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

European Union
Union européenne

The Locally-Managed Marine Area (LMMA) Network

Improving the practice of marine conservation

SPC CPS

Original text: English

Secretariat of the Pacific Community Cataloguing-in-publication data

Guide and information sheets for fishing communities / produced by the Secretariat of the Pacific Community

1. Marine fishes — Classification — Oceania.
2. Marine invertebrates — Classification — Oceania.
3. Fishery management — Oceania.

I. Title II. Secretariat of the Pacific Community

338.3720995 AACR2

ISBN: 978-982-00-0504-4

Secretariat of the Pacific Community
BP D5 98848 Noumea Cedex, New Caledonia
Tel: +687 26 2000 Fax: +687 26 3818
Web: http://www.spc.int
Prepared for publication at
SPC Headquarters
Noumea, New Caledonia, 2011
Printed by Stredder Print Ltd, New Zealand

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 Secretariat of the Pacific Community (SPC – www.spc.int) in collaboration with the Locally-Managed Marine Area (LMMA) Network (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

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. **Mullets** (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**

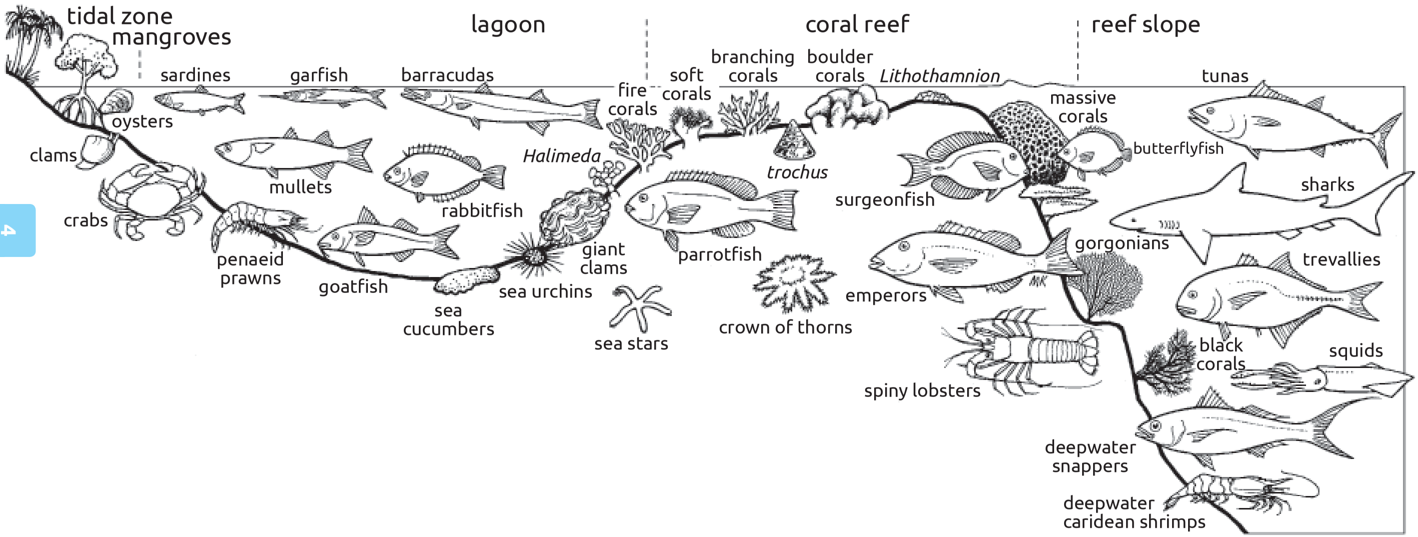
2 Fish in Pacific Island coastal fisheries

Between 200 and 300 species of fish are caught in coastal fisheries in the Pacific Islands. The following table (from Dalzell and Schug, 2002[1]) 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**
Mullets	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**

[1] 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.

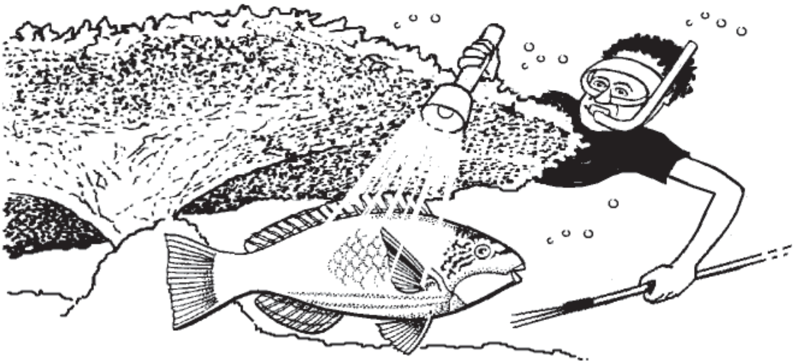
REEF GLEANING

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 to draw octopus, crabs or fish from holes 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.

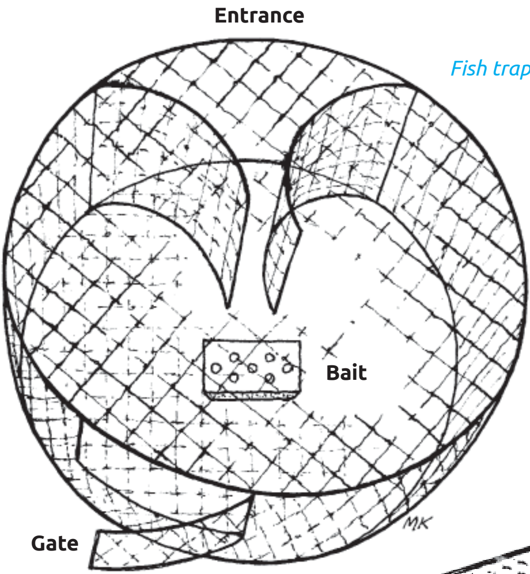
Some larger fish, such as parrotfish, sleep among the corals at night for protection from predators, making them easy targets for fishers with torches and spears. Masks, fins, SCUBA gear, steel spears and spear guns have also increased the effectiveness of spear fishing.



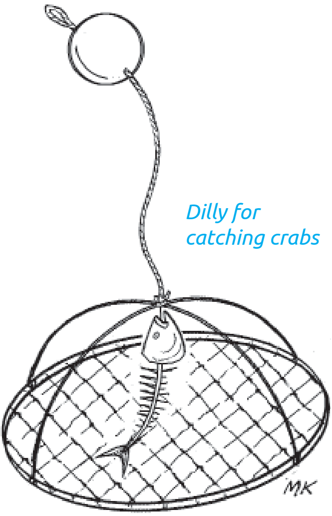
PORTABLE TRAPS

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.

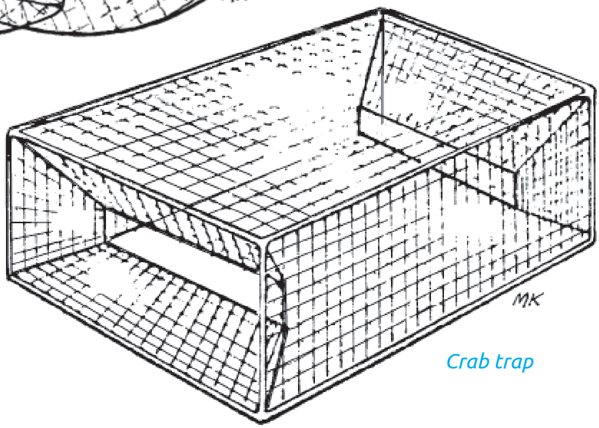
The principle of baited traps is that animals, attracted to the bait, enter the trap through tapered openings from which it is difficult to escape. Baited traps or pots are used to catch crabs and various flesh-eating species of fish.



Fish trap



Dilly for catching crabs

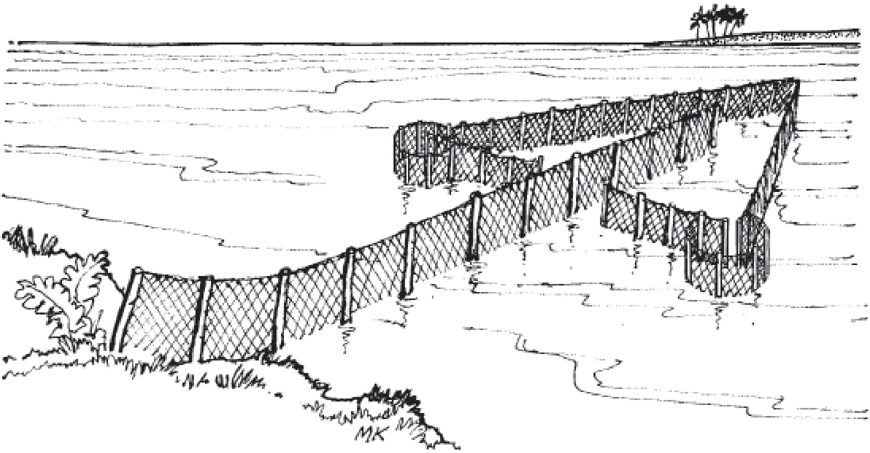


Crab trap

BARRIER AND FENCE TRAPS

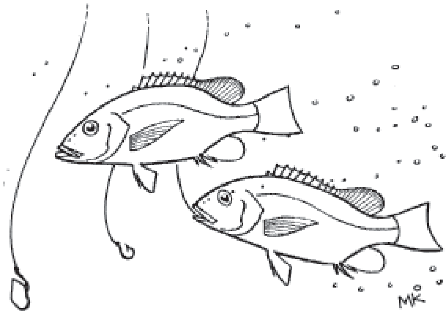
Barrier and fence traps are some of the oldest ways of community fishing. The simplest traditional traps use the falling tide to strand fish in v-shaped or semi-circular walls of stone or coral. Barrier nets can be set across reef passages and channels to trap fish as they try to return to deeper water 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.

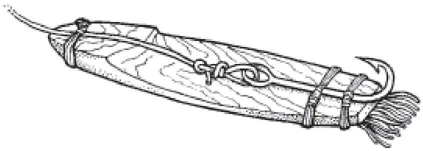


LURES AND TROLLING (TOWING LURES)

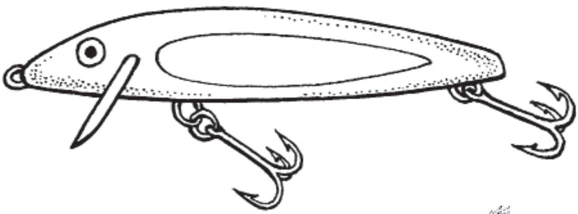
Natural or artificial lures attached to lines may be towed (or trolled) behind boats in inshore areas to catch fish such as trevallies and snappers. In general, lures are designed to attract fish by having one or more of the following characteristics: an erratic movement when towed through the water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

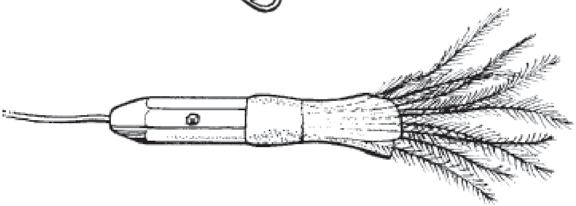
Lures can also be used in casting. In this method, the lure is attached to a line on a fishing rod. The rod is used to cast the line and the lure into the sea and then used to reel the lure back in.



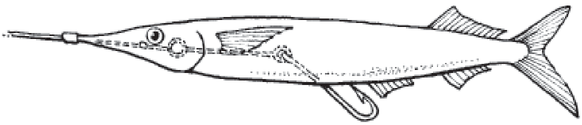
Traditional pearl-shell lure with a steel hook



Manufactured 'hard' fish diving lure



Manufactured 'soft' fish lure



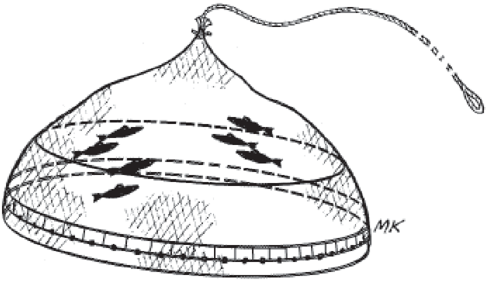
Garfish used as natural bait

CAST NETS

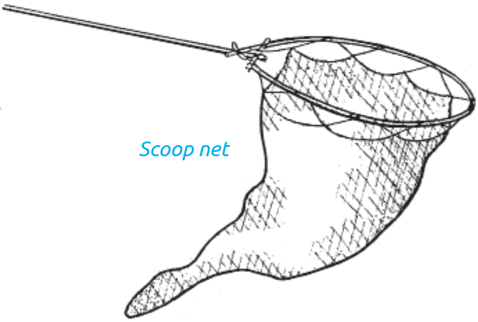
A cast net is a circular net which is thrown (or cast) from the shore or from a small boat into shallow water. When the net is thrown it opens into a large rounded cone (like a parachute). Weights at its edge drag the net down over schooling fish and the net closes as it is hauled in. Catches include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

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.



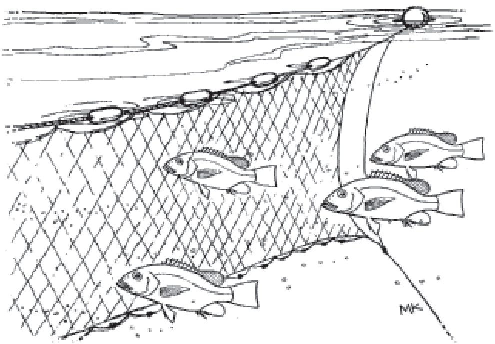
Cast net after it has been thrown



Scoop net

GILL NETS

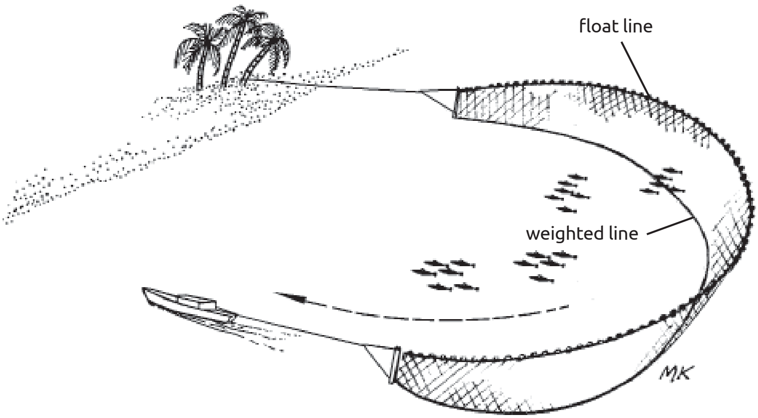
Gill nets are panels of netting held vertically in the water by a series of floats attached to their upper edge (the floatline) and weights attached to their lower edge (the leadline). These nets are anchored in shallow water to catch several species of fish including mullet and mackerel. The nets are 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.

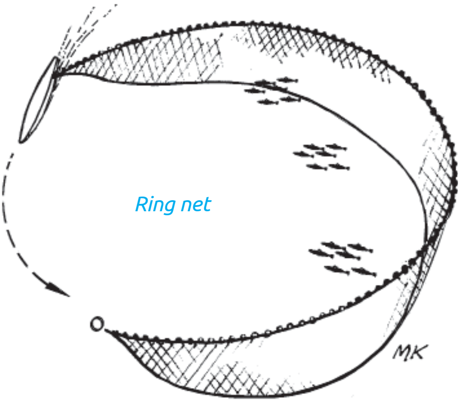
Some beach seines have a central panel of loose netting which forms a bag (or codend) to retain fish. Ways of employing beach seines vary, but often one end of the net is anchored on the shore, and a boat is used to set the net in a large arc and back to the shore before hauling (see illustration).



Beach seine

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;**

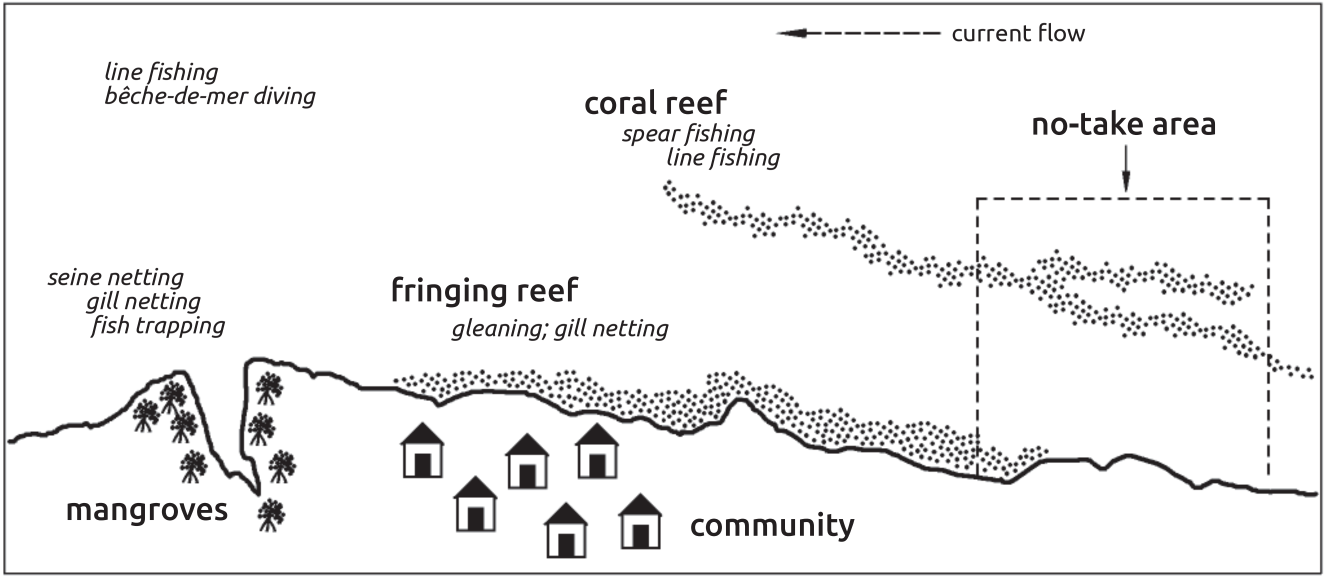
→ **For species that move to distant spawning areas, a local small reserve will not protect them from being over-exploited as they move to, or gather in, spawning aggregations;**

→ **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.

