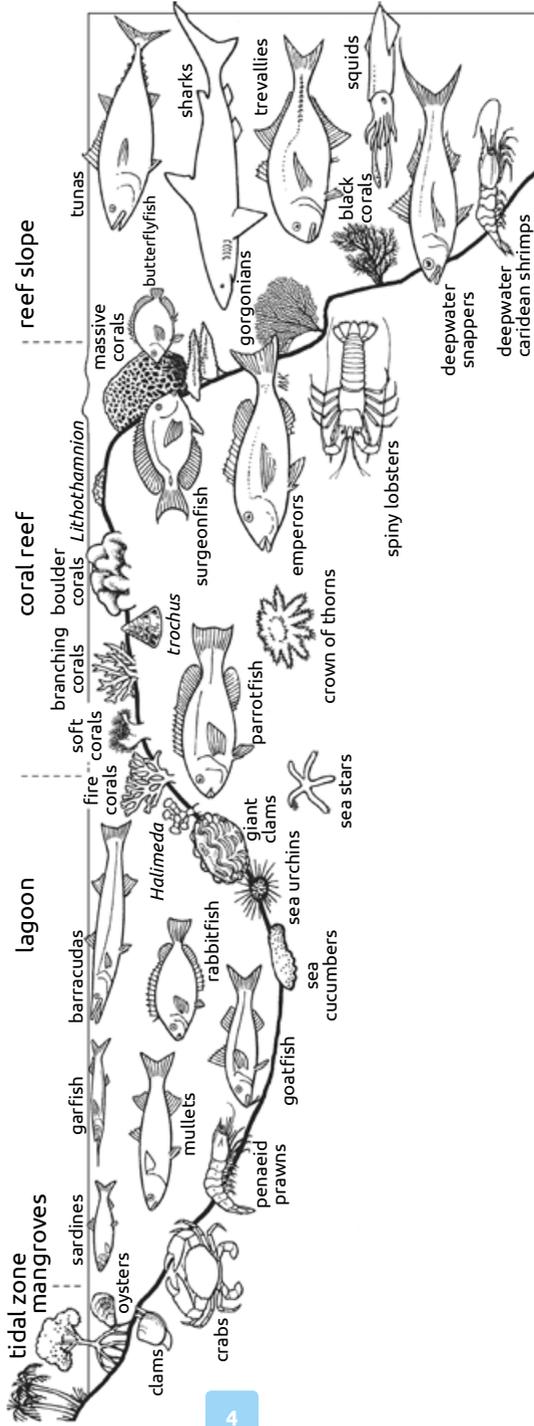
15 locations in the western and central areas of the region. Approximately one-third of the catch total is made up of emperors (Lethrinidae), surgeonfish (Acanthuridae) and snappers (Lutjanidae).

Common name	Family name	Percentage
Emperors	Lethrinidae	13.32
Surgeonfish	Acanthuridae	10.91
Snappers	Lutjanidae	9.19
Trevallies	Carangidae	7.19
Groupers	Epinephelidae	6.96
Mulletts	Mugilidae	6.90
Parrotfish	Scaridae	6.58
Tuna/mackerels	Scombridae	5.53
Goatfish	Mullidae	3.25
Rabbitfish	Siganidae	2.92
Soldierfish/squirrelfish	Holocentridae	2.69
Barraccudas	Sphyraenidae	1.53
Bonefish	Albulidae	1.36
Grunts	Haemulidae	0.89
Needlefish	Belonidae	0.81
Triggerfish	Balistidae	0.74
Wrasses	Labridae	0.52
Mojarras	Gerridae	0.49
Garfish	Hemiramphidae	0.17
Milkfish	Chanidae	0.15
Surf perches	Theraponidae	0.03
Others		17.87

<sup>1</sup> Dalzell, P. and Schug, D. 2002. Synopsis of information relating to sustainable coastal fisheries. Technical Report 2002/04. International Waters Programme, South Pacific Regional Environment Programme, Apia, Samoa.



**A profile of a typical lagoon and barrier reef system with some representative marine species.**





# 3 Inshore fishing methods and gear

A large range of fishing gear is used in fishing communities and some basic types are described in this section.