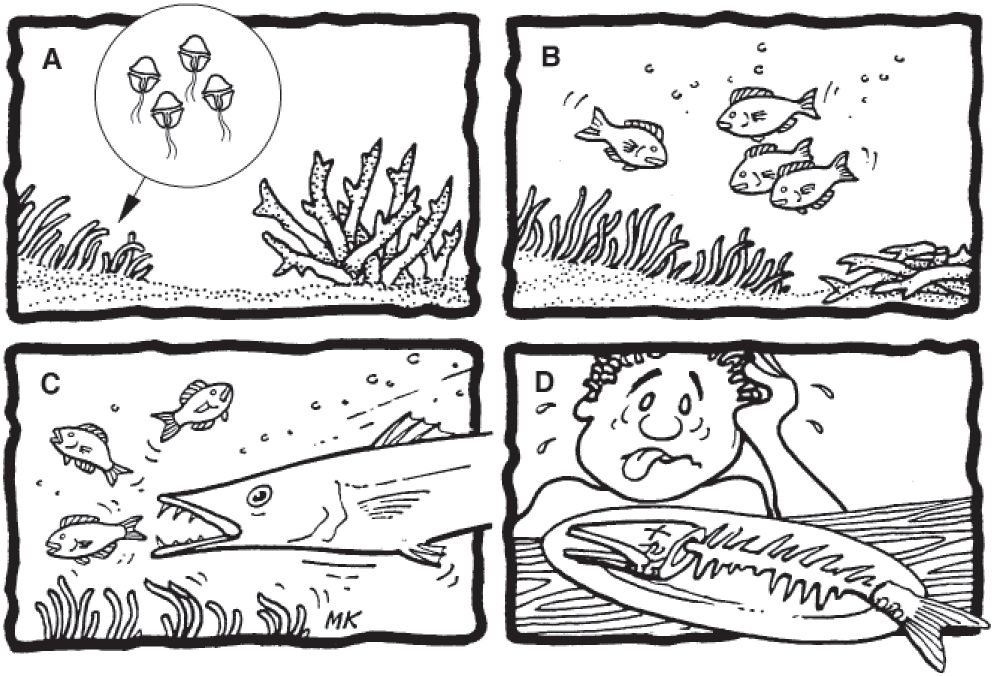
Subsistence fishery:
A fishery in which the catches are shared and consumed directly by the families of the fishers and community members rather than being sold.

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.

This booklet and the information sheets have been prepared by Michael King with information and comments supplied by Mike Batty, Lindsay Chapman, Ian Bertram, Hugh Govan, Simon Albert, Etuati Ropeti, Being Yeeting, Kalo Pakoa, Aymeric Desurmont, Jean-Baptiste Follin, Maria Sapatu, Simon Foale, Ron Vave, Toni Parras, Jovelyn Cleofe, Alifereti Tawake, Chito Dugan, Michael Guilbeaux, Helen Sykes, Wendy Tan and Magali Verducci.

Booklet: cover photo by Matthieu Juncker; other photos by Etuati Ropeti, Franck Magron and Pierre Boblin; inside illustrations by Michael King.

Information sheets: colour illustrations by Les Hata, Rachel O'Shea and Hazel Adams; line drawings by Michael King.

Layout design by Jean-Baptiste Follin.

Pacific Community
Communauté du Pacifique

PACIFIC COMMUNITY

BP D5 • 98848 NOUMEA CEDEX • NEW CALEDONIA

Telephone: +687 26 20 00

Facsimile: +687 26 38 18

Email: spc@spc.int

http://www.spc.int

The Locally-Managed Marine Area (LMMA) Network

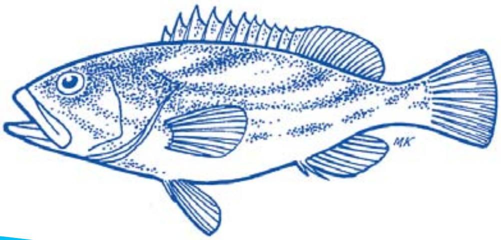
Improving the practice of marine conservation

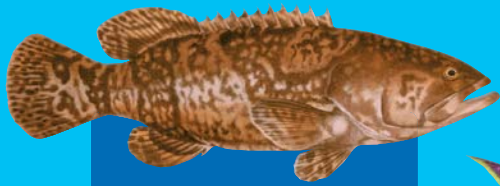
Email: info@lmmanetwork.org

http://www.lmmanetwork.org

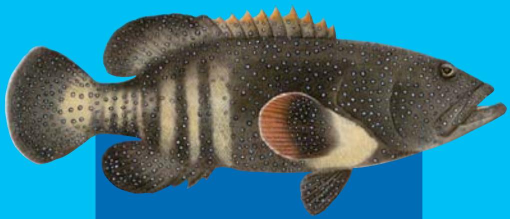
#01

Groupers
(Epinephelidae)





Giant grouper
(Epinephelus lanceolatus)



Peacock hind
(Cephalopholis argus)

Yellow-edged lyretail
(Variola louti)

Leopard coralgrouper
(Plectropomus leopardus)

Honeycomb grouper
(Epinephelus merra)

Brown-marbled grouper
(Epinephelus fuscoguttatus)

Species & Distribution

There are approximately 160 species of groupers. The species vary greatly but most have a wide body with a large head and mouth. Many species are well camouflaged in spots of yellow, green and brown.

Different species are found in tropical and temperate waters around the world. In the Pacific the number of species generally decreases from west to east but important food species are found in all tropical islands.

The giant grouper, *Epinephelus lanceolatus*, is one of the largest bony fish in the world and grows up to 3 m long and weighs up to 600 kg. Many of the smaller groupers (40 to 50 cm long) are more important in the catches of coastal communities, however.

Habitats & Feeding

The key habitats in the life cycle of groupers are the shallow water areas of coral rubble (where the young fish settle), the coral reef (where the adults live) and the spawning aggregation sites (where adults gather to reproduce).

Adults of many species appear to have relatively small home ranges (areas in which they live and feed) and one male may have a group of several females in an area of reef.

Groupers are not fast swimmers over long distances and they often lie in wait for their prey or use their mouths and gills as powerful pumps to suck their prey from crevices. They eat fish, small sharks, juvenile sea turtles, octopuses and spiny lobsters.

#01 Groupers (Epinephelidae)

Reproduction & Life cycle

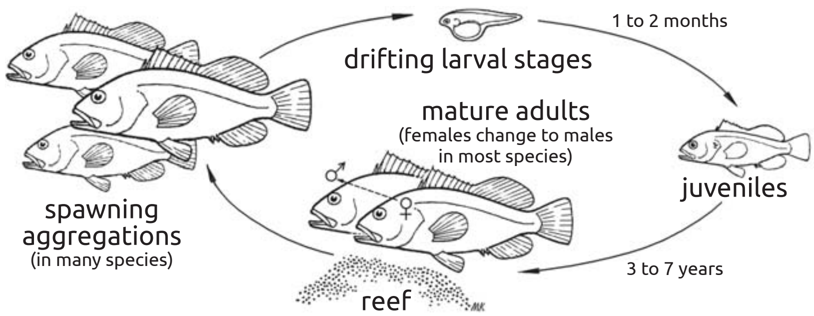
Most groupers grow relatively slowly and various species live for 5 to 15 years.

Generally, several common species reach reproductive maturity at 30 to 50 per cent of their lifespan. Most grouper species start out life as females (♀) and change sex to males (♂) at an age of about half their lifespan (that is, from 3 to 7 years depending on species).

Many species move to particular areas at the same time each year to reproduce in spawning aggregations. In these aggregations, females release eggs (some larger individuals produce over 1 million eggs) and these are fertilised by sperm released by males.

The fertilised eggs hatch to very small forms (larval stages) which drift in ocean currents for 1 to 2 months. Less than one in every thousand of the small floating forms survives to settle as a juvenile in shallow water near reefs.

As they grow, they move onto coral reefs and less than one in every hundred of the young fish (juveniles) survives to become an adult.



Fishing methods

Groupers are caught using baited hooks and lines, baited traps, gill nets and spears.

They aggressively strike baited hooks before retreating into coral crevices where they use their powerful gill muscles to lock themselves in. Spearing is done during the evening or at night when the groupers are most active. Groupers caught in baited traps are important in the live fish trade.

Many groupers are caught as they gather in large groups to breed (in spawning aggregations). Fishing in this way is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years.

Management measures & Options

Several management measures have been used on groupers in fisheries.

These measures include limiting the numbers of fishers (through fishing licences), limiting the amount of fish caught (quotas) and restricting the type of fishing gear used. These measures are generally used more often in commercial fisheries than those in communities.

Minimum size limits have been imposed (but often poorly enforced) in several countries. However, minimum size limits applied to a species that changes sex from female to male may not help. If only large individuals can be legally caught, the catches will be made up of almost all males, leaving mostly females in the population.

Options for community-based management include:

- → **a ban on gill nets which, especially if used on spawning aggregations, have been responsible for reducing the number of breeding fish;**
- → **a ban on spear fishing at night, which has been responsible for removing many large fish from extensive areas of reef.**

Fishing communities usually have some local knowledge of the timing and location of spawning aggregations and this information makes the following options possible:

- → **a ban on fishing in areas (sites) where spawning aggregations occur – which assumes that the community has some control over the spawning sites which may be some distance away;**
- → **a ban on fishing during the peak of the spawning season, which may involve several short closures at monthly intervals as some species appear to aggregate at particular times in the moon cycle.**

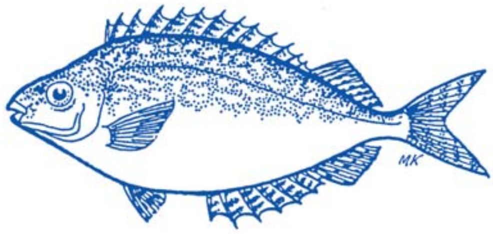
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Eric Clua and Matthieu Juncker.

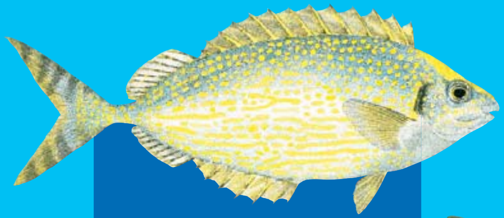
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Information sheets for fishing communities

#02

Rabbitfish
(Siganidae)





Streamlined spinefoot
(Siganus argenteus)

Mottled spinefoot
(Siganus fuscescens)

Goldspotted spinefoot
(Siganus punctatus)

Little spinefoot
(Siganus spinus)

Vermiculated spinefoot
(Siganus vermiculatus)

Species & Distribution

***The family Siganidae includes 28 species, commonly called rabbitfish, in a single genus,* Siganus.**

Rabbitfish have small mouths and many species are covered in maze-like patterns. The fin spines are equipped with poison glands that are capable of giving a painful wound.

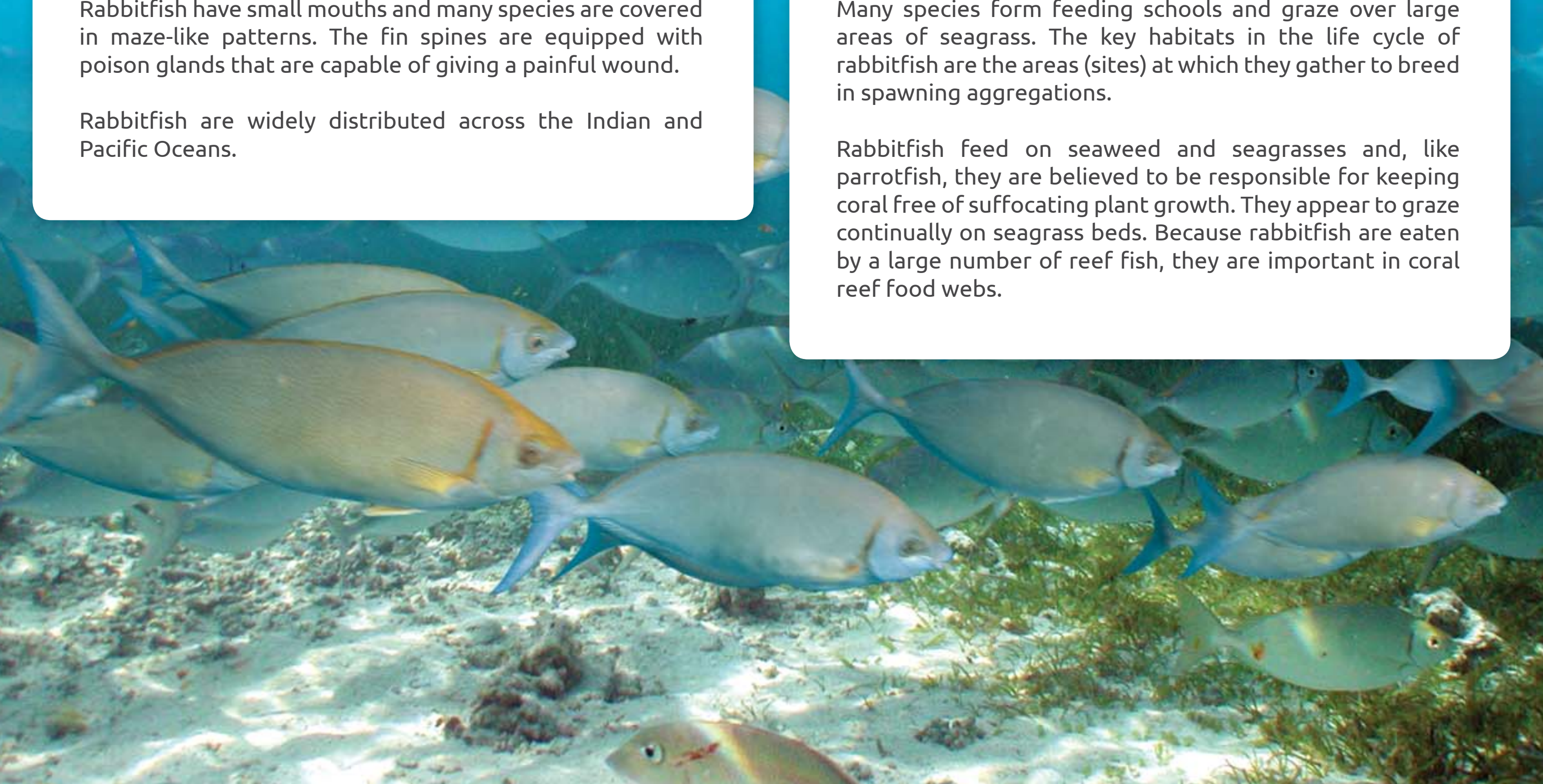
Rabbitfish are widely distributed across the Indian and Pacific Oceans.

Habitats & Feeding

Adult rabbitfish are active in estuaries, lagoons and shallow coral reef flats during the day.

Many species form feeding schools and graze over large areas of seagrass. The key habitats in the life cycle of rabbitfish are the areas (sites) at which they gather to breed in spawning aggregations.

Rabbitfish feed on seaweed and seagrasses and, like parrotfish, they are believed to be responsible for keeping coral free of suffocating plant growth. They appear to graze continually on seagrass beds. Because rabbitfish are eaten by a large number of reef fish, they are important in coral reef food webs.



Rabbitfish (Siganidae)

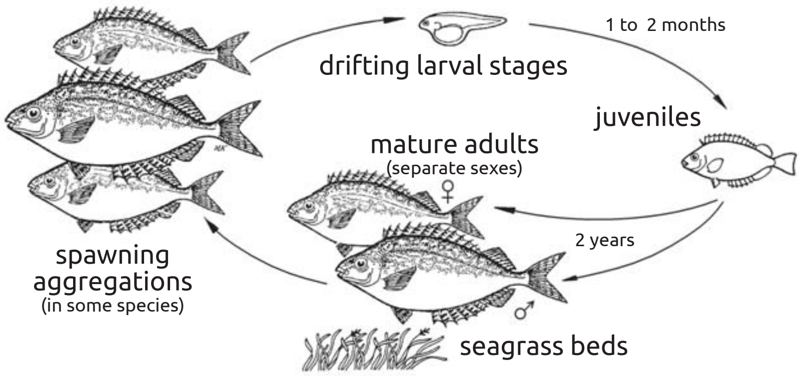
Reproduction & Life cycle

Rabbitfish have separated sexes and grow moderately quickly. Different species may become sexually mature within 1 or 2 years (at a length of about 15 cm) and reach lengths of over 40 cm.

Most species appear to have an extended reproductive season with waves of spawning that are linked to the moon cycle, often around the period of the new moon. They form large gatherings to breed (in spawning aggregations), often at sites with access to the open sea.

Half a million to more than 2 million eggs may be released by each female (♀) and these are fertilised by sperm released by the males (♂). The fertilised eggs become attached to the sea floor before hatching to small forms (the drifting larval stages), which float in the sea for 1 to 2 months; less than one in every thousand survives to become a juvenile.

Juveniles often arrive at shallow seagrass beds in dense schools, sometimes called bait balls. Less than one in every hundred of these juveniles survives for the 2 years or so that it takes for them to become adults.



Fishing methods

Rabbitfish are caught by using several different fishing methods:

- **spears are used at night when the fish are inactive and lying motionless on seagrass beds;**
- **gill nets and beach seines are used to catch feeding schools and to catch the breeding fish;**
- **small-mesh nets, cast nets, and seine nets are used to catch "bait balls" of juvenile fish;**
- **baited hooks and lines are also used, even though the fish are mainly plant eaters.**

Many rabbitfish are caught as they gather in large groups to breed (in spawning aggregations). Fishing in this way is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years.

Management measures & Options

Several management measures have been applied to rabbitfish.

Minimum size limits have been applied in many Pacific Island countries but it is doubtful that any nationally imposed regulation could be enforced over a large coastline with many fishing communities. Catch (bag) limits have also been applied, but such a measure is usually inappropriate in community fisheries unless the catch is to be sold.

Some fishing communities have banned night fishing with spears because the fish are vulnerable when sleeping in seagrass.

In some areas the banning of gill nets by fishing communities has protected against the overharvesting of rabbitfish on their spawning migrations and in their spawning aggregations. However, the permanent banning of gill net fishing may be unreasonable as adult rabbitfish (as well as mullet) are difficult to catch by other methods. An alternative is to restrict the use of small-mesh gill nets by imposing a minimum mesh-size.

The setting up of a community-managed area where no fishing is allowed (a no-take area) may allow fish numbers to increase but will not protect the fish during their spawning migrations and at their aggregation sites unless other measures are taken.

Fishing communities usually have some local knowledge of the timing and location of spawning aggregations and this information makes the following management options possible:

- **a ban on fishing in areas (sites) where spawning aggregations occur, which assumes that the community has some control over the spawning sites perhaps some distance away;**
- **a ban on fishing during the peak of the spawning season, which may involve several short closures at monthly intervals as some species appear to aggregate around the period of the new moon.**

Combining one or both of the above two measures with restricting mesh-sizes in nets used and the protection of local seagrass beds may be the most effective actions a community can take to address the sustainability of rabbitfish fisheries.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

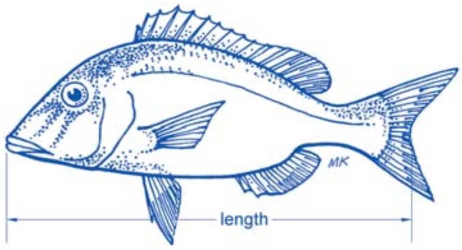
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Information sheets for fishing communities

#03

Emperors

(Lethrinidae)



Thumbprint emperor
(Lethrinus harak)

Pacific yellowtail emperor
(Lethrinus atkinsoni)

Trumpet emperor
(Lethrinus miniatus)

Orange-striped emperor
(Lethrinus obsoletus)

Spangled emperor
(Lethrinus nebulosus)

Yellowlip emperor
(Lethrinus xanthochilus)

Species & Distribution

The Lethrinidae family of fish includes about 20 different species of emperors, which are found almost entirely in the tropical waters of the Indian and Pacific oceans.

Features common to all species include thick lips, strong jaws, and cheeks without scales.

In the Pacific Islands, two common species are the spangled emperor, *Lethrinus nebulosus*, which has blue spots on its body and blue lines below its eyes, and the trumpet emperor, *Lethrinus miniatus*, which has a grey body with red areas near its eyes, mouth and fins.

Habitats & Feeding

Most species of emperors live on coral reefs or areas associated with them, including sandy areas and seagrass beds in lagoons.

Some species live on rocky reefs down to depths of more than 200 m. The juveniles of some species live in shallow seagrass and mangrove areas.

Emperors are bottom-feeding fish that eat sea snails, crabs, sea urchins, worms and many other animals that live on the sea floor. Some of the larger species feed on other fish. They are eaten by a range of larger fish including sharks.

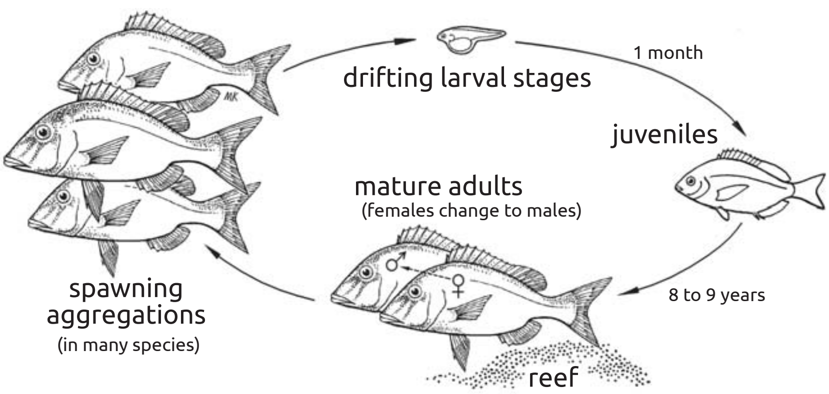
#03 Emperors (Lethrinidae)

Reproduction & Life cycle

Most species of emperors begin life as females (♀) and change sex to become males (♂) as they grow. In general, common species of emperors reach reproductive maturity at 30 to 50 per cent of their lifespan. The spangled emperor, for example, grows to a maximum of 90 cm over a lifespan of about 25 years and reaches reproductive maturity at a length of about 45 cm in 8 to 9 years.

Spawning aggregations may occur at the time of the new moon or the full moon in particular months. These aggregations occur in various places, including the edges of barrier reefs and in channels and passages. Each female releases many thousands of eggs and these are fertilised by sperm released by males.

In most reef-associated emperors, fertilised eggs hatch within a day or two into small forms (larval stages) that drift with currents for about a month. Less than one in every thousand of these survives to settle on reefs as a juvenile. And less than one in every hundred juveniles survives the 8 to 9 years it takes to become a mature adult.



Fishing methods

Fishing methods for emperors include:

- **baited hooks and lines;**
- **spearfishing, usually during the day;**
- **seine nets and cast nets used in shallow lagoons;**
- **gill netting is the main fishing method and is often used on spawning aggregations.**

Many emperors are caught as they gather in large groups to breed (in spawning aggregations). Fishing in this way is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years.

Management measures & Options

Management measures applied to fishing for emperors include limiting the numbers of people fishing, limiting the amount of fish caught (bag limits or quotas) and restricting the type of fishing gear used. These measures are generally used more in commercial fisheries than in community-based fisheries.

Several Pacific Island countries have imposed minimum size limits (between 15 and 25 cm length from the tip of the mouth to the middle of the tail) although in most cases the particular species of emperor to which the regulation applies has not been stated. Taking into account the wide variation in sizes of the different species of emperors, these size limits would be of little use for larger species. They would not protect species such as the spangled emperor, for example, which does not reproduce until it reaches a size of about 45 cm. To be effective, size limits should be applied to particular species.

In addition, because emperors start life as females and later change sex to become males, most of the smaller fish caught are female and the larger ones are male. Catching large, legally-sized fish, therefore, would leave many females but very few males in the sea.

The most effective community-based management strategy for emperors is likely to involve the protection of breeding adults. Community-managed fish reserves (no-take areas) will not protect reproducing fish that migrate to spawning sites.

However, fishing communities usually have some local knowledge of the timing and location of spawning aggregations and this information makes the following options possible:

- **a permanent ban on fishing in areas (sites) where spawning aggregations occur, which assumes that the community has some control over the spawning sites that may be some distance away;**
- **a temporary ban on fishing during known spawning times; as emperors spawn at various phases of the moon this may mean a series of short closures at appropriate times.**

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Bruno Manach and Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network

Improving the practice of marine conservation

European Union
Union européenne

SPC CPS

Parrotfish
(Scaridae)

Green humphead parrotfish
(Bolbometopon muricatum)

Spotted parrotfish
(Cetoscarus ocellatus)

Steephead parrotfish
(Chlorurus mirorhinos)

Daisy parrotfish
(Chlorurus sordidus)

Darkcapped parrotfish
(Scarus oviceps)

Species & Distribution

The family Scaridae includes over 90 species of fish known as parrotfish.

Parrotfish have evolved bright colours and teeth fused into parrot-like beaks. Most species reach 30 to 50 cm in length. The largest species, the green humphead parrotfish, *Bolbometopon muricatum*, may grow to 1.3 m long, and weigh up to 46 kg. Parrotfish are found in relatively shallow tropical waters throughout the world and the largest number of species is found in the Indian and Pacific oceans.

Habitats & Feeding

Parrotfish are found on rocky coasts and in seagrass beds as well as on coral reefs.

At night parrotfish sleep in crevices or holes after wrapping themselves in a transparent covering or cocoon of mucus. The mucus may repel parasites or hide the scent of the fish from night-time predators. The key habitats in the life cycle of parrotfish are coral reefs and, in many species, the areas where they gather to breed (the spawning aggregation sites), often on the outer reef slope or in channels.

With their fused teeth, parrotfish scrape coral to feed on plant growth and some may feed on the very small plants (zooxanthellae) living within the coral. Some of the coral surface is eaten and this helps with the digestion of the plant material. They graze large quantities of coral to gain small amounts of food and continually release clouds of fine coral particles. As each adult parrotfish can produce about 90 kg of coral particles each year, their contribution to the sand of lagoons and tropical beaches is important. Their feeding activity also prevents coral becoming smothered by plants. The predators of parrotfish include moray eels, snappers and a wide range of larger reef fish.

#04

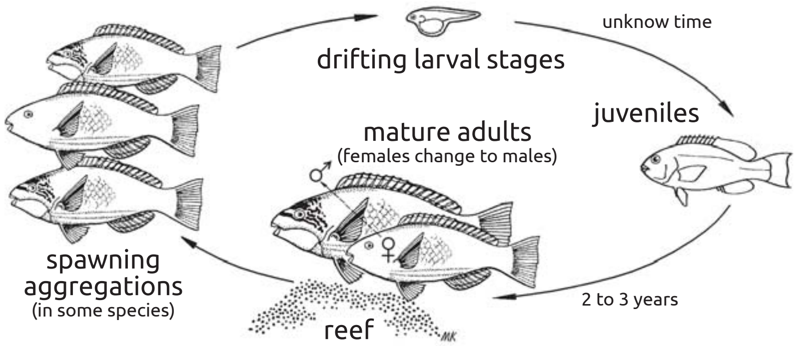
Parrotfish (Scaridae)

Reproduction & Life cycle

Almost all species of parrotfish start life as females (♀) and later in life change to the vivid green or blue coloured males (♂). Some species have relatively fast growth rates, are able to reproduce within 2 to 3 years, and have an average lifespan of 5 to 6 years. However, larger species appear to grow more slowly and reach ages of more than 15 years.

Some parrotfish species move to particular areas to reproduce in large spawning aggregations. In these aggregations, each female produces thousands of eggs which are fertilised by sperm released by the males.

Within about 25 hours, the fertilised eggs hatch into small forms (the drifting larval stage) about 1 mm long. These drift in the sea for an unknown length of time before settling on coral reefs.



Management measures & Options

Minimum size limits have been applied to parrotfish in some Pacific Islands, which may not be beneficial in species that change sex from female to male as they grow. If only large individuals can be legally caught, catches will be made up of almost all males, leaving an excess of females in the population.

Catch limits (quotas or bag limits) have also been applied to parrotfish but generally such measures are not suitable for community fisheries. Some countries have placed minimum mesh sizes on gill nets and banned the use of underwater breathing apparatus when spear-fishing.

Fish reserves (areas where no fishing is allowed), particularly if small, are generally not suitable for protecting parrotfish. This is because they move over wide areas to feed and make long migrations to spawning aggregation sites.

Fishing communities usually have some local knowledge of the timing and location of spawning aggregations and this information makes the following management options possible:

→ **a ban on fishing during the times of forming spawning aggregations, which may require a number of short closures as some species spawn several times each year;**

→ **a ban on fishing at known spawning areas or sites.**

Additional community actions could include:

→ **a ban on fishing for parrotfish using spears at night; some communities have already taken this action because this fishing method has been responsible for removing all large parrotfish from local fishing areas;**

→ **a ban on the use of small-mesh gill nets; this action may allow smaller fish to escape and grow to a size when they can reproduce.**

Fishing methods

Methods used to catch parrotfish include:

→ **gill nets; this common fishing method is often used in areas containing large groups of breeding fish;**

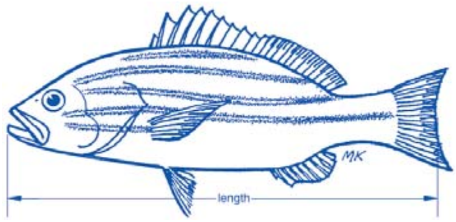
→ **spearfishing; often with underwater torches during the night when the fish are sleeping under coral.**

Many parrotfish are caught as they gather in large groups to breed (in spawning aggregations). Fishing in this way is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Reef snappers
(Lutjanidae)



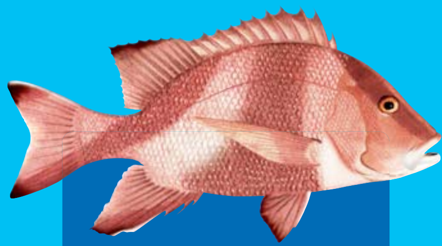
Two-spot red snapper
(Lutjanus bohar)

Mangrove red snapper
(Lutjanus argentimaculatus)

Blacktail snapper
(Lutjanus fulvus)

Common bluestripe snapper
(Lutjanus kasmira)

Humpback red snapper
(Lutjanus gibbus)



Emperor red snapper
(Lutjanus sebae)

Species & Distribution

The family Lutjanidae contains more than 100 species of tropical and sub-tropical fish known as snappers.

Most species of interest in the inshore fisheries of Pacific Islands belong to the genus *Lutjanus*, which contains about 60 species.

One of the most widely distributed of the snappers in the Pacific Ocean is the common bluestripe snapper, *Lutjanus kasmira*, which reaches lengths of about 30 cm. The species is found in many Pacific Islands and was introduced into Hawaii in the 1950s.

Habitats & Feeding

Although most snappers live near coral reefs, some species are found in areas of less salty water in the mouths of rivers.

The young of some species school on seagrass beds and sandy areas, while larger fish may be more solitary and live on coral reefs. Many species gather in large feeding schools around coral formations during daylight hours.

Snappers feed on smaller fish, crabs, shrimps, and sea snails. They are eaten by a number of larger fish. In some locations, species such as the two-spot red snapper, *Lutjanus bohar*, are responsible for ciguatera fish poisoning (see the glossary in the Guide to Information Sheets).

#05 Reef snappers (Lutjanidae)

Reproduction & Life cycle

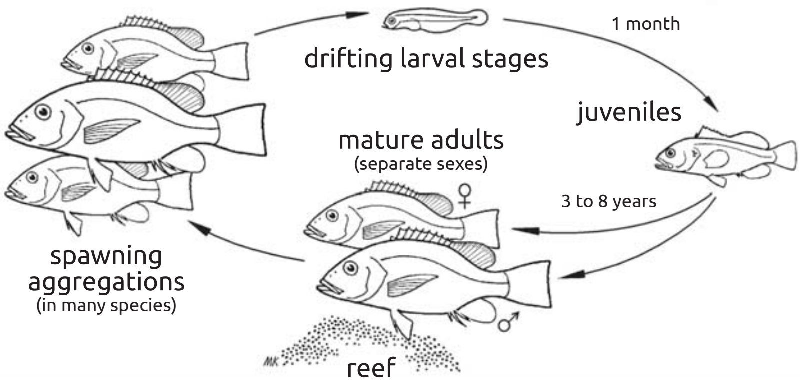
Snappers have separate sexes. Smaller species have a maximum lifespan of about 4 years and larger species live for more than 15 years.

Many common species grow to sizes of 25 to 35 cm and reach reproductive maturity at about 45 per cent of their maximum size (that is, 11 to 16 cm in the most common species).

Snappers generally spawn throughout the year in warmer waters but during the warmer months in cooler waters. Many snappers travel long distances to particular areas along outer reefs and channels to breed (in spawning aggregations), often around the time of the new moon and full moon.

During breeding, females (♀) release eggs (often more than 1 million) and these are fertilised by sperm released by males (♂). In most reef-associated snappers, fertilised eggs hatch within a day or two into small forms (larval stages) that drift with currents for about 1 month. Less than one in every thousand of these small floating forms survives to settle on a reef as a young fish (juvenile).

And less than one in every hundred juveniles survives the period of 3 to 8 years that it takes to become a mature adult capable of reproducing.



Fishing methods

Snappers are most often taken by using baited hooks and handlines but are also caught by using spears, traps and gill nets.

Many snappers are caught as they gather in large groups to breed (in spawning aggregations). Fishing in this way is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years.

Management measures & Options

Minimum size limits for snappers have been applied in some countries (e.g., 30 cm length from the tip of the mouth to the middle of the tail). However, the particular species of snapper is not usually stated. Taking into account the wide variation between snapper species, this size limit would be of little use in protecting larger species. Size limits should be applied to individual species.

Some countries have restricted fishing methods to the use of hook and line only. Catch (bag) limits have also been applied but such a measure is usually inappropriate in community-based fisheries.

Locally managed fish reserves (no-take areas) could be established but, for species that travel long distances to spawning sites, these will not protect reproducing fish. However, if spawning times and areas are known by local fishers, the following management actions are possible:

- → **a ban on fishing during the times that fish form spawning aggregations, which may require a number of short closures (say for 3 to 4 days) around the periods of new moon and full moon, depending on the particular species;**
- → **a ban on fishing at known spawning areas or sites; such sites may include particular areas along outer reefs and channels where snappers are known to gather to breed.**

Additional community actions could include:

- → **support for local national minimum size limits or (if not available) set community-based minimum size limits at about 50 per cent of the maximum size of the species;**
- → **a ban on the use of gear such as gill nets which catch too many fish;**
- → **a restriction on small-mesh gill nets; enforcing a minimum mesh size may allow smaller fish to escape and grow to a size when they can reproduce.**

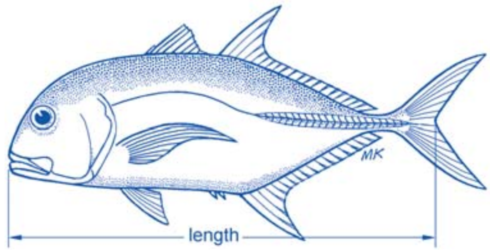
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

#06

Trevallies

(Carangidae)



Island trevally
(Carangoides orthogrammus)

Longnose trevally
(Carangoides chrysophrys)

Giant trevally
(Caranx ignobilis)

Bluefin trevally
(Caranx melampygus)

Black jack
(Caranx lugubris)

Bigeye trevally
(Caranx sexfasciatus)

Species & Distribution

The Carangidae family of fish contains approximately 200 different species of trevallies, jacks and scads distributed in all oceans.

Many species of medium to large trevallies are found across the Pacific Ocean as far as Hawaii including the island trevally, *Carangoides orthogrammus* (reaching lengths of 75 cm), the bluefin trevally, *Caranx melampygus* (90 cm), the six-banded or bigeye trevally, *Caranx sexfasciatus*, (150 cm) and the giant trevally, *Caranx ignobilis*, (160 cm).

Habitats & Feeding

Most trevallies live in a wide range of offshore and inshore habitats including coral reefs. Juveniles are sometimes found in less salty water in river mouths. Many species are active at night feeding up in the water as well as on the sea floor.

Trevallies are fast-swimming fish that hunt for small fish. Some species dig in the sea floor for worms, shrimps, crabs and other small burrowing animals. Trevallies have small teeth and usually swallow small fish whole.

#06 Trevallies (Carangidae)

Reproduction & Life cycle

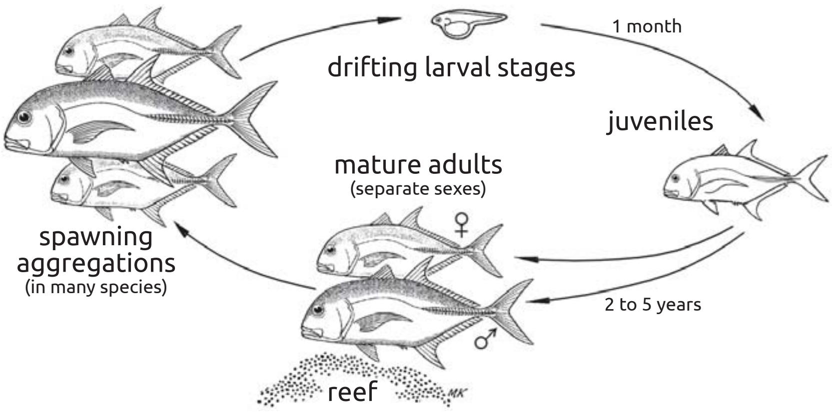
Trevallies have separate sexes. Many common species appear to reach reproductive maturity at lengths between 35 and 56 per cent of their maximum size.

The giant trevally, for example, grows to about 160 cm and 80 kg over a lifespan of about 24 years and reaches reproductive maturity at a length of about 60 to 95 cm when they are between 3 and 5 years old. The smaller bluefin trevally, which grows to 90 cm, reaches sexual maturity at between 30 and 40 cm at an age of about 2 years.

Many species travel long distances to breed in large numbers (in spawning aggregations). The areas at which they gather (spawning sites) are often at the outer edge of fringing reefs or near reef passages. These aggregations often occur as waters become warmer and at times are related to the cycle of the moon.

During spawning, each female (♀) releases many thousands of eggs into the water and these are fertilised by sperm released by males (♂). The fertilised eggs hatch into very small forms (larvae) that drift in the sea for periods often greater than a month. Less than one in every thousand of the small floating forms survives to become a young fish (juvenile).

When the drifting forms settle out as juveniles these may enter inshore shallow water and move out to deeper reefs as they grow. Less than one in every hundred juveniles survives the 2 to 5 years that it takes to become a mature adult.



Fishing methods

Trevallies are caught by casting and trolling using artificial lures, jigs and natural baits. Gill nets, cast nets and various traps are also used. Trevallies are also important in sports fishing.

Some species have been reported to be responsible for ciguatera poisoning (see the glossary in the Guide to Information Sheets).

Management measures & Options

Authorities in several Pacific Island countries have imposed minimum size limits for trevallies (variously 25 to 30 cm length from the tip of the mouth to the middle of the tail).

Although separate minimum sizes have sometimes been used for scads and smaller trevallies, in many cases the particular species of trevally to which the minimum size regulations apply has not been stated. Taking into account the variation in sizes of the different species, these size limits would not allow larger species to reach breeding size. To be effective, size limits should be applied to individual species.

Some fisheries authorities have the ability to declare closed fishing seasons but this regulation would be difficult to apply in different regions where trevallies may have different breeding times and areas.