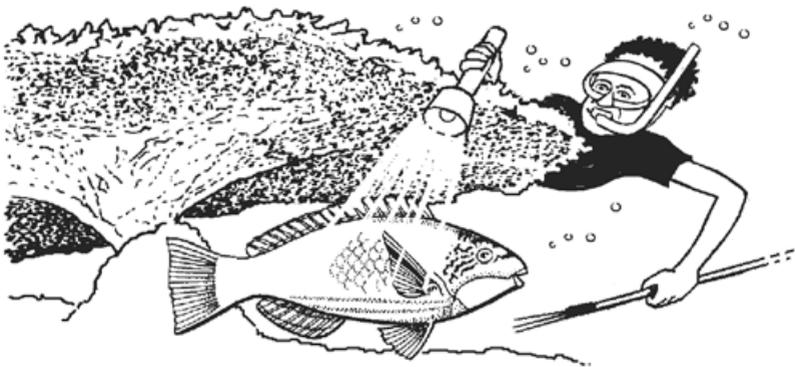
## REEF CLEANING

Collecting marine animals and seaweed in lagoons or on the reef flat at low tide is a common activity, particularly for women and children. A variety of species is collected in this way, including sea cucumbers, sea urchins, crabs, sea snails, seaweeds, eels, small fish, worms, jellyfish and octopuses. Lobsters are also collected on the reef at night. Collection can be done by hand, by digging in the sand or mud with the feet, by overturning or breaking corals and rocks, and by using sticks and hooks in the reef. Although the amount of food collected by one person in this manner may be quite small, damage to the reef and marine life can be considerable.

## SPEARS

Spears are used in a variety of ways, 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. Fishers 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 some inshore marine life.

Some larger fish, such as parrotfish, sleep among the corals at night for protection from predators, making them easy targets for fishers with torches and spears. Masks, fins, SCUBA gear, steel spears and spear guns have also increased the effectiveness of spear fishing.

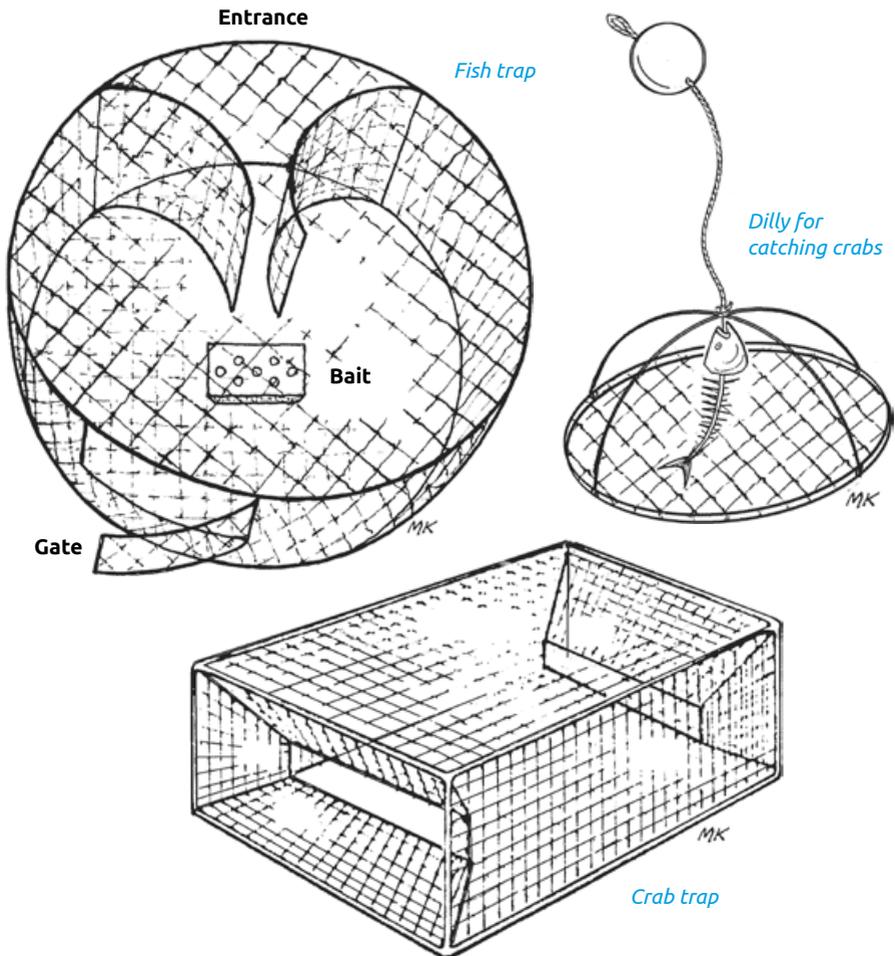




## PORTABLE TRAPS

Cane, bamboo and mangrove wood traps have been used throughout the Pacific for hundreds of years. The use of modern materials, including synthetic netting and wire mesh, has made traps easier to build and their use is now more widespread.

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 crabs and various flesh-eating species of fish.



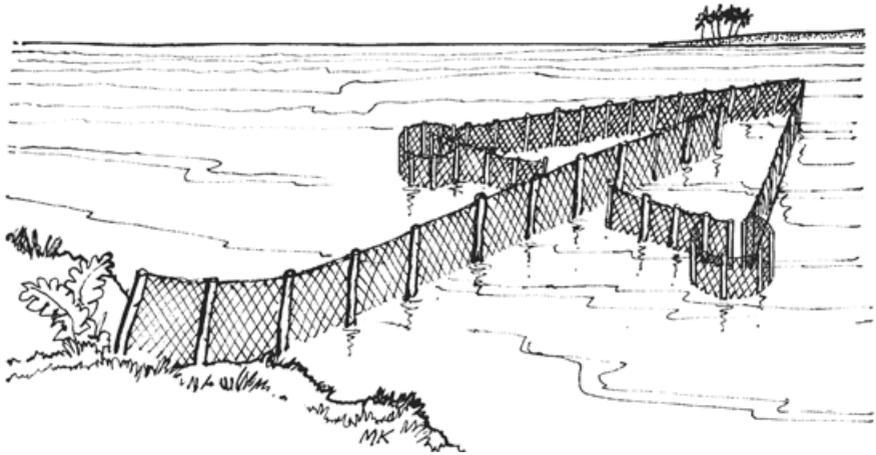


## BARRIER AND FENCE TRAPS

Barrier and fence traps are some of the oldest ways of community fishing. The simplest traditional traps use the falling tide to strand fish in v-shaped or semi-circular walls of stone or coral. 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.

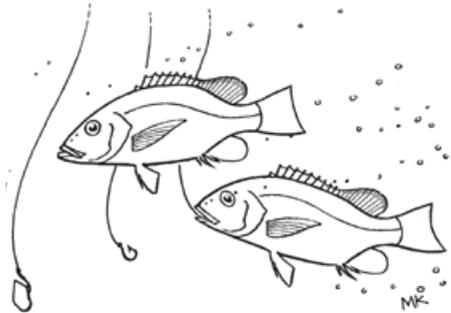
Fence traps usually consist of a fence or wall built at right-angles from shore-lines and reefs to guide migrating coastal fish into

a large retaining area. When fish meet the fence they swim along it until they reach the retaining area from which it is difficult to escape. Designs are often traditional and vary between regions. Although originally made from stone or coral blocks, fence traps are now usually made from modern materials such as wire-mesh netting. Their ease of construction, as well as their use by increasing numbers of people, has resulted in decreases in many populations of fish such as mullet.



## BAITED HOOKS AND LINES

Hook and line gear is used in a wide range of configurations. Handlining gear consists simply of one or more baited hooks attached to a line, which is weighted at the bottom when used to catch fish that live on the sea floor. Modern circle hooks are similar in design to the bone or shell hooks used since prehistoric times in the Pacific Islands.





## LURES AND TROLLING (TOWING LURES)

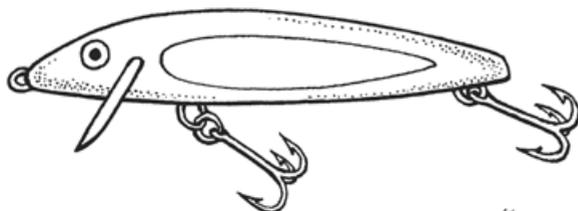
Natural or artificial lures attached to lines may be towed (or trolled) behind boats in inshore areas to catch fish such as trevallies and snappers. In general, lures are designed to attract fish by having one or more of the following characteristics: an erratic movement when towed through the water (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 more hooks as a natural bait for trolling.

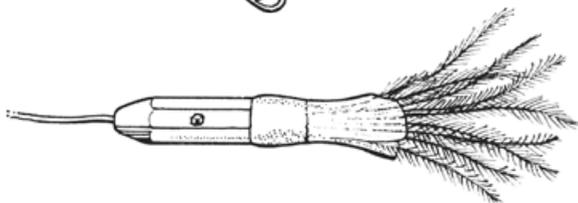
Lures can also be used in casting. In this method, the lure is attached to a line on a fishing rod. The rod is used to cast the line and the lure into the sea and then used to reel the lure back in.



*Traditional pearl-shell lure with a steel hook*



*Manufactured 'hard' fish diving lure*



*Manufactured 'soft' fish lure*

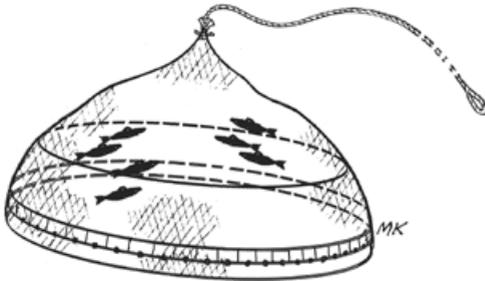


*Garfish used as natural bait*



## CAST NETS

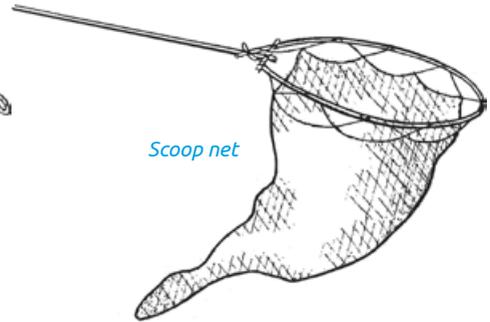
A cast net is a circular net which is thrown (or cast) from the shore or from a small boat into shallow water. When the net is thrown it opens into a large rounded cone (like a parachute). Weights at its edge drag the net down over schooling fish and the net closes as it is hauled in. Catches include sardines, mullets, rabbitfish and scads.