Establishing a fixed community-managed reserve where no fishing is allowed (a no-take area) will not protect trevallies because they move from reef to reef and often travel long distances to particular spawning sites. Many local fishers will have some local knowledge of the timing and location of spawning aggregations, however, which makes certain management options possible:

→ **a ban on fishing during the peak of the spawning season, which may require a number of short closures when trevallies aggregate, perhaps at times related to the cycle of the moon;**

→ **a ban on fishing at known spawning areas or sites, which may be the outer edges of reefs or near reef passages; the small drifting forms produced at such spawning sites are likely to settle on other reefs, including fishing areas, particularly those in down-current places.**

Other community actions could include:

→ **a ban on overly efficient fishing methods such as gill nets;**

→ **a ban on small-mesh gill nets; a minimum mesh size may allow smaller fish to escape and grow to a size at which they can reproduce.**

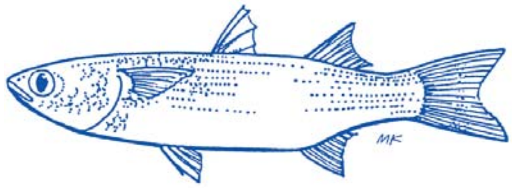
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photo by Matthieu Juncker.

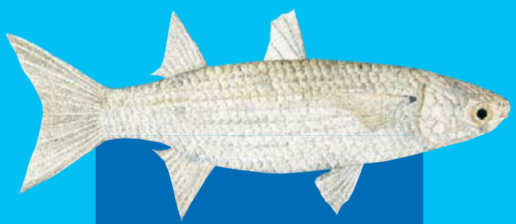
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Information sheets for fishing communities

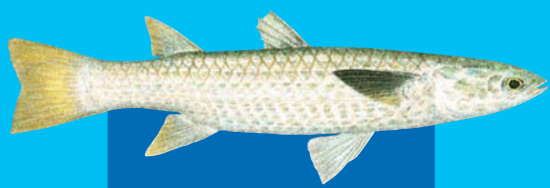
#07

Mullets
(Mugilidae)





Fringelip mullet
(Crenimugil crenilabis)



Squaretail mullet
(Liza vaigiensis)

Flathead grey mullet
(Mugil cephalus)

Species & Distribution

The family Mugilidae includes about 80 different species of mullet that are found worldwide in coastal temperate and tropical waters.

Mullets have two separate upper (dorsal) fins and small triangular mouths. The flathead or striped mullet, sometimes called the sea mullet, *Mugil cephalus*, appears to be the main one of interest in the South Pacific. The species is olive green on the back and silvery on the sides and belly with about seven dark stripes along the sides.

Habitats & Feeding

Adult mullet live in shallow coastal areas, often in schools, over sand, mud or seagrass beds down to depths of about 10 m. They may enter rivers but do not necessarily require freshwater.

Mullets are active during the day, when the adults feed on plants and small animals (invertebrates), and suck up sediments on the sea floor. They often form schools to graze on the small plants that grow attached to seagrasses. Mullets are eaten by larger fish such as snappers and barracudas.

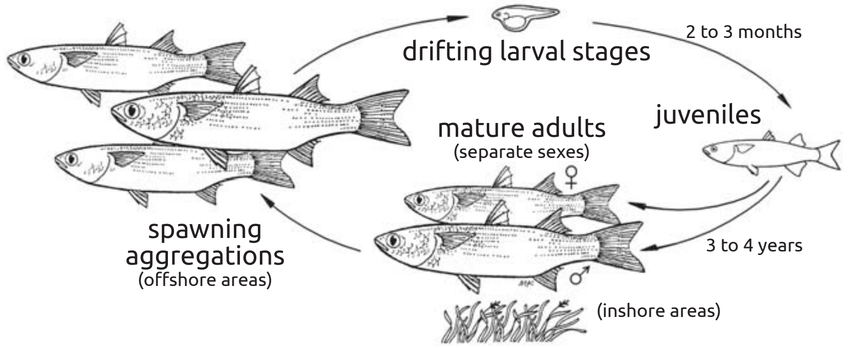
#07 Mullets (Mugilidae)

Reproduction & Life cycle

Mullets have separate sexes and become sexually mature in 3 to 4 years at a size of about 30 cm. They commonly grow to lengths of 60 cm and weights of 4 kg but may reach 100 cm and live for up to 16 years.

Each year, mullets move long distances along the coast to offshore waters where they breed in large numbers (in spawning aggregations). During spawning, each female (♀) releases many eggs, often over 1 million, and these are fertilised by sperm released by males (♂). The fertilised eggs hatch into very small forms (larval stages) that drift in the sea.

Less than one in every thousand of the small drifting larval forms survives to enter shallow inshore areas 2 to 3 months later. And less than one in every hundred juveniles survives the 3 to 4 years that it takes to grow into a mature adult.



Fishing methods

Mullets are usually caught by using cast nets, gill nets, beach seine nets, ring nets and traps. Fence or maze traps, built at right-angles from shore-lines, are used to guide spawning migrations of mullets into large retaining areas.

Mullets are caught in large numbers as they migrate along the coast to breed in spawning aggregations. Fishing in this way is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years.

Management measures & Options

Mullet fisheries have been managed by the application of several different regulations.

As the mullets migrating along a coastline are all adults and often of a similar size, minimum size limits are of little use. The same is true for restricting mesh sizes in the nets and traps to some minimum size (because there are very few smaller fish to pass through the fishing gear unharmed).

Catch (bag) limits have also been applied but catches made in large nets and traps are often large and, even if the excess catch is released, fish that are let free may not survive.

Establishing community-managed reserves or no-take areas (where no fishing is allowed) is unlikely to benefit migrating species such as mullets and will not protect the fish during their spawning movements along the coast.

One of the problems in managing mullet fisheries is that the fish are often caught by many different communities as they migrate along the coast. There is no use in one community protecting the migrating fish if they are going to be caught by the next community along the coast. **Ideally, neighbouring communities should work together and agree to enforce the same management measures.**

The common aim of management would be to allow a sufficient number of mullets to reach the spawning areas and produce small fish, many of which will grow and be available to be caught in future years.

Cooperative community management measures could include these actions:

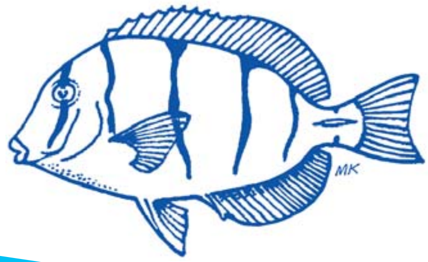
- → **a ban on gill nets and fence traps during the time of spawning migrations of mullets – which may be unreasonable, because mullets are not easily caught by other fishing methods. A more reasonable action may be to:**
  - → **restrict the number and the size of fence traps and the length of gill nets that are allowed to be used during the mullets' migrations, which can be made more effective by actions to:**
    - → **ban the use of gill nets and fence traps in particular areas where mullets are most vulnerable. These areas could include narrow passages between the shore and reefs through which the migrating mullets have to pass.**

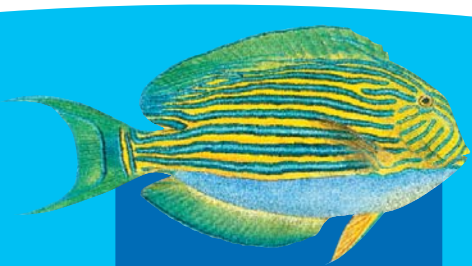
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

#08

Surgeonfish
(Acanthuridae)



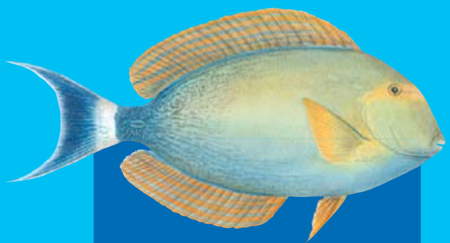


Lined surgeonfish
(Acanthurus lineatus)

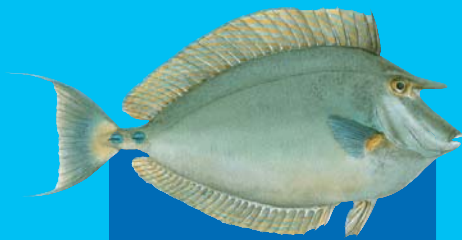
Whitespotted surgeonfish
(Acanthurus guttatus)

Convict surgeonfish
(Acanthurus triostegus)

Striated surgeonfish
(Ctenochaetus striatus)



Yellowfin surgeonfish
(Acanthurus xanthopterus)



Bluespine unicornfish
(Naso unicornis)

Species & Distribution

Acanthuridae is the fish family of surgeonfish, tangs, and unicornfish. The family includes about 80 species that live in tropical seas.

All surgeonfish have one or more sharp spines or blades on each side of the tail.

Most surgeonfish are medium sized (15 to 40 cm) although some unicornfish reach lengths of more than 1 m. Several species are important food fish including the widely distributed convict surgeonfish, *Acanthurus triostegus*, as well as the lined surgeonfish, *Acanthurus lineatus*, and the striated surgeonfish, *Ctenochaetus striatus*.

Habitats & Feeding

Most surgeonfish are associated with coral reefs and often form very large feeding schools around corals and rocky outcrops in shallow water.

The key habitats that are crucial in the life cycle of many surgeonfish are the areas where they gather to breed (the spawning aggregation sites). Surgeonfish have small mouths with a single row of teeth used to scrape plants off corals and rocks.

#08

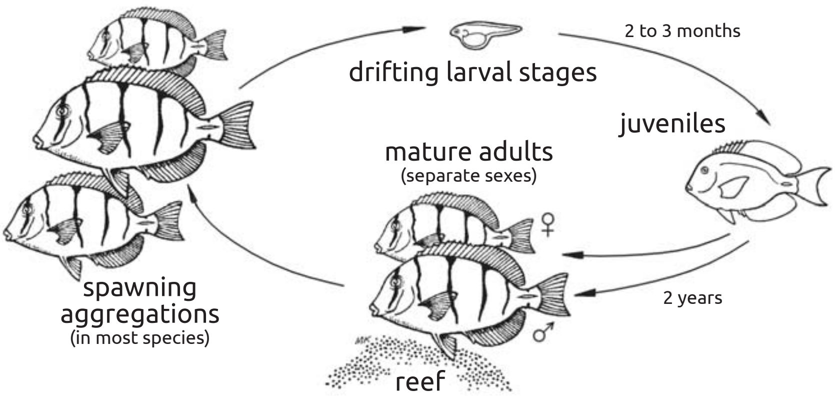
Surgeonfish (Acanthuridae)

Reproduction & Life cycle

All surgeonfish have separate sexes and most medium sized species have similar life cycles. The convict surgeonfish, used here as an example, commonly reaches lengths of 17 cm (with a maximum length of 27 cm) and lives for more than 4 years. Males and females reach reproductive maturity at different sizes; females are able to reproduce at close to their maximum size, at an age of about 2 years.

Most surgeonfish gather in large schools to breed (in spawning aggregations) when waters become warmer and often at times of the full moon. The spawning areas or sites are often at the outer edge of fringing reefs or near reef passages.

At the spawning site, each female (♀) releases millions of very small eggs into the water and these are fertilised by sperm released by males (♂). The masses of eggs and sperm appear as white clouds in the water and are fed upon by many fish. The fertilised eggs develop into small forms (larval stages) that drift in the sea for 2 to 3 months. Less than one in every thousand of the small floating forms survives to become a young fish (juvenile) about 3 cm in length. And less than one in every hundred juveniles survives the 2 years or so that it takes to become a mature adult.



Fishing methods

In many Pacific Island coastal fisheries, surgeonfish are the most important group of fish taken for food. They are usually caught by the use of spears, nets and traps. Juveniles often settle out on reefs in massive numbers and these are sometimes caught with fine-mesh nets.

Although they are plant eaters, some surgeonfish can be caught on baited hooks. Some surgeonfish in particular areas are believed to be responsible for ciguatera fish poisoning (see Glossary in the Guide to Information Sheets).

Many surgeonfish are caught as they gather in large groups to breed (in spawning aggregations). Fishing in this way is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years.

Management measures & Options

National fisheries authorities in several Pacific Islands have imposed minimum size limits for surgeonfish (for example, 20 cm length from the tip of the mouth to the middle of the tail) although in most cases the particular species to which the regulation applies has not been stated. To be effective, size limits should be applied to individual species.

To ensure that catches of surgeonfish are sustainable it is essential to protect breeding adults. Community-managed fish reserves (no-take areas) may allow surgeonfish to grow but, as most species migrate to spawning sites, these would not protect reproducing fish.

Many fishing communities will have some local knowledge of the timing and location of spawning aggregations, however, which makes certain management options possible:

→ **a ban on fishing during the peak of the spawning season, which may require a number of short closures when surgeonfish aggregate. If the species of concern forms spawning aggregations at the time of the full moon, banning fishing for a few days on each side of the full moon may be sufficient;**

→ **a ban on fishing at known spawning areas or sites, which may be at the outer edges of fringing reefs or near reef passages.**

The above actions would give some protection to breeding adults. And, as the small larval forms produced drift in the sea for 2 to 3 months, they are likely to settle on surrounding reefs, including fishing areas, particularly those in down-current places.

An additional community action could include banning the use of fine-mesh nets to protect juvenile fish.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

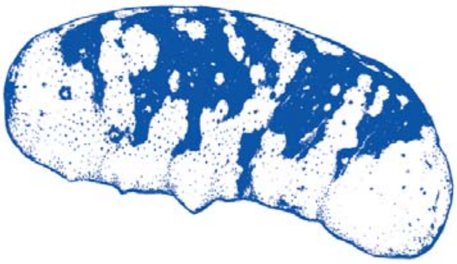
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

European Union
Union européenne

SPC CPS

#09

Sea cucumbers
(Holothurians)



Sandfish
(Holothuria scabra)

White teatfish
(Holothuria fuscogilva)

Black teatfish
(Holothuria whitmaei)

Curryfish
(Stichopus herrmanni)

Greenfish
(Stichopus chloronotus)

Prickly redfish
(Thelenota ananas)

Species & Distribution

Sea cucumbers have a tough skin and a cucumber-shaped body. Of the thousand or more species distributed throughout the world's oceans, 35 are commercially important in the Asia-Pacific region. Some species are exported in the boiled, smoked and/or dried form known as bêche-de-mer or trepang.

Sea cucumbers are classed into three groups based on their value – low, medium or high. The high value group include the white teatfish, *Holothuria fuscogilva*, the black teatfish, *Holothuria whitmaei*, the sandfish, *Holothuria scabra*, and the prickly red fish, *Thelenota ananas*. Species in the medium and low value groups are changing as demand and prices continue to rise. A booklet on identifying sea cucumber species is available from SPC (www.spc.int).

Habitats & Feeding

Sea cucumbers are associated with coral reef ecosystems. Some species are found in shallow lagoons, on seagrass beds and reef flats, while others prefer wave-exposed areas and deep passages.

Sea cucumbers move slowly across sandy areas of lagoons feeding on dead plant and animal material (detritus) in the sand. The sand is taken in, the detritus digested and the clean sand passed out behind. For this reason, sea cucumbers are important in cleaning and turning over sand on the sea floor.

#09 Sea cucumbers (Holothurians)

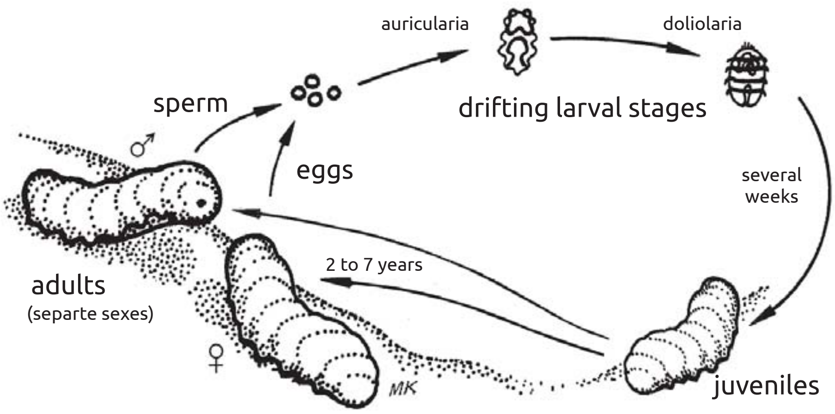
Reproduction & Life cycle

Most exploited sea cucumbers have separate sexes. Some species, like the sandfish, are relatively fast growing and reach reproductive size within a year or more but take another two years to reach an acceptable market size. Other species grow more slowly and live between 5 to 15 years.

Many tropical species reproduce at the start of the warmer months. A few species, such as the black teatfish, spawn during the cooler months. During spawning, females (♀) release eggs into the water and these are fertilised by sperm released by males (♂). Successful reproduction depends on large numbers of sea cucumbers being in the same place.

Fertilised eggs hatch and develop through very small forms (larval stages) that drift with ocean currents for several weeks; less than one in every thousand of these survives to settle on the sea floor as a young (juvenile) sea cucumber.

Sea cucumbers do not move very far from the areas in which they settle and less than one in every hundred juveniles survives to become an adult.



Fishing methods

Sea cucumbers are usually collected by hand at low tide or by free diving. Underwater breathing apparatus, which has also been used, is now illegal in many countries as its use has severely reduced many populations.

In some Pacific Islands the guts and reproductive organs, sometimes partially fermented in seawater, are consumed. A slit is made in the body wall of species such as the curryfish, *Stichopus herrmanni*, and the internal organs are removed; the sea cucumber is then returned to the sea where it is believed to regenerate its internal organs.

Management measures & Options

Minimum size limits have been applied by many fishery authorities. As sea cucumbers shrink during processing, minimum sizes are usually given for both live sea cucumbers and the dried product. Minimum sizes for various species are given in the sea cucumber identification cards available from SPC.

In some areas, national authorities have declared a moratorium (during which fishing is prohibited) to allow sea cucumber populations to recover. Others have banned the export of particular species.

In addition to supporting national regulations, communities could take the following actions:

- → **ban the use of underwater breathing apparatus for collecting sea cucumbers in local fishing areas, which has caused the loss of many sea cucumber populations;**
- → **place a ban (or tabu) on collecting sea cucumbers, which may be necessary if stocks have been severely depleted. Bans would have to be in place for several years to allow time for stocks to recover and for adults to breed;**
- → **establish rotational harvesting in which different areas are fished in rotation. If the community fishing area is large enough, it could be divided into four or five smaller areas. Sea cucumber collecting could be allowed in a single area during 1 year and then allowed in the other areas in turn during the following years. A large number of smaller areas are required because populations of sea cucumbers increase relatively slowly;**
- → **establish small, community-managed marine reserves or no-take areas. As sea cucumbers do not move much, these reserves could be relatively small (between 0.5 and 3 km²). However, because of the relatively long drifting stage, juveniles are likely to become distributed in areas some distance from the reserve. This suggests that the following option is ideal;**
- → **work with neighbouring communities to establish a network of small sea cucumber reserves along the coast.**

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Emmanuel Tardy and Eric Clua.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Information sheets for fishing communities

#10

Giant clams

(Tridacnidae)

Bear paw giant clam
(Hippopus hippopus)

Elongate giant clam
(Tridacna maxima)

Fluted giant clam
(Tridacna squamosa)

Crocus giant clam
(Tridacna crocea)

Species & Distribution

Tridacnid clams include several species commonly called giant clams, which have various distributions in the Indian and Pacific Oceans.

Species range in size from the 15 cm crocus giant clam, *Tridacna crocea*, to the true giant clam, *Tridacna gigas*, which grows to lengths of more than 1 m and reaches weights of more than 200 kg.