*Cast net after it has been thrown*

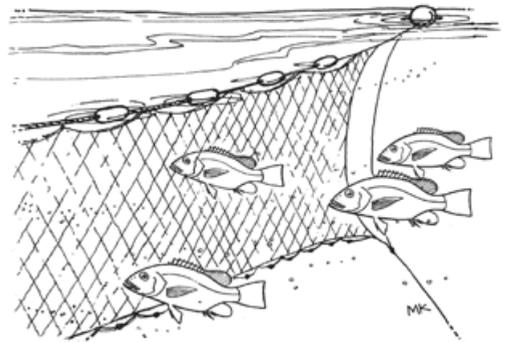
## SCOOP NETS

A scoop net consists of a cone-shaped net attached to a circular frame at the end of a handle. Scoop nets are used, sometime at night with the aid of a light, to catch small fish and prawns.



## GILL NETS

Gill nets are panels of netting held vertically in the water by a series of floats attached to their upper edge (the floatline) and weights attached to their lower edge (the leadline). These nets are anchored in shallow water to catch several species of fish including mullet and mackerel. The nets are often made from almost invisible nylon strands, which lock behind the gill covers of fish. Gill nets have a mesh size designed to catch a specific size range of particular fish; a well-set gill net with the correct sized mesh will allow very small and very large fish to escape.

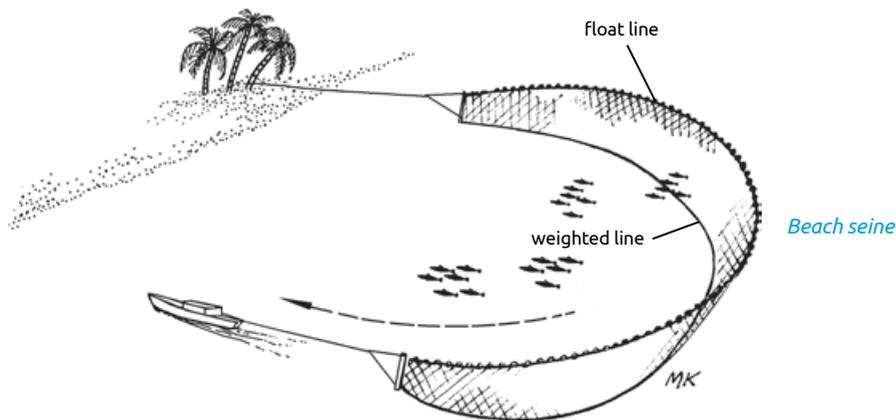




## SEINE NETS

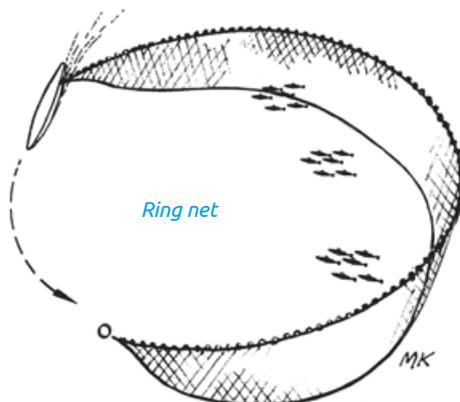
A seine net (sometimes called a beach seine if it is set from the shore) consists of a long panel of netting which is set around shore-line schools of fish and dragged ashore. The net is weighted to keep the lower side of the panel in contact with the sea floor, and has floats to keep its upper side at the sea's surface.

Some beach seines have a central panel of loose netting which forms a bag (or codend) to retain fish. Ways of employing beach seines vary, but often one end of the net is anchored on the shore, and a boat is used to set the net in a large arc and back to the shore before hauling (see illustration).



## RING NETS

A ring net is a panel of netting used to surround fish. Often, one end of the net is tied to a float and a boat is used to set the net in a circle around a school of fish. When the circle is completed, the end of the net is attached to the front of the boat. The net is then slowly pulled in from the back of the boat to reduce the size of the circle and concentrate the fish. The water is splashed to scare the fish into the net. Hauling of the net continues and the fish are removed as the net comes onboard the boat. Sometimes ring nets are used at night with a light mounted on the boat to attract fish.





## 4 Fisheries management by communities

The main aim of fisheries management, whether by communities or national fisheries authorities, is to ensure that fishing is sustainable. If management is successful, seafood will continue to be available for local fishers both now and in the future.

Sustainable fishing means allowing adult fish to live long enough to breed and produce small fish, many of which will grow and be available to be caught in future years, and protecting the habitats on which the fish and other species rely. Important habitats include mangroves, seagrass beds and corals.

This broad approach of managing not only fish but the areas in which they live has been called an ecosystem approach to fisheries management. When applied by fishing communities, the approach has been called the community-based ecosystem approach to fisheries management (CEAFM), that is, the management of fisheries, within an ecosystem context, by local communities working with government and other partners.