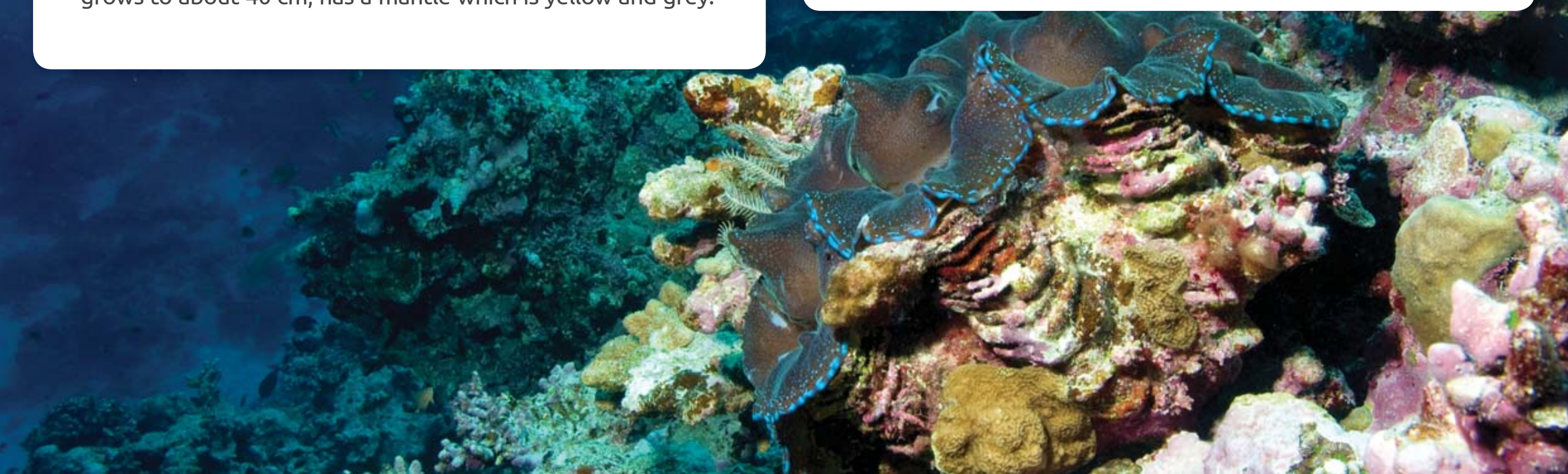
The elongate giant clam, *Tridacna maxima*, has perhaps the widest distribution among giant clam species in the Pacific, followed by the fluted giant clam, *Tridacna squamosa*. In these species, the colour of the flesh exposed when the shells gape open (the mantle) ranges from browns and purples to greens and yellows. The bear paw giant clam, *Hippopus hippopus*, which grows to about 40 cm, has a mantle which is yellow and grey.

Habitats & Feeding

Giant clams are distributed in areas of coral reef, where they lie with the hinge (pointed end) downward.

The elongate giant clam, *Tridacna maxima*, and the crocus giant clam, *Tridacna crocea*, appear to be buried in large corals, the latter to the upper edges of its shells.

Giant clams feed by filtering food (small drifting plants) from the seawater that passes through their openings (see illustration). They can also obtain food from the very small plant cells (called zooxanthellae) that live within the flesh of the clam. Because the plant cells within the flesh require sunlight, giant clams can only live and grow in water that is clear and shallow.



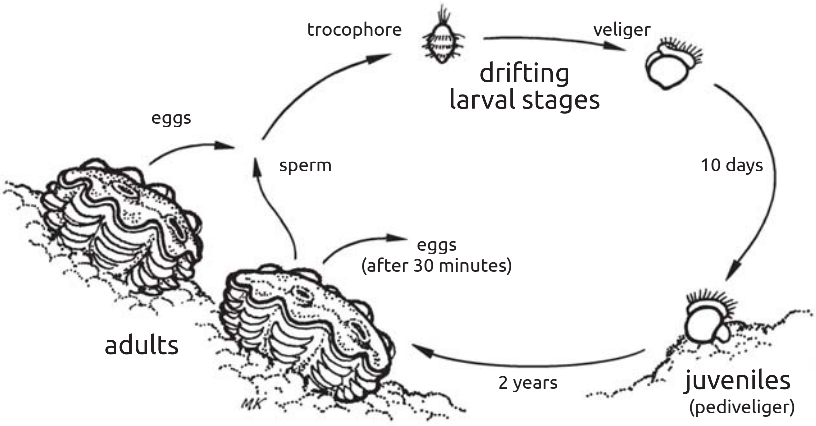
#10 Giant clams (Tridacnidae)

Reproduction & Life cycle

Giant clams begin life as males and mature at about 2 years of age, after which they act as both males (♂) and females (♀).

Spawning occurs during the warmer months when clams, becoming aware of eggs in the water, release sperm through their outlet openings. About 30 minutes after releasing sperm, an individual clam releases its own eggs, thereby avoiding the eggs being fertilised by its own sperm.

The number of eggs released by each individual varies between species, and hundreds of millions are produced by large individuals. The fertilised eggs hatch into very small floating forms (larval stages) that drift in the sea for about 10 days. Less than one in every thousand of the small floating forms survives to become a young clam (juvenile) that settles permanently on the sea floor. And less than one in every hundred juveniles survives to become a mature adult.



Fishing methods

Giant clams may be collected by hand at low tide. They are also taken by free diving, although unfortunately, underwater breathing apparatus is sometimes used.

Management measures & Options

The management of giant clam stocks is important as many species have been overfished and have disappeared from many local areas in the Pacific.

Many fishery authorities have applied minimum legal size limits with the intention of allowing clams to spawn at least once before capture. The size limits for various species are given in the booklet, *Size limits and other coastal fisheries regulations used in the Pacific Islands region*, available from SPC (www.spc.int).

In some cases, such limits have been applied collectively to all species (for example, 180 mm across the shell for all species). However the limit may be too large for the smaller clams, such as the elongate giant clam, *Tridacna maxima*, which grows to 350 mm and too small for the larger species such as the smooth giant clam, *Tridacna derasa*, which grows to 600 mm. To be effective, size limits should be applied to individual species.

Some fishery authorities have banned the commercial harvest of giant clams and have placed catch or bag limits on clams collected for personal use (variously 3 to 10 clams per person per day). The local sale of clams to hotels and restaurants may be banned or strictly controlled. National authorities can play an important role in banning the export of clams and preventing the illegal collection of clams by foreign fishing vessels.

Regulations imposed by national authorities can be supplemented or supported by community actions such as:

- → **a ban of the use of underwater breathing apparatus, which would provide some protection for larger clams living in deeper water where they may produce young that settle in shallower water areas;**
- → **establishing reserves (no take areas) in which the taking of giant clams is banned. In these reserves, the presence is needed of large numbers of clams in small areas, so that sperm have a better chance of fertilising eggs released by nearby clams. The time in which the small drifting (larval) stages float in the sea (about 10 days) may result in juvenile clams settling in nearby down-current areas where they can grow and eventually be collected.**

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network

Improving the practice of marine conservation

European Union
Union européenne

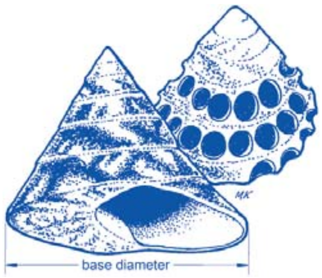
SPC CPS

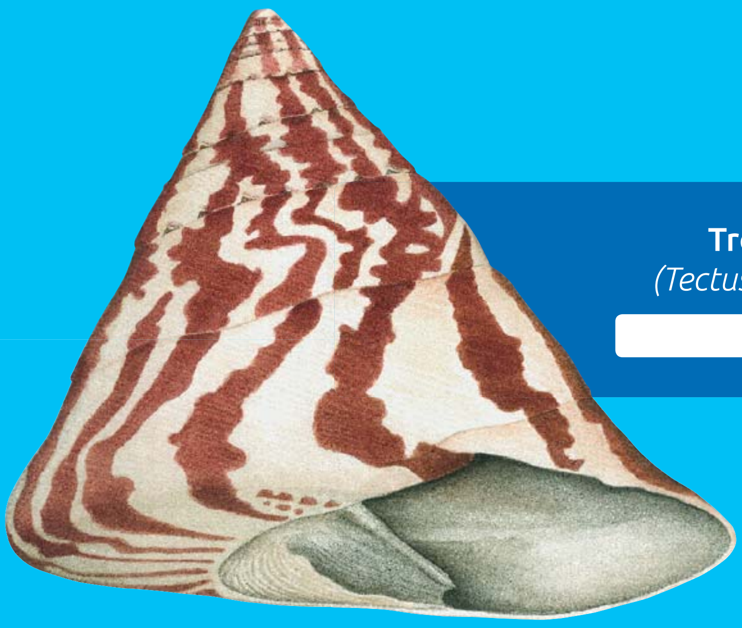
Information sheets for fishing communities

#11

Trochus

(*Tectus niloticus*)





Trochus

(Tectus niloticus)

Species & Distribution

The genus* Trochus *contains many different species of sea snails commonly called top shells.

The main species of interest in the Pacific Islands is *Tectus niloticus* (ex *Trochus niloticus*), a large species (up to 150 mm across the shell base) which has an off-white shell with oblique reddish stripes and an interior layer of thick pearly shell. This species is harvested for its flesh and particularly for its shell which is used to make mother of pearl buttons (the figure on the top of this page shows two trochus shells, one of which has been drilled to produce button blanks).

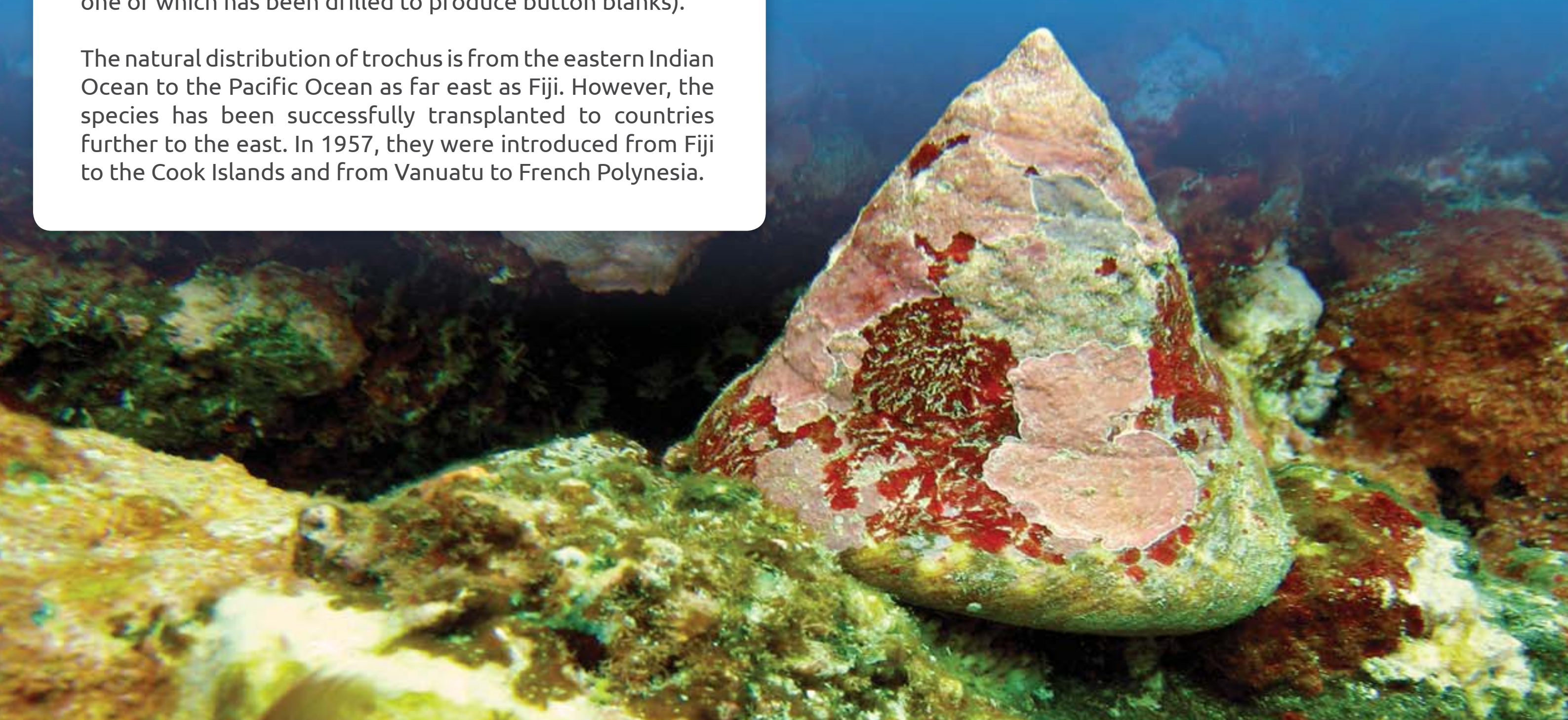
The natural distribution of trochus is from the eastern Indian Ocean to the Pacific Ocean as far east as Fiji. However, the species has been successfully transplanted to countries further to the east. In 1957, they were introduced from Fiji to the Cook Islands and from Vanuatu to French Polynesia.

Habitats & Feeding

Juvenile trochus settle in shallow areas among the boulders and rubble on intertidal reef flats.

On atoll reefs, adult trochus tend to aggregate along the reef crest while on high islands, they are on reef slopes down to depths of about 20 m.

Trochus graze on coral and rocks for very small plants.



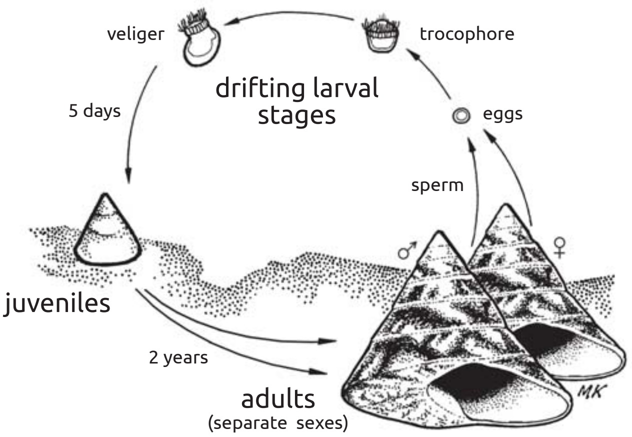
#11 Trochus (*Tectus niloticus*)

Reproduction & Life cycle

Trochus have separate sexes and are able to reproduce at about 2 years of age when they have a base diameter of between 50 to 70 mm. They can live for up to 15 years.

Spawning occurs throughout the year in warmer areas and during the warmer months in cooler areas. They may form loose spawning aggregations at night within 1 or 2 days of either a full or new moon.

During spawning, females (♀) release more than 1 million eggs that are fertilised by sperm released by males (♂). The fertilised eggs hatch to very small forms (the larval stages) that drift with currents in the sea for up to 5 days before settling on a rocky surface. Less than one in every thousand of these survives to become a young trochus (a juvenile). And less than one in every hundred juveniles survives the 2 or more years it takes to become a mature adult.



Fishing methods

Trochus are usually taken by free diving or by wading on the reef crest at low tide.

Unfortunately, the use of underwater breathing apparatus has severely reduced many populations of trochus.

Management measures & Options

Minimum and maximum size limits have been imposed in many countries.

Minimum size limits allow individuals to spawn at least once before capture. Maximum size limits are justified on the grounds that larger females produce a greater number of eggs and the shells of older individuals are less valuable due to worm infestation. Limits are often set at 80 mm and 120 mm base diameter.

Many countries have banned the use of underwater breathing apparatus for collecting trochus. Some countries have banned fishing for trochus for extended periods to allow populations to recover. The minimum population size that has been recommended before fishing can commence is 500 to 600 trochus per hectare (10 000 m^2).

Management measures that communities could take depend on the state of trochus populations. If they have been depleted, priority actions could include:

→ **placing and enforcing a total ban on collecting trochus in the local fishing area. Any closure would have to be for a long period to allow time for stocks to recover and for adults to breed;**

→ **establishing a permanent marine reserve (no-take area) in an area where there are adult trochus (or where trochus can be introduced). The expectation is that young trochus will be produced and these will settle in nearby areas.**

Both these actions could be enhanced by the transplantation or introduction of adult trochus from other reef areas where they are not overexploited.

If existing stocks of trochus are healthy, or once stocks have recovered, regulations imposed by national authorities can be supported or supplemented by community actions such as:

→ **establishing rotational harvesting, in which a community fishing area is divided into a number of smaller areas that are fished in rotation each year. If there were four smaller areas, each area would have three years protection from being fished;**

→ **establishing a community quota (or annual bag limit) for an area or region. Fishery authorities could assist communities by conducting a preseason survey to estimate the number of legal sized trochus in each area. The total number of trochus allowed to be taken could then be set at 30 to 40 per cent of the number of legal sized individuals present.**

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Emmanuel Tardy.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

European Union
Union européenne

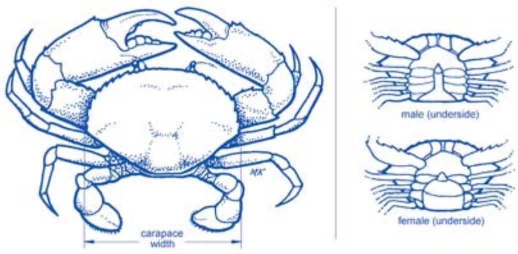
SPC CPS

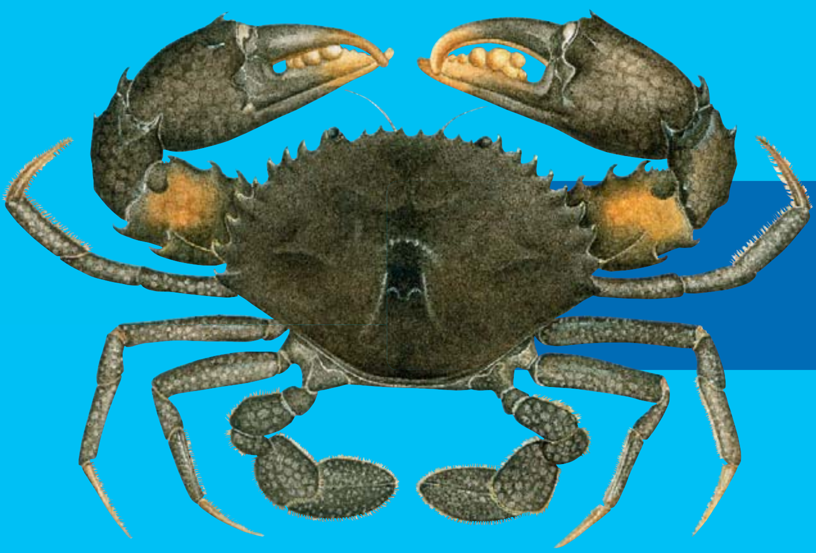
Information sheets for fishing communities

#12

Mangrove crab

(Scylla serrata)





Mangrove or mud crab
(Scylla serrata)

Species & Distribution

The mangrove or mud crab,* Scylla serrata*, is found in tropical and sub-tropical inshore areas from Africa to the Pacific Islands.

The shell colour varies from a deep, mottled green to very dark brown/purple. Other related species of *Scylla* may exist in some areas.