Communities should use all available information to manage their seafood resources. Scientific information is available from community advisers, national fisheries agencies, non-government organisations such as the LMMA Network, and regional organisations such as SPC.

**It must be remembered that fisheries management is mainly about managing people. Often it involves preventing people from taking too many fish, using damaging fishing methods and harming the marine environment.**



But most of all, communities should take advantage of the knowledge of local fishers. People fishing locally will often know where and when fish breed. They may also know which fishing methods are damaging fisheries and the marine environment.

Many methods or 'tools' are available to manage fisheries and some are listed in Section 5. Many of these have been applied by Pacific Island fishing communities for hundreds of years.

Whatever management tools are used, it is necessary to determine whether they are achieving what they are meant to. For a community, the most appropriate indication is whether management measures are improving or sustaining catches in the managed area.

**Thus answers to certain questions, such as the following, are needed:**

- **is the fish reserve working? Are numbers of fish increasing?**
- **is the ban (or 'tabu') on fishing with nets increasing the numbers of fish?**
- **is the tabu on catching certain species resulting in a greater number of fish?**



If the management measures taken by the community are not working then some other measures should be taken. This is the process of what fisheries scientists call 'adaptive management' – trying some sensible management measure and then seeing if it works; if it's not achieving results then it should be modified or other management measures should be tried.



Community fishers are most interested in whether or not management measures are resulting in, or will result in, increased catches in local fishing areas. The most basic measures are catch rates and fish sizes (see points 7e and 7f in section 7).

Catch rates refer to the amount of fish caught in a given fishing time or, alternatively, the amount of time it takes to catch a certain amount of fish, such as the time taken to catch a standard string of fish, a basket of clams, or a number of lobsters.

→ If this fishing time is increasing, the numbers of fish are probably decreasing and management is not effective. **In this case, different or additional management measures should be applied.**

→ If this fishing time is remaining the same, the numbers of fish are probably remaining the same. **In this case, some additional, or adjustment to management measures could be considered.**

→ If this fishing time is decreasing, the numbers of fish or other species are probably increasing. **In this the case, the management measures taken are probably effective.**

This assessment based on information from local fishers has sometimes been called 'data-less management' as it is not based on time-consuming and often expensive surveys by fisheries scientists.



# 5 Fisheries management measures

Fisheries management measures include the regulations applied by national fisheries authorities, and the rules made by a community, to try to ensure that fishing is sustainable and that fish stocks will continue to provide food in the future. A wide range of measures could be applied to protect different species and some of these are listed below.

**Not all of these measures are appropriate for all species. Each individual information sheet should be consulted for the management options that are appropriate for specific species.**

- **Limiting the amount of fishing:**  
a regulation that limits the number of people fishing or the time that can be spent fishing; for example by restricting fishing to members of a particular community.
- **Limiting the type or efficiency of fishing gear used:**  
a regulation that bans or controls the use of damaging or over-efficient gear; for example, not allowing the use of gill nets over a certain length and with mesh sizes less than a certain size or banning the use of underwater breathing apparatus, such as SCUBA, in dive fisheries.
- **Limiting the amount of fish that can be caught:**  
a regulation that places limits (bag limits or quotas) on the number or weight of fish caught; for example, the limits placed on trochus catches in some countries.
- **Minimum size limit:**  
a regulation that specifies the smallest captured individual that may be kept, usually justified on the grounds that an individual should be allowed to reproduce at least once before being caught.
- **Maximum size limit:**  
a regulation that specifies the largest captured individual that may be kept, usually justified on the grounds that larger females produce a greater number of eggs or that larger individuals are less valuable than smaller individuals.
- **Rejecting breeding female crustaceans:**  
a regulation that requires fishers to return females bearing eggs to the sea in order to allow them to produce young.
- **Closing fishing areas and seasons:**  
a regulation that bans fishing either during particular times or seasons or in particular areas, or during a combination of both; for example, a particular spawning aggregation site could be closed on a seasonal basis.
- **Fish reserves (permanent no-take areas):**  
an area in which no fishing is allowed; benefits may include allowing numbers of fish to increase and individuals to grow and reproduce; a community's expectation is often that banning fishing in part of its traditional fishing area will eventually improve fish catches in nearby areas. Fish reserves are discussed as a special case in Section 6.

**It is important to note that none of the measures will be of any use unless people agree to respect any management rules made and unless these are enforced by community leaders.**

In most fisheries a mixture of one or more of the above management measures or regulations may be needed to achieve the sustainability of fish stocks.



## 6 Community-managed fish reserves or no-take areas

Because fish reserves, marine reserves or no-take areas have been established or are being considered by many communities in various Pacific Islands, they are discussed here as a special case. However, establishing a no-take area is just one of the management measures that can be taken to protect fish populations; they do not work equally well in protecting all marine species.

Nevertheless, no-take areas have the potential to protect many of the plants and animals (the biodiversity) of an area including fish habitats, ecosystems and the species that depend on them. However, local people who require a daily supply of seafood are more interested in whether or not the reserve will result in increased catches in nearby local fishing areas.