Male and female crabs can be distinguished from each other by the shape of the flap (abdomen) on the underside of the crab; the flap is narrow in males and much wider in females (see illustration).

Habitats & Feeding

The mangrove crab is found in muddy areas associated with mangroves and seagrass beds in the tidal mouths of rivers and sheltered bays.

The crabs burrow in the mud and generally have a restricted home range (area over which they move to feed).

Mangrove crabs eat small clams, worms, shrimps, barnacles, small fish, plant material and other crabs. They also eat smaller, injured or weak mangrove crabs. Juvenile mangrove crabs are eaten by wading birds and a wide range of fish. Adult crabs have been found in the stomachs of sharks and larger fish.

#12 Mangrove crab *(Scylla serrata)*

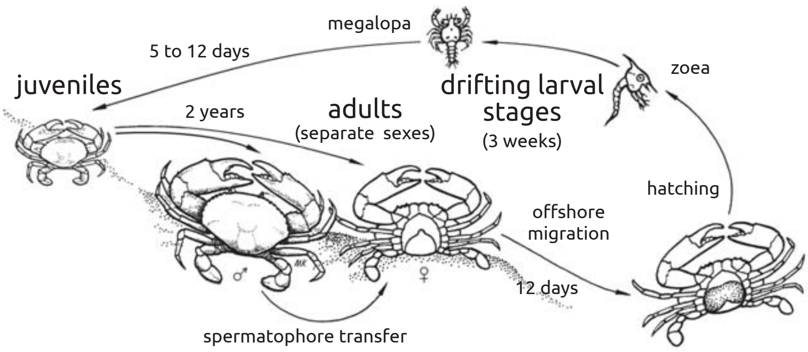
Reproduction & Life cycle

Mangrove crabs reach reproductive maturity in about 2 years and live for about 3 to 4 years when they can weigh up to 3.5 kg with a shell width of up to 24 cm.

During mating, the male crab (♂) transfers sperm packets (spermatophores) to the underside of a soft-shelled female (♀) where the sperm is stored for many months. The female releases over a million eggs which are fertilised by the stored sperm. The female (now said to be 'berried') carries the eggs for about 12 days. During this period the colour of the eggs changes from bright orange to almost black as the young crabs grow inside.

The female moves offshore where the eggs are released and hatch to become small floating forms (the drifting larval stages) about 1 mm long. These float in the sea for about 3 weeks and drift with currents back to inshore areas.

The final larval stage settles on the sea floor and turns into a miniature adult or juvenile (about 4 mm wide) within 5 to 12 days. Less than one in every thousand of the small floating forms survives to become a juvenile. And less than one in every hundred juveniles survives to become an adult.



Fishing methods

Mangrove crabs are caught by:

- **simple hand collection, sometimes with the aid of a hooked stick to remove crabs from their burrows;**
- **spears used at night with light from torches;**
- **long-handled scoop nets used among seagrass beds;**
- **gill nets set at the edge of the mangroves to catch crabs as they move into deeper water;**
- **baited traps and dillies made of string or wire mesh.**

Management measures & Options

Many fisheries management regulations have been applied to mangrove crabs, particularly in places where they are valuable in local markets. These measures include quotas or catch limits (a particular number of crabs per day), limiting the number of traps used and the licensing of those selling crabs. These measures are generally not applicable in community-based fisheries.

Measures applicable to all fishing for mangrove crabs include the application of minimum size limits (often between 120 mm and 150 mm shell width), banning the taking of female crabs, banning the taking of berried female crabs, and banning the use of certain fishing methods such as gill nets and spears. Traps are one of the best ways of catching mangrove crabs as they do not damage the caught crabs which can therefore be released if they are females or are too small.

In some countries catching mangrove crabs is prohibited during the reproductive period. Applying this measure relies on having knowledge of the timing of the spawning season in the particular area of concern.

Reserves (no-take areas) are unlikely to result in an increase in numbers of local populations of mangrove crabs as females move considerable distances offshore to spawn. This and the fact that the larval stages drift for several weeks suggests that juvenile crabs may settle in areas some distance from the reserve and local fishing areas.

The most effective measures that a fishing community can take to make fishing for mangrove crabs sustainable may be a combination of:

- **banning the taking of female crabs or, at least, berried female crabs;**
- **banning the taking of all crabs smaller than the national minimum size limit (if there is no national size limit, a minimum size of 140 mm width could be imposed by the community);**
- **protecting the local areas of mangroves and seagrass beds that are essential habitats for mangrove crabs.**

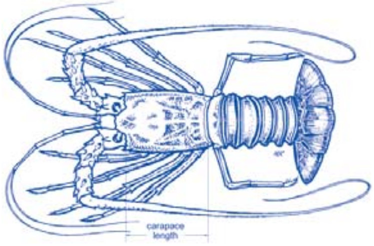
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photo by Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Information sheets for fishing communities

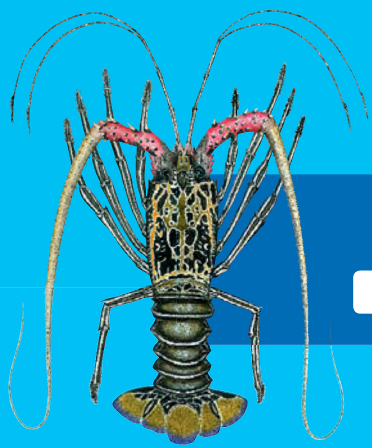
#13

Spiny lobsters
(Palinuridae)



Stripe-leg spiny lobster
(Panulirus longipes spinosus)

Pronghorn spiny lobster
(Panulirus penicillatus)



Painted spiny lobster
(Panulirus versicolor)

Species & Distribution

***Unlike true lobsters, spiny lobsters do not have large claws and are found in almost all warm seas. Those of interest in Pacific Islands belong to the genus* Panulirus.**

There are six species in the Solomon Islands, but only one, the pronghorn spiny lobster, *Panulirus penicillatus*, ranges out to eastern Polynesia. Except in Papua New Guinea, where the ornate lobster, *Panulirus ornatus* is caught, the main species caught are the pronghorn spiny lobster mixed with smaller quantities of the stripe-leg spiny lobster, *Panulirus longipes spinosus*. The painted spiny lobster, *Panulirus versicolor* is of minor importance.

Habitats & Feeding

Spiny lobsters live in crevices on reefs and move out at night to feed.

The pronghorn spiny lobster lives in the outer surf zone and moves onto the reef flats to find food. The stripe-leg spiny lobster lives in deeper water. The painted spiny lobster lives among the corals as well as in deeper water on outer reef slopes. The ornate lobster is found from shallow lagoons to continental shelves.

Spiny lobsters feed on sea snails, clams, crabs, sea urchins, plants (coralline algae) and dead animals. They are eaten by large fish, sharks and octopuses.

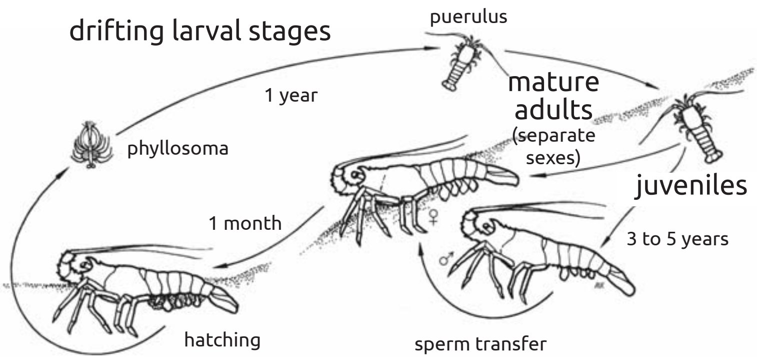
#13

Spiny lobsters (Palinuridae)

Reproduction & Life cycle

The different species of Pacific Island lobsters have similar life cycles. They have separate sexes and, depending on species and location, reach reproductive maturity at around 80 mm carapace length. They become mature adults within 3 to 5 years and live for about 10 years.

Many species appear to breed throughout the year, sometimes with a peak in the warmer months of the year. A male (♂) deposits a sperm packet (spermatophore) on the underside of a female (♀). The female releases many thousands of eggs which are fertilised as they pass over the sperm packet. The fertilised eggs are carried for about a month before they hatch into very small floating forms (the larval stages). These drift in the sea for a year or more, and less than one in every thousand survives to settle on the sea floor as a young lobster (juvenile). And less than one in every hundred juveniles survives to become a mature adult.

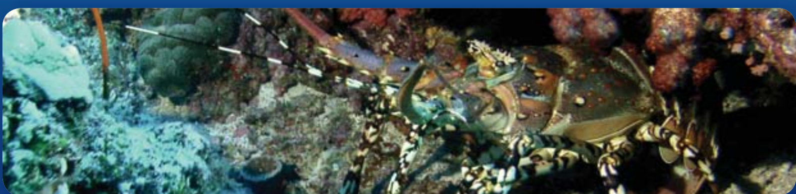


Fishing methods

In most Pacific Islands, the main fishing method used is the collection of lobsters by hand or by free diving at night with underwater lights.

Some lobsters are taken by the use of spears and, unfortunately, underwater breathing apparatus is sometimes used.

Many large-scale operations to catch lobsters in Pacific Islands have failed because the main species are generally present in low abundance and, except for the Hawaiian spiny lobster, do not enter traps or pots readily. It is important that fishery authorities reserve lobster fishing for local people selling to local markets.



Management measures & Options

Fishery authorities have applied minimum size limits on various species and these are given in the booklet* Size limits and other coastal fisheries regulations used in the Pacific Islands region*, available from SPC (www.spc.int). National size limits are particularly useful if lobster catches can be checked at relatively few market places.

Some authorities have banned the taking of egg-bearing females and soft-shelled lobsters. Some have applied catch or bag limits (for example, 10 lobsters per person per day), banned the use of underwater breathing apparatus, and banned the export of lobsters.

Management of lobsters by individual communities is often difficult because the small drifting (larval) stages float in the sea for a very long time (often, over a year) before settling on reefs as juveniles. Therefore, the young produced by adult lobsters in a community's fishing area may settle on reefs some distance away.

If an atoll or a small island community takes actions to manage its lobster fishery, these are likely to benefit local fishers. If only one of many communities on a long coastline takes management actions, lobster numbers may still decrease if other, nearby communities have depleted their own lobster numbers. In this case, the best solution is for many neighbouring communities to work together and agree to the same management measures.

In addition to supporting national regulations, communities could take the following actions:

- → **restrict the total community catch of lobsters to a sustainable level. A sustainable catch may be as low as 20 kg of lobster per km of reef-face per year;**
- → **rotate the catching of lobsters on different areas of reef. Each area could be fished for 1 year and then left unfished for a number of years;**
- → **ban the taking of small lobster (enforce national minimum size limits);**
- → **ban the use of underwater breathing apparatus;**
- → **ban the use of spears. Collecting lobsters by hand allows fishermen to avoid small lobsters and live lobsters are more marketable than dead ones;**
- → **ban the taking of female lobsters carrying eggs.**

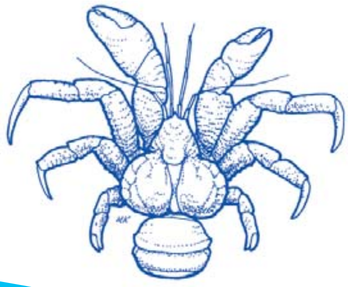
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker and Eric Clua.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

#14

Coconut crab

(Birgus latro)



Coconut crab
(Birgus latro)

Species & Distribution

The coconut crab,* Birgus latro, *is a crustacean related to hermit crabs.

The juveniles live in sea-snail (gastropod) shells but the adults live without shells and grow to large sizes on land. The coconut crab is one the largest of all crabs and reaches weights of over 4 kg (with some reports of weights up to 14 kg). The adults have massive crushing claws and long legs which enable them to climb trees. The colour of adults varies from light violet through to deep purple to brown.

The coconut crab is distributed in tropical islands from the Indian Ocean to French Polynesia in the Pacific Ocean. Its vulnerability to animals such as dogs and pigs as well as the destruction of its coastal habitats have probably accounted for its disappearance in many islands and atolls.

Habitats & Feeding

Adult coconut crabs live alone in underground burrows and rock crevices in coastal forest regions and some have been found up to 6 km from the sea. Adults cannot swim and will drown in seawater.

Coconut crabs generally remain hidden during the day and come out to look for food at night. They eat other crabs, dead animals, and will sometimes raid rubbish bins for human food scraps. They eat rotting leaves as well as *Pandanus* fruit and coconuts that have fallen to the ground.

They are capable of removing the husk of a coconut with their large claws and piercing its soft germination eye with one of their legs.

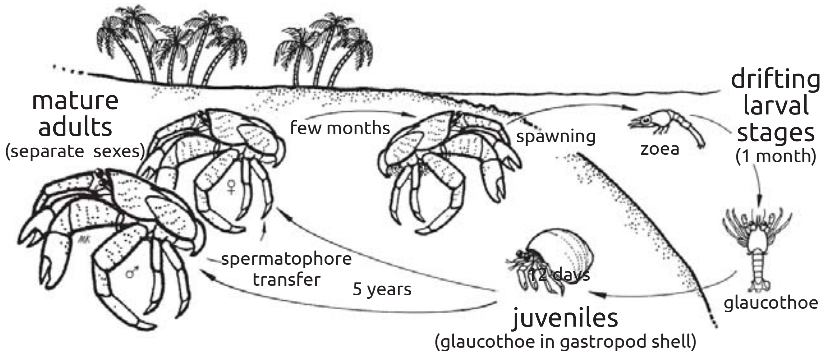
Coconut crab *(Birgus latro)*

Reproduction & Life cycle

Coconut crabs have separate sexes. During mating, the male (♂) transfers sperm packets (spermatophores) to the underside of a soft-shelled female (♀). A few weeks later, the female releases her eggs. These are fertilised as they pass over the spermatophores and form a spongy, orange, egg mass, which is carried underneath her body for a few months.

The female moves to the shore-line and releases the fertilised eggs into the ocean at high tide. These hatch into small forms (the larval stages) which drift in the ocean for about a month. Less than one in every thousand survives to settle on shore and enter a suitable sea-snail shell. As they change into juveniles, they lose the need for protective shells and move further inland as they grow. Less than one in every hundred survives to become an adult.

As in all crustaceans, coconut crabs cast off their hard covering at intervals in order to grow. When the old shell is cast off, it takes about 30 days for a new shell to harden and, as the crab is vulnerable during this time, it stays hidden for protection. Coconut crabs are capable of reproducing at approximately 5 years of age and can live for over 30 years.



Fishing methods

Coconut crabs are highly prized as food and their ease of capture has resulted in their disappearance in many island countries.

Local people may set baits of split coconuts pinned to the ground and check the baits at night with a torch.

Although farming is often suggested as a way of producing coconut crabs for the market, their complex life cycle and slow growth make this a difficult undertaking.

Management measures & Options

National fisheries authorities have applied catch limits, bans on taking females bearing eggs and size limits. These rules are set out in the booklet,* Size limits and other coastal fisheries regulations used in the Pacific Islands region, *available from SPC.

These national regulations are effective if catches of coconut crabs can be checked at relatively few market places. However, as fishing is usually done at night and the catch is disposed of through scattered outlets including local markets, hotels and restaurants, these regulations are difficult to enforce.

Banning the capture of crabs during the breeding season is not practical as females carry their eggs for an extended time period.

In some countries it has been made illegal for restaurants to buy coconut crabs. Although commendable, this has deprived local people of a source of income. However, it is possible for communities to make up for this loss through eco-tourism.

Community actions could include:

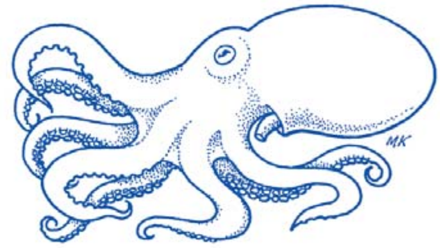
- **setting up a coconut crab reserve in an area with suitable habitats, which would have to be fenced to exclude livestock and have access to the sea to allow crabs to reproduce. Initially, it may be necessary to transplant coconut crabs into the reserve from nearby areas;**
- **allowing fee-paying tourists to take guided evening tours to view the crabs in their natural habitat. National tourism organisations and hotels may assist in attracting tourists;**
- **restricting the capture and sale of large coconut crabs from areas outside the reserve to a reasonable bag limit and enforcing national regulations, including minimum size limits.**

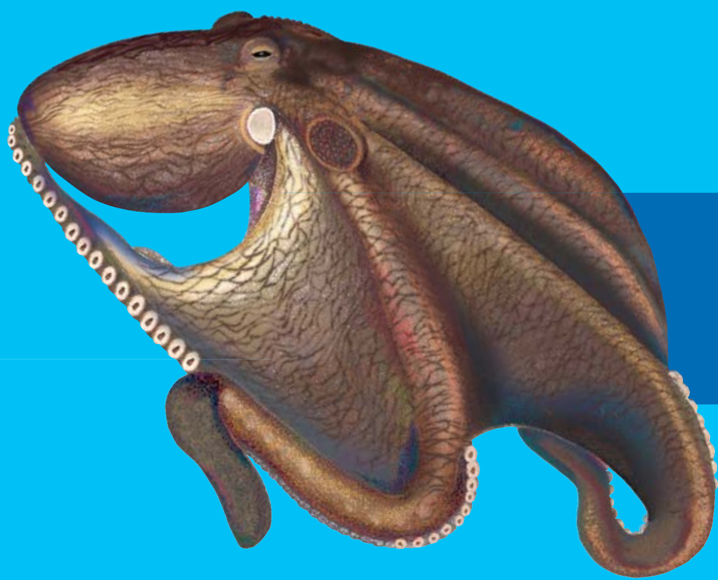
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

#15

Octopuses





Big blue octopus
(Octopus cyanea)

Species & Distribution

Octopuses are related to squids and clams and have eight arms with suckers, soft saclike bodies, and strong, beaklike jaws. At least 100 species of octopuses are distributed in seas around the world.

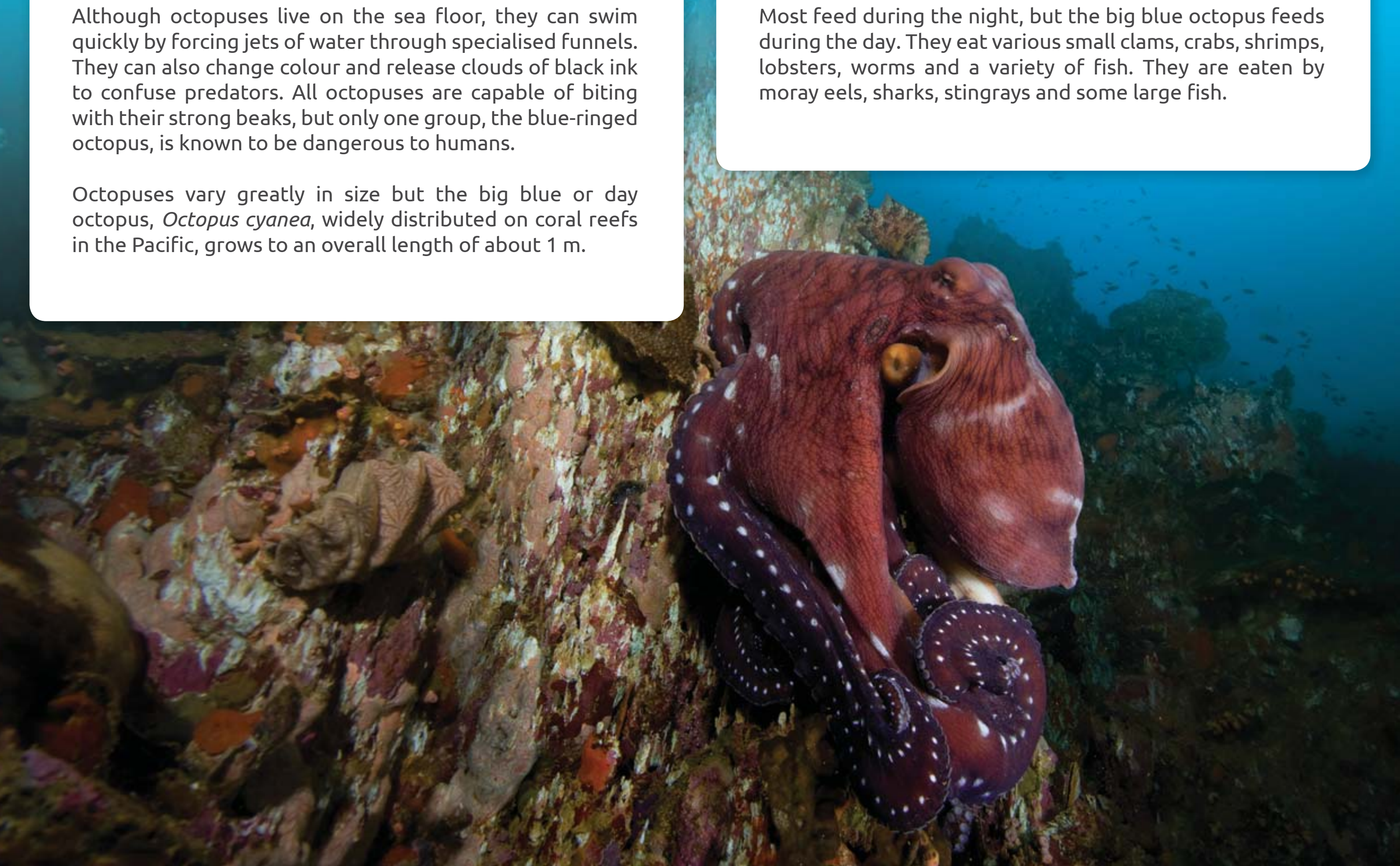
Although octopuses live on the sea floor, they can swim quickly by forcing jets of water through specialised funnels. They can also change colour and release clouds of black ink to confuse predators. All octopuses are capable of biting with their strong beaks, but only one group, the blue-ringed octopus, is known to be dangerous to humans.

Octopuses vary greatly in size but the big blue or day octopus, *Octopus cyanea*, widely distributed on coral reefs in the Pacific, grows to an overall length of about 1 m.

Habitats & Feeding

Reef octopuses live under ledges or in holes in the coral reef. These nests can often be recognised by the rubble and the remains of their food, including empty shells, found near the entrances.

Most feed during the night, but the big blue octopus feeds during the day. They eat various small clams, crabs, shrimps, lobsters, worms and a variety of fish. They are eaten by moray eels, sharks, stingrays and some large fish.

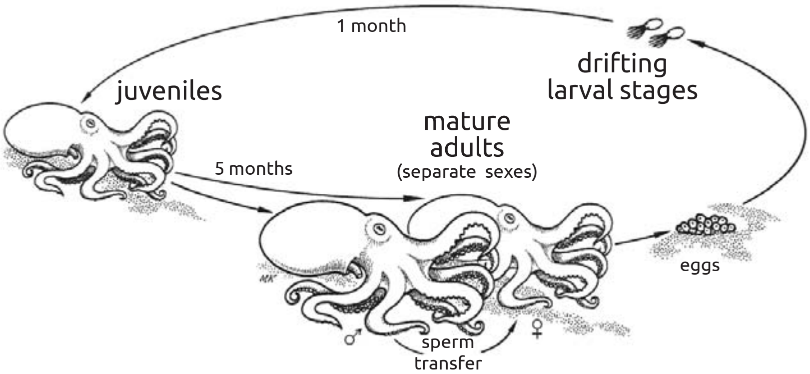


#15 Octopuses

Reproduction & Life cycle

Octopuses have separate sexes. During breeding, the male (♂) uses one of its arms to place packets of sperm under the body covering (mantle) of the female (♀). The female releases hundreds of eggs, which are fertilised by the stored sperm.

The female lays the fertilised eggs in bunches under a ledge or within a nest on the reef. She protects the eggs and does not go hunting for a period of several weeks until they hatch. The newly hatched forms (the drifting larval stages) look like small adults and swim in the water for about a month. Only a few, perhaps one in every hundred, survive to settle to the sea floor as juveniles. They grow to become reproducing adults in less than five months and have a lifespan of only 1 or 2 years.



Fishing methods

Octopuses are fished locally throughout the Pacific Islands using a variety of fishing methods including lures, baited lines and spears as well as by hand.

Some fishing methods result in considerable destruction of corals as the octopuses are removed from their nests. In some countries, traditional lures made of cowry shells are used to attract and catch octopuses.

Management measures & Options

Not many fisheries management regulations have been applied to octopuses although their numbers have decreased on many reefs.

Minimum legal size limits, intended to allow individuals to spawn at least once before capture, are of little use in octopus fisheries. Many of the commonly used fishing methods damage the octopuses and any under-sized individuals released after capture would be unlikely to survive.

Possible community management measures include banning the use of fishing methods that result in the destruction of surrounding corals.

Regulations imposed by national authorities can be supported or supplemented by community actions such as:

→ **establish reserves (no-take areas) in which the catching of octopuses is banned. Adult octopuses within the reserve will increase in number and be responsible for repopulating nearby areas, particularly those that are down-current, where they can be caught;**

→ **establish rotational harvesting in which the fishing area is divided into smaller sections which are fished in rotation, often 1 year at a time. A community could, for example, divide its reef fishing area into two or three smaller areas. The community would then allow octopuses to be caught in one area during 1 year and then to be caught in the other areas in turn during the following years. Because octopuses grow very quickly, those in areas that are protected even for a short time, say 1 to 2 years, are likely to increase in number and reach a size at which they can reproduce.**

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

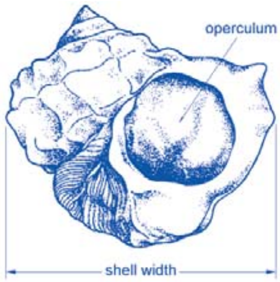
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Information sheets for fishing communities

#16

Green snail

(Turbo marmoratus)



Green snail
(Turbo marmoratus)

Species & Distribution

The green snail or turban,* Turbo marmoratus*, is a large sea snail that grows up to 2 kg. It has a heavy shell and a large lid or operculum (sometimes called a "cat's eye"), which can close off the opening of the shell when the snail is disturbed or attacked.

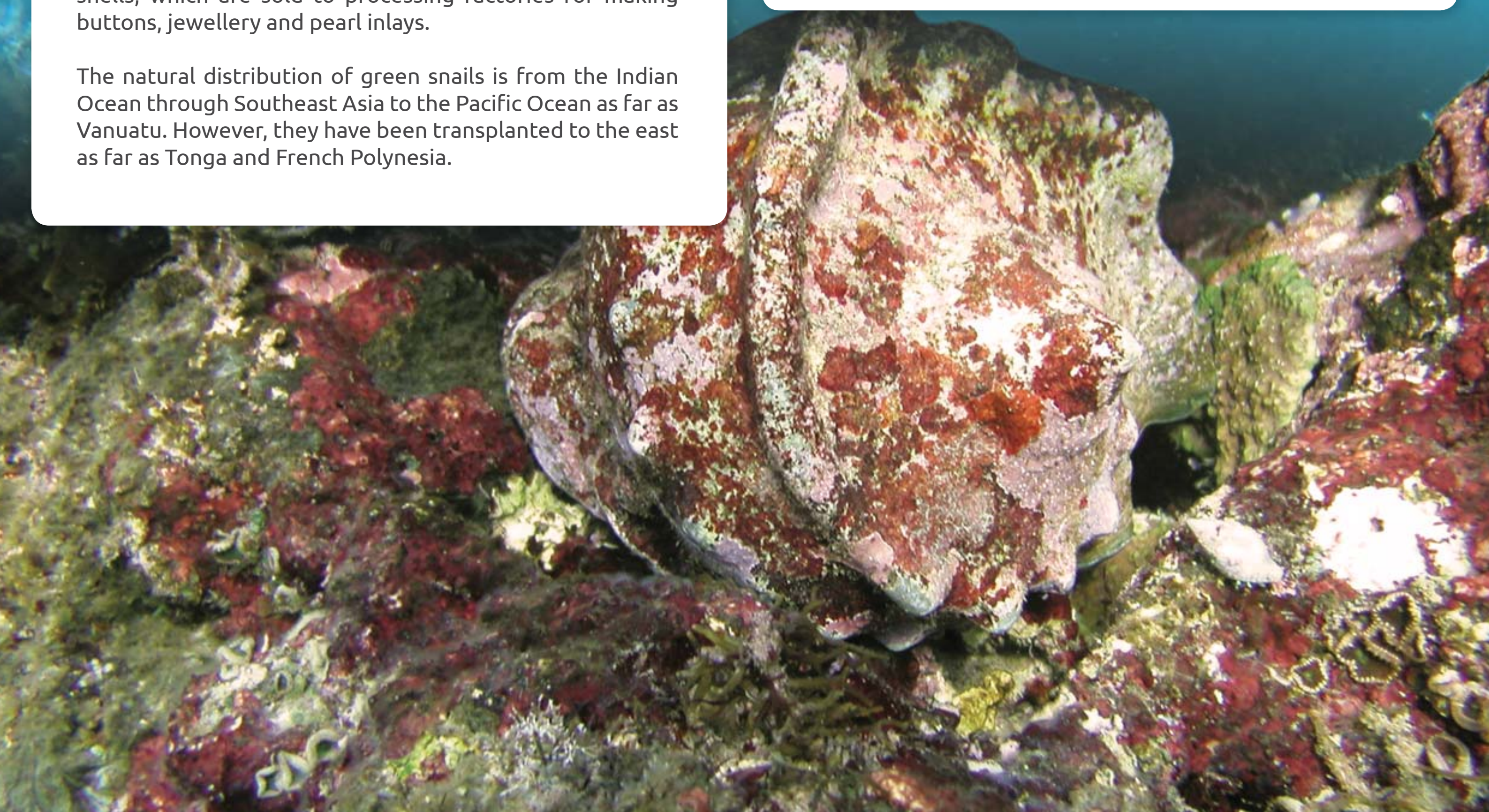
Green snails are harvested for their meat and their pearly shells, which are sold to processing factories for making buttons, jewellery and pearl inlays.

The natural distribution of green snails is from the Indian Ocean through Southeast Asia to the Pacific Ocean as far as Vanuatu. However, they have been transplanted to the east as far as Tonga and French Polynesia.

Habitats & Feeding

Green snails prefer the surf zones and reef slopes on coral reefs. Juvenile green snails hide in crevices and holes.

Adults move around at night to feed on plants (red and green algae). They are eaten by many animals including crabs, mantis shrimps, other sea snails, octopuses and large fish.

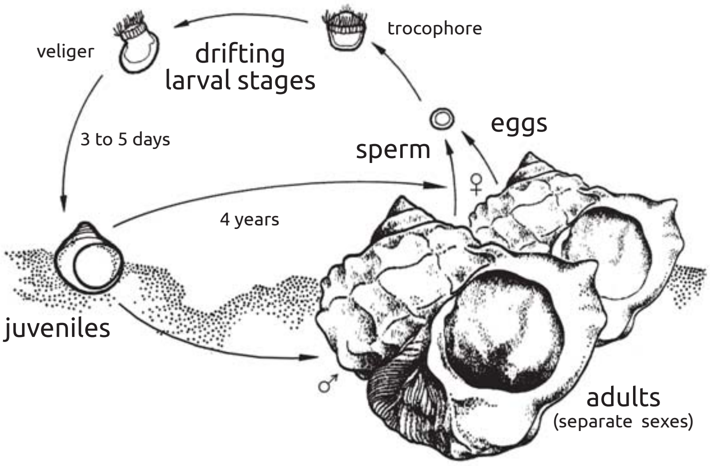


#16 Green snail *(Turbo marmoratus)*

Reproduction & Life cycle

Green snails have separate sexes and are able to reproduce at a shell width of about 130 to 150 mm and an age of about 4 years. In cooler areas, green snails appear to breed in the summer months but, in warmer areas, they breed throughout the year.

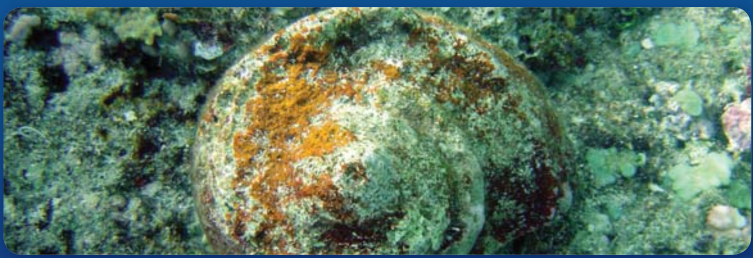
During reproduction, each female (♀) releases millions of eggs into the sea and these are fertilised by sperm released by the males (♂). Although heavier than seawater, the eggs may be carried by sea currents over considerable distances. The fertilised eggs develop into very small forms (the larval stages) that drift in the sea. Less than one in every thousand survives to settle on the sea floor as a shelled juvenile within 3 to 5 days. And less than one in every hundred juveniles survives to become an adult.



Fishing methods

Green snails are usually taken by free diving or snorkelling and wading on the reefs at low tide.

Unfortunately, the use of underwater breathing apparatus has been responsible for removing nearly all green snails in many areas. Fisheries for green snails have collapsed in several Melanesian countries.



Management measures & Options

Many fisheries authorities have applied minimum size limits (often within the range 130 to 150 mm shell width) with the intention of allowing individuals to breed at least once before capture.

The use of underwater breathing apparatus for collecting green snails has been banned in many countries. This measure may provide some protection for larger reproducing snails living in deeper water and these may breed and repopulate shallower areas.

These regulations are of little use in many areas where green snails have disappeared due to heavy fishing. Some countries have banned fishing for green snails for periods of up to 15 years to allow populations to recover. Due to the high value of green snails, many communities have difficulty protecting green snails from commercial operators.

Management measures that communities could take depend on the state of local green snail populations. If green snails have been severely depleted, possible priority actions could include:

→ **placing and enforcing a ban on the collecting of green snails in the local fishing area. Any closure would have to be for several years to allow time for stocks to recover and for adults to breed;**

→ **establishing a permanent marine reserve (no-take area) in an area where there are adult green snails (or where green snails can be introduced). The expectation is that adults in the reserve will grow and reproduce. Due to the very short time that small green snails (the larvae) drift in the sea, juveniles may settle both within the reserve and in nearby down-current areas.**

If existing stocks of green snails are healthy, or once stocks have recovered, the following management measures can be taken to ensure that collecting green snails is sustainable;

→ **establishing rotational harvesting, in which a community fishing area is divided into a number of smaller areas that are fished in rotation. If there were five smaller areas, each area would have four years protection from being fished and this may allow green snail stocks to rebuild and reproduce;**

→ **establishing a community quota (or annual bag limit). Fisheries authorities could assist communities by conducting a preseason survey to estimate the number of green snails over a minimum size in each area. The community quota (the total number of green snails allowed to be taken) could then be set at 40 per cent of the number of legal sized snails present; if there is no national minimum size, a community could apply a minimum size of 140 mm shell width.**

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Kim Friedman and Antoine Teitelbaum.

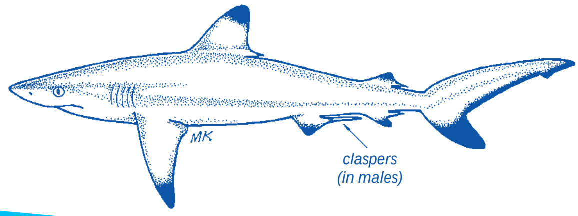
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

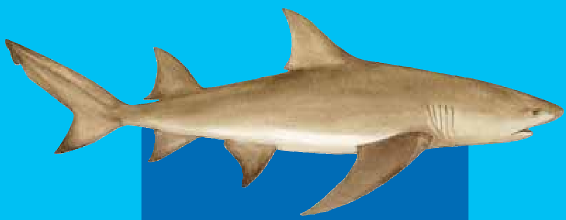
Information sheets for fishing communities

#17

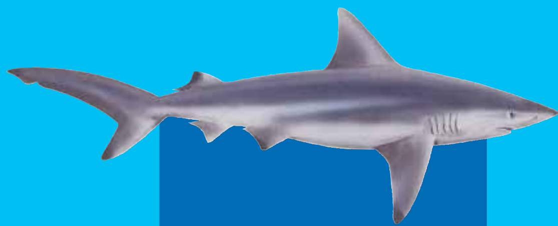
Reef sharks

(Carcharhinidae)



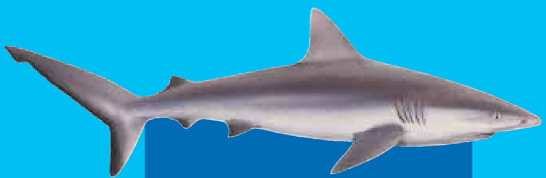


Sicklefin lemon shark
(Negaprion acutidens)

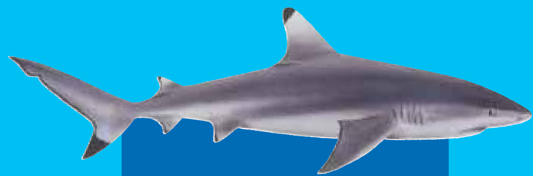


Blacktip shark
(Carcharhinus limbatus)

Whitetip reef shark
(Triaenodon obesus)



Grey reef shark
(Carcharhinus amblyrhynchos)



Blacktip reef shark
(Carcharhinus melanopterus)

Species & Distribution

In the Pacific, inshore species caught by coastal communities for food include several species of small requiem sharks (family Carcharhinidae).

Common species include the blacktip reef shark, *Carcharhinus melanopterus*, the blacktip shark, *Carcharhinus limbatus*, the grey reef shark, *Carcharhinus amblyrhynchos*, the sicklefin lemon shark, *Negaprion acutidens*, and the whitetip reef shark, *Triaenodon obesus*.

These smaller species have a wide distribution in the IndoPacific and, other than the lemon shark that grows to 3 metres, most reach a size of about 2 metres. Several other larger and more dangerous species, including tiger sharks and bull sharks, are caught, mainly by commercial fishers.

Most of these sharks swim continually to obtain oxygen from water flowing over their gills; the whitetip reef shark, however, can pump water over its gills and lie motionless on the sea floor.

Habitats & Feeding

Generally, small reef sharks prefer shallow, inshore areas including reef flats and coral reefs. Young sharks may live in inshore areas that offer plentiful food. Most species remain in particular areas whereas blacktip sharks move over considerable distances.

Most reef sharks hunt alone but can form feeding frenzies when people spearfish or gut fish in the water. They eat fish such as sardines, mullets, mackerels, trevallies and emperors as well as octopuses and shrimps. Whitetip reef sharks often rest under coral during the day and hunt at night.

Small reef sharks are eaten by larger fish including sharks and groupers.