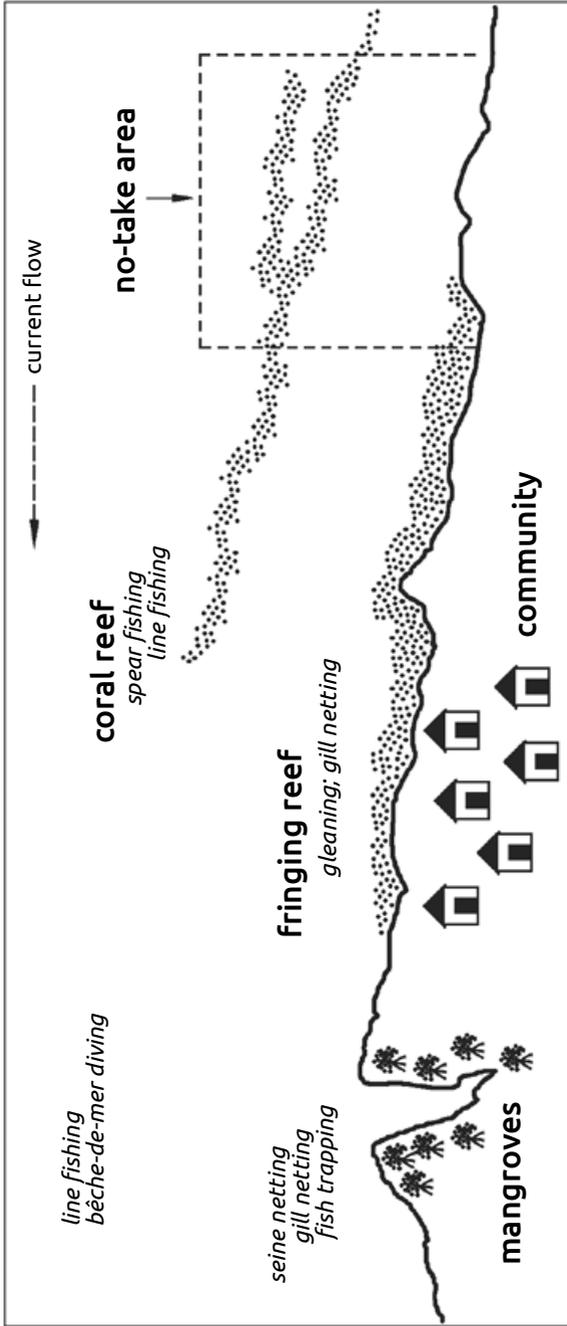
**The effectiveness of a marine reserve depends on several things including the size and location of the reserve and the species that are being managed. In general the following points should be considered:**

- For species that move a lot (highly mobile species) such as mullet, a small reserve will not be of any use;
- For species that move to distant spawning areas, a local small reserve will not protect them from being over-exploited as they move to, or gather in, spawning aggregations;
- For some species with a short drifting larval stage (for example, trochus), reproduction will produce juveniles that are likely to become distributed within the reserve and in nearby fishing areas. This suggests that even small local marine reserves may be effective in building up local populations, especially if the reserve is positioned so that the larvae are carried by currents from the reserve into the fishing area;
- For some species with a long larval stage (for example, lobsters) reproduction will produce juveniles that are likely to become distributed in areas some distance from the reserve and local fishing areas. This suggests that local fish reserves may not be so effective in building up *local* populations of such species. Such reserves may be beneficial on a *wider regional or country-wide scale*, particularly if there are a large number of small reserves spread over a coastline.



## Managed areas

A managed area is one that contains the resources that are to be managed. In many cases, this includes the traditional fishing grounds of a community and, often, the area over which a local community, or several communities, has some degree of control.



The above sketch map of a managed area shows key features including a mangrove forest, fringing reef, coral reef and various fishing areas. The managed area may include, although not necessarily, a no-take area. Note that the no-take area has been positioned so that the current is likely to distribute the small floating forms (the larvae) from the reserve into the fishing area.



## 7 Discussions in fishing communities

This section provides a guide for topics that should be discussed in fishing communities. Such discussions are essential in all community-based resource management approaches to ensure that the best use is made of local and traditional knowledge. This approach also ensures that fisheries management is 'owned' by the fisheries community.

### a) What are the local names for this (these) species?

Common names within a country may differ from place to place. It is important to be sure that everyone is referring to the same species or group of species. It may be helpful to have some illustrations or photographs of the species available during meetings.

### b) Are there any national fisheries regulations that apply to this (these) species?

National regulations take precedence over community rules. It is important to know if there are any regulations that apply and that the fishers in the community are aware of them. Community rules must not contravene or contradict national laws and regulations.

### c) What is the community's fishing area for this species (or species group)?

The fishing area should be recorded in a sketch map of the managed area (or the area intended to be managed) with items of interest, such as reefs and shoreline landmarks, included. A sketch map including many such features is shown in the box. Take note of areas that are being affected (for example, by siltation, rubbish dumps, and pollution) through the actions of people, including those outside the community.

### d) Does the community have some control over its fishing area?

Some communities have traditional control over adjacent fishing areas. If communities have no traditional control, some countries, such as Tonga, have established Special Management Areas (SMAs) to allow coastal communities to manage their fisheries.

### e) How have catch rates (catch per day or fishing trip) changed over the past 10 years?

It is important to have some idea of any changes in catch rates. For example, how long did it take to catch a basket or a string of fish 10 years ago and 5 years ago; how do these catch rates compare with those at present? As a very general rule, if it takes people twice as long to catch the same amount of fish as in the past, the fish stock is likely to be fully exploited. If it takes people more than twice as long to catch the same amount of fish as in the past, the fish stock is likely to be overexploited.

### f) How have fish lengths changed over the past 10 years?

Fishing usually removes the larger fish from fish populations. If the average (or usual) size of a particular species in catches is decreasing, it may mean that the species is being too heavily fished (or being overfished). Management measures are needed to protect the species.



**g) What fishing methods are used by fishers in the community?**

The community may use fishing methods that are different from the general ones given in the information sheets. Are any of these fishing methods harmful to the species' population or the marine environment?

**h) Does the species have particular spawning seasons or spawning areas?**

Members of the community may have answers to this question. This information could be used by the community in managing the fishery, for example, by reducing or stopping fishing at certain times of the year or in certain areas.

**i) What can be done to make catches of the species more sustainable?**

Members of the community may suggest practical management actions that could be taken. These suggestions should be discussed with the options given in the various information sheets.

**j) Does the fishing community have the motivation and ability to take management actions in the interests of sustainable fish catches and the well-being of future generations?**

The three ingredients of successful community-based fisheries management are awareness, concern, and action. In other words, a community must be aware of their fisheries problems and sufficiently concerned about these to take strong, independent actions.

**k) Is the fishing community willing to enforce any management rules that it makes?**

The success of community-based fishing management relies heavily on all members of the community respecting the management rules that are made. What would the community or its leaders do about those who disregard the management rules made by the community?





## 8 Glossary of useful terms

Although information sheets in the series have been prepared using as few technical terms as possible, the following definitions may be useful.

**Adult:**

A mature, grown-up stage in a species life cycle.

**Ciguatera:**

Fish poisoning resulting from eating fish that have built up poisons by eating particular very small plants (phytoplankton) that are associated with coral reefs. A cartoon used to raise community awareness of ciguatera in Pacific Islands is shown at the end of this section.

**Community rule:**

A rule (similar to a nationally-imposed regulation) that is decided on, agreed to and enforced by a fishing community.

**Community-based ecosystem approach to fisheries management (CEAFM):**

The management of fisheries within an ecosystem context (including fishers, fish and their habitats) by local communities working with government and other partners. This includes the management of shore-based activities (such as agriculture and farming) that affect the marine environment.

**Community-based fisheries management (CBFM):**

Arrangements under which a community takes responsibility, usually with government or NGO assistance, for managing its coastal environment and fisheries.

**Customary marine tenure (CMT):**

Legal, traditional or de facto control of land, sea and resources by indigenous people.

**Destructive fishing:**

Methods of fishing that are harmful to populations of fish (for example, fishing

on spawning aggregations) or the marine environment (for example, the breaking of coral to catch small fish and the use of poisons or dynamite to capture fish).

**Ecosystem:**

A system containing plants and animals (including humans) which interact with each other as well as with the non-living components of the environment.

**Eggs:**

Cells produced by a female, which can develop into new individuals when fertilised by sperm.

**Fish reserve (no-take area):**

An area in which no fishing is allowed.

**Food web:**

The feeding relationships connecting all plants and animals.

**Habitat:**

The natural home of an animal such as a fish or clam.

**Hookah:**

Gear that pumps air to people diving underwater without the use of SCUBA.

**Juvenile:**

The young of a species not yet able to reproduce.

**Key habitats (or critical habitats):**

The most important habitats in the life cycle of species; for fisheries these may include nursery and spawning areas such as estuaries, mangroves, seagrass meadows and reefs.

**Larva (plural larvae; pronounced lar-vee):**

In marine species, often the very small floating stages between eggs and juveniles.

**Managed area:**

The area containing the resources that are to be managed, often the traditional area controlled to some extent at least by a local community or several communities.

**Marine Protected Area (MPA):**

A protected marine area set aside by law or other effective means to provide degrees of preservation and protection for important marine biodiversity, resources and habitats depending on the degree of use permitted. Fishing may be regulated and could be prohibited in some part or all of an MPA. In some Pacific Island countries, the term is often used imprecisely to denote a no-take area in which fishing is prohibited.

**No-take area (or Fish reserve):**

An area in which no fishing is allowed.

**Overexploitation or overfishing:**

The fishing or exploitation of a population (including fish, clams, crabs and others) to a level that is not sustainable, that is, fishing that will result in catches continuing to decrease over time.

**Pollution (marine):**

The introduction by humans, either directly or indirectly, of any substance into the sea which results in harm to the marine environment.

**Scientific name:**

A name of a species that is the same in all countries and in all languages. It consists of two parts – the genus name (a grouping of individuals with some common features) and the species name (individuals within a genus with many common features) – for example, the white teatfish, *Holothuria fuscogilva* and the black teatfish, *Holothuria whitmaei*, are similar enough to be in same genus but are sufficiently different to be regarded as separate species.

**SCUBA:**

Self-Contained Underwater Breathing Apparatus which consists of an air bottle or tank with a regulator and mouthpiece such as the aqualung.

**Spawning aggregation:**

A grouping of a single type of fish, gathered together in greater numbers than normal for the specific purpose of reproducing. Many aggregations form at the same place and the same time each year. The best-known examples are certain species of grouper and snapper, but many surgeonfish, rabbitfish, parrotfish, and wrasses also aggregate to spawn.

**Spawning site:**

The place at which a species gathers in a spawning aggregation.

**Spawning:**

The act of releasing eggs and sperm.

**Species:**

A group of living things in which individuals are, in many ways, the same and are capable of breeding with each other.

**Sperm:**

Substance released by males that is capable of fertilising the eggs produced by females.

**Subsistence fishery:**

A fishery in which the catches are shared and consumed directly by the families of the fishers and community members rather than being sold.

**Sustainable:**

Something (in this case, fishing) that can be kept up forever.

**Underwater breathing apparatus:**

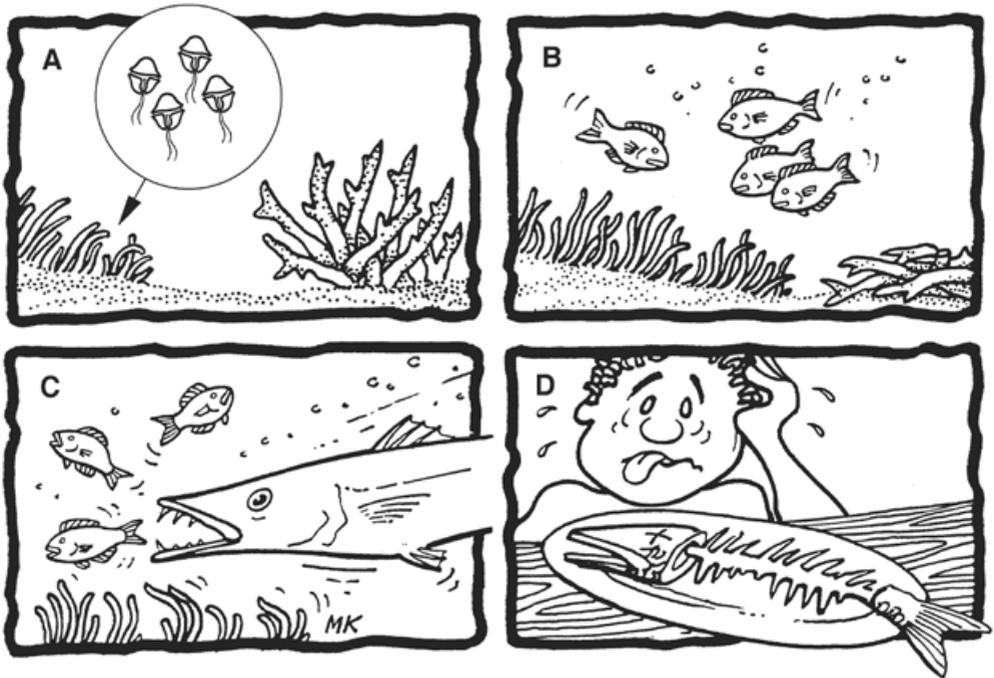
Equipment, such as SCUBA or Hookah, which allows a person to breath air or gas while underwater.

**Wetlands:**

Low-lying areas on land that are flooded by tides and either contain or are saturated with water. Examples include salt marshes, coastal swamps and mangrove forests.



## The sequence of events in ciguatera poisoning:



**A. A very small plant** (a dinoflagellate) occurs as a film on corals and seagrasses.

It is not usually abundant, but numbers increase dramatically when high levels of nutrients are available. Nutrients increase naturally during the wet season with runoff from the land and during cyclones when nutrients are released from damaged shorelines and coral reefs.

Nutrients also increase when sewage and agricultural fertilisers enter coastal waters.

**B. Small fish** eat the tiny plants that contain the poison.

**C. Larger fish** eat the smaller fish and so the poison builds up to dangerous levels in some larger fish.

**D. People** eating these fish suffer from tingling, numbness, muscle pains, and a curious reversal of temperature sensations (cold objects feel hot to touch). In extreme cases, death occurs through respiratory failure.



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