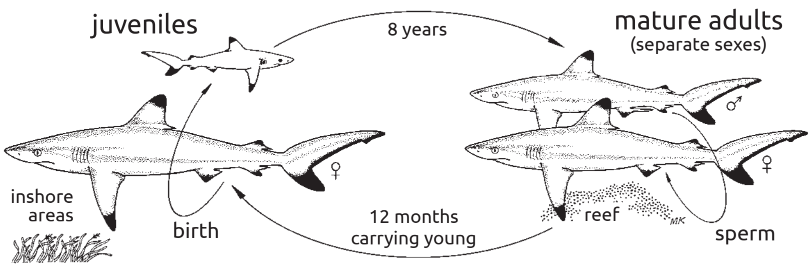
#17 Reef sharks (Carcharhinidae)

Reproduction & Life cycle

Sharks have separate sexes and males have two external sex organs called claspers located beneath the body just in front of the tail. During mating, usually at the end of winter, a male inserts one of his claspers into the opening (cloaca) of the female to transfer sperm packets (spermatophores).

In reef sharks, the female carries the young developing sharks within her body and gives birth to up to ten live young sharks, about 65 cm in length, about a year later. About nine of every ten young sharks die before moving out of shallow inshore areas.

Sharks reach maturity within 8 years at a length of about 1 metre and most species reach a maximum size of 2 metres or more in approximately 12 years. After maturity, females may return to the shallow water areas where they were born to give birth themselves.



Fishing methods

In Pacific Island countries, sharks are caught using spears, baited hooks, gillnets and traps. Some traditional fishing methods have also been used, such as by lassoing or "noosing" sharks in Tonga. Sharks are not eaten in some areas, particularly in parts of Melanesia.

Although small reef sharks are not regarded as dangerous to humans they can be aggressive toward people spear fishing or standing fishing in shallow water. Whitetip reef sharks, in particular, are known to respond very rapidly to the sound of a spear gun being fired.

Sharks retain urea (a nitrogen compound in the urine of many animals) in their blood and flesh and this gives a strong flavour to the meat. For this reason, the carcass of a freshly caught shark should be bled (by removing the head and gills, for example) and thoroughly washed in seawater.

Sharks are fished in large numbers for their fins, which are used in shark fin soup. Tens of millions of sharks are caught each year and in many cases their fins are removed and the rest discarded. This practice, called finning, results in a waste of fish flesh.

Management measures & Options

Because sharks produce only a small number of young, stocks can be easily overfished. Several species have been classified as threatened by the International Union for Conservation of Nature (IUCN).

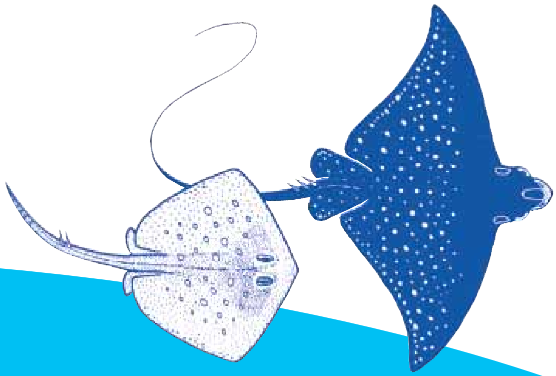
Sharks are important in reef ecosystems as they remove weak and sick fish and thereby ensure that only the healthiest individuals are left to breed. Options for community-based management include the following:

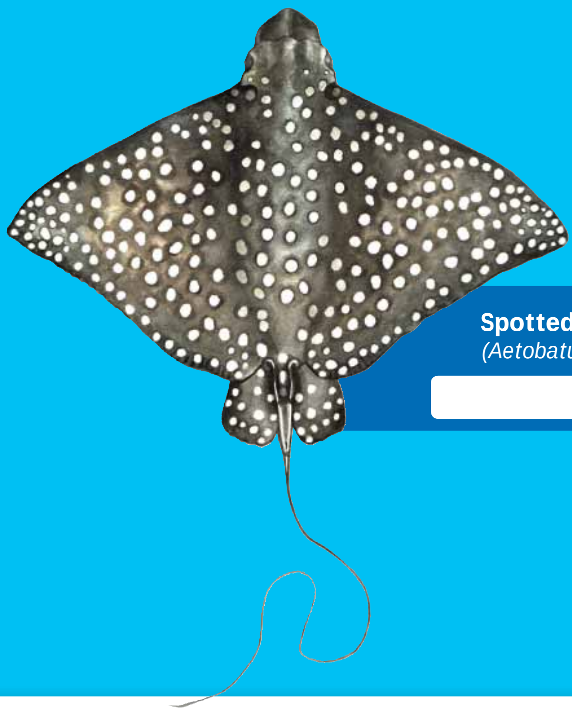
- **Ban the local fishing of sharks for their fins.** Insist that all sharks caught for food are bled and gutted and landed with their fins intact.
- **Establish no-take areas for short periods where sharks are known to gather.** These may include shallow-water nursery areas where young sharks are born — these areas are often known to local fishers.
- **Develop ecotourism based on "shark watching".** Tourists will pay to see non-aggressive sharks in their natural environment. A single caught shark may be worth a few dollars but the same shark left in the water may be worth many thousands of dollars if tourists pay to see them alive.
- **Regulate fishing gear.** For example ban large-mesh gillnets used to catch sharks or ban the use of wire leaders that attach fish hooks to nylon fishing lines — a nylon leader can be bitten through and allow sharks to escape.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker and Kydd Pollock/Marine Photobank.

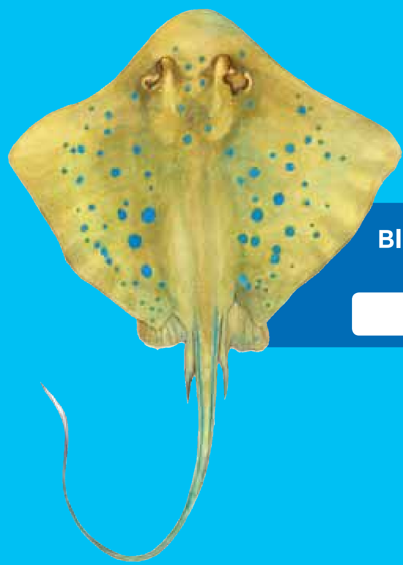
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Rays & Skates





Spotted eagle ray
(Aetobatus ocellatus)



Blue-spotted stingray
(Dasyatis kuhlii)

Species & Distribution

There are several hundred species of fish commonly known as skates, stingrays and eagle rays. They are similar to sharks in that they have a skeleton made of tough, elastic material rather than bone, but have flattened bodies and wing-like side fins (pectoral fins).

These "wings" which provide most of the edible meat do not contain the soup needles (or finrays) found in sharks so they are not as sought after as sharks in the overfished sharkfin fishery.

Several species are used as food across the Pacific and the spotted eagle ray, *Aetobatus ocellatus*, and the blue-spotted stingray, *Dasyatis kuhlii*, are used here as examples. The spotted eagle ray, which has many white spots on a dark blue/green body and a wingspan width of 2.5 metres, is common throughout the entire tropical Indo-Pacific. The blue-spotted stingray, which has a brown body covered with light blue spots and reaches a width of 35 centimetres, is common in sandy patches on coral reefs across the western Pacific.

Most stingrays have, on their tail, one or more barbed stings covered with a thin layer of skin in which the venom is concentrated. In the past, some Pacific communities used stingray barbs to make heads for arrows and spears.

Habitats & Feeding

Most species are adapted for life on the sea floor and can take in water through large openings called spiracles, rather than through the mouth as most fish do. Most species feed on soft sandy sea floors though eagle rays often swim up in the water column, as do giant manta rays.

Most species have heavy, rounded teeth for crushing the shells of bottom-dwelling species such as sea snails, clams, oysters and crabs. They also eat worms, shrimps and some fish. The related manta ray, however, filters small animals (plankton) from the water.

The main predators of smaller stingrays in tropical waters are sharks and large species of fish.

#18 Rays & Skates

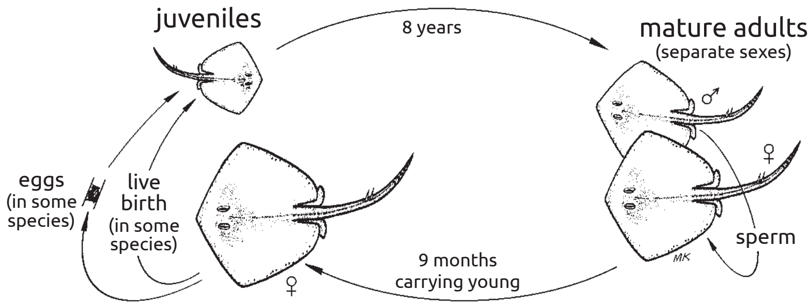
Reproduction & Life cycle

Rays and skates have separate sexes and fertilisation is internal — that is, males transfer sperm to females which eventually either give birth to live young or lay large leathery eggs.

Males have two external sex organs called claspers located beneath the body. During mating, a male (|) uses one of his claspers to transfer sperm into the opening (cloaca) of the female (~).

In most species, the female carries the young within her body for around nine months before giving birth to up to 15 live young rays, which swim about and go hunting with their mother. In some species, notably the skates, the female lays leathery eggs on the sea floor. The eggs (sometimes called mermaids' purses) hatch to juvenile rays that look like small adults.

Most rays and skates that have been studied grow slowly, and perhaps only one in ten juveniles survives the eight years or so required to reach sexual maturity. They have a lifespan of up to 30 years.



Fishing methods

Rays are caught using spears and baited hooks and lines. Like sharks, rays retain urea (a nitrogen compound present in the urine of many animals) in their blood and flesh, and have to be bled immediately after being caught and the meat washed and soaked.

Many species should be considered dangerous, as their barbs are venomous. However, most rays will swim away at the approach of someone wading in shallow water.

Management measures & Options

Because they grow slowly and produce only a small number of young each year, rays must not be heavily fished.

In most rays, females mature at a relatively large size and advanced age and this makes the application of size limits difficult. In addition, there is the danger involved in measuring a recently caught and flapping stingray.

Options for community-based management include taking the following actions. The first two options assume that the species of interest gathers to reproduce in particular areas and/or at particular times and this information is known by local fishers. Many species of rays and skates form loose breeding aggregations.

- **Establish local no-fishing zones in areas where rays are known to gather.** This restriction is suitable for species that are known by local fishers to gather in particular areas to breed.
- **Ban fishing for rays at times when they gather to breed.** This restriction is suitable for species that are known, by the community, to gather to breed at particular times of the year. Most species aggregate only once a year at a time that may be related to the lunar cycle.
- **Develop ecotourism based on stingray viewing.** Many tourists will pay to observe stingrays in their natural habitat. Stingrays can become conditioned to be being fed at particular locations.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker and Éric Clua.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

European Union
Union européenne

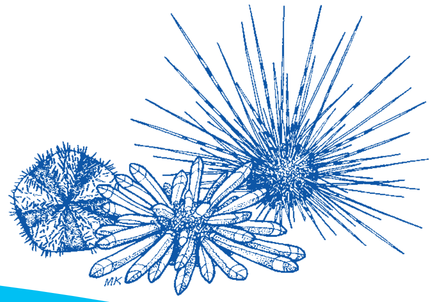
SPC CPS

Information sheets for fishing communities

#19

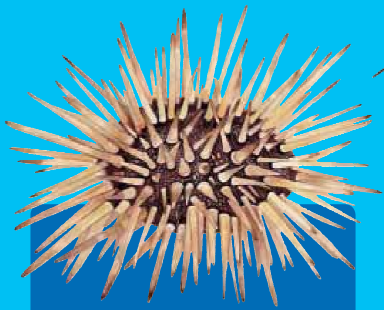
Sea urchins

(Echinoidea)



Coarsed spined urchin
(Echinotrix diadema)

Red slate-pencil urchin
(Heterocentrotus mamillatus)



Hedgehog sea urchin
(Echinometra mathaei)

Striped sea urchin
(Tripneustes gratilla)

Species & Distribution

Sea urchins have globe-like bodies with the mouth directed downwards and the anus directed upwards. They move on small tube-like feet which end in suckers and have a hard external shell (known as a test) with moveable spines of varying length.

The needle-like spines of the long-spined urchin, *Diadema*, reach over 30 cm in length and contain toxins capable of inflicting a painful wound. The spines of the slate-pencil urchin, *Heterocentrotus*, on the other hand, are heavy and blunt and are adapted for wedging the urchin into crevices on coral reefs. Species of *Echinometra* and the striped sea urchin, *Tripneustes gratilla*, are widely collected for food in many Pacific island countries; the latter is believed to have a high aquaculture potential.

Sea urchins are found in both temperate and tropical waters around the world and are the basis of commercial fisheries. Sea urchins have five reproductive organs (gonads or roe) suspended on the inside of the test and these are regarded as delicacies in many countries.

Habitats & Feeding

Young sea urchins often prefer rocky areas where they can hide and mature urchins prefer open sea floors with some cover.

They move over the sea floor feeding on seagrass, seaweed (algae) and sometimes small animals using their five pointed teeth. Many urchins play a vital role in reef health by eating seaweed which would otherwise smother corals.

In tropical waters, sea urchins are eaten by stingrays, puffer fish, triggerfish and octopuses.

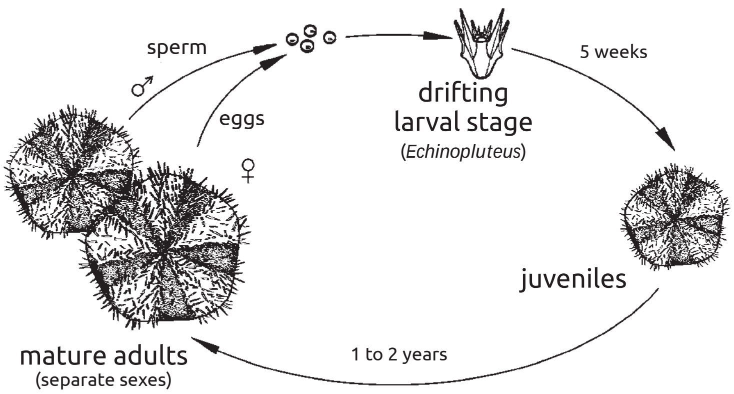
#19 Sea urchins (Echinoidea)

Reproduction & Life cycle

Sea urchins have separate male and female sexes which are externally identical. In many species a large number of individuals gather to reproduce in spawning aggregations.

Females (~) release several million eggs and males (|) release sperm into the water from five pores arranged around the anus. Fertilised eggs develop rapidly into a swimming cone-shaped larval stage which may remain in the plankton for about 5 weeks. Only a few in a million survive to sink to the bottom and change into adult forms.

Many tropical species of sea urchins reach reproductive maturity within two years. The short-spined sea urchin grows very quickly to reach reproductive maturity at 75 mm in the first year and may live for 2 to 5 years and reach sizes of 160 mm.



Fishing methods

In Pacific island countries, sea urchins are usually picked by hand (gleaned) by women walking in shallow water. In some cases, sea urchins have been collected by divers using SCUBA.

Some urchins, such as the flower urchin, *Toxopneustes pileolus*, are poisonous and should not be handled; they are easily identified by the flower-like extensions (pedicellaria) between the spines.

Management measures & Options

On a worldwide basis, various controls including catch quotas and licensing of fishers have been used to manage commercial sea urchin fisheries; these management measures are generally unsuitable for use by fishing communities in which urchins are collected as food. In most Pacific Islands there are no management controls placed on the collection of sea urchins.

Members of fishing communities should be able to judge whether or not sea urchins are being overfished (overfishing could be indicated if an increasing amount of time is needed for one person to collect a basket of sea urchins).

If sea urchins have been overfished, the remaining sea urchins may be too far apart for eggs released by females to be fertilised by sperm released by males. Sea urchins have to be close to each other and present in sufficient numbers for reproduction to be successful.

If it is believed that urchin populations have decreased, actions that could be taken include the following:

- **Ban the commercial collection and selling of sea urchins.** Local stocks of sea urchins should be reserved for use as food by local fishing communities.
- **Ban the use of underwater breathing apparatus for collecting sea urchins.** Fishing methods should be restricted to collection by hand.

If the timing and location of sea urchin spawning aggregations are part of the traditional knowledge of the community, the following actions are possible.

- **Establish small community-managed no-take areas.** These areas should include places where sea urchins are known to spawn and produce larval stages that have the potential to drift and settle in nearby fishing grounds. If permanent closures are not possible, the following is an option.
- **Protect sea urchins during the spawning season.** This may involve closures at spawning aggregation sites for periods of several weeks.

If sea urchin stocks have been severely depleted it may be possible to collect mature urchins from another location and move them to form an effective spawning population in a no-take zone; the advice of local fisheries authorities and scientists should be sought before attempting this.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker and Pierre Laboute/IRD.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

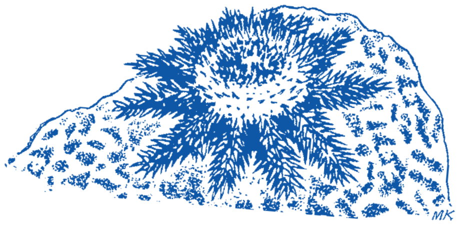
European Union
Union européenne

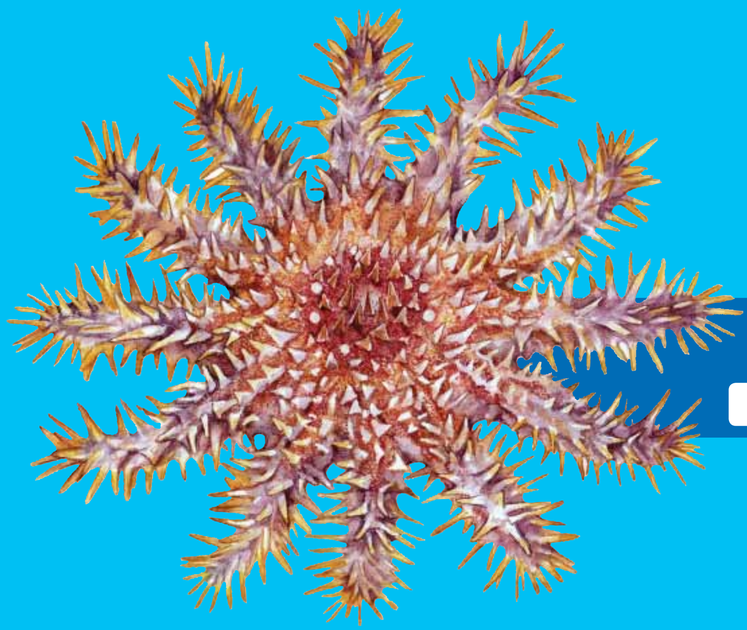
SPC CPS

#20

Crown-of-thorns

(*Acanthaster planci*)





Crown-of-thorns
(Acanthaster planci)

Species & Distribution

The crown-of-thorns,* Acanthaster planci*, is a large greenish brown starfish or sea star with up to 23 arms. It reaches a diameter of over 35 cm and is covered with sharp spines up to 5 cm long. It occurs naturally on coral reefs throughout the Indo-Pacific Region.

The skin on the crown-of-thorns' spines contains a toxin called saponin. When humans are 'spiked' (usually in the feet or lower legs while walking in shallow water) the effects may include intense pain, nausea and vomiting. Any spines should be carefully removed, and the injured part bathed in hot salty water and loosely bandaged. Antibiotic treatment may be required if the wound becomes infected.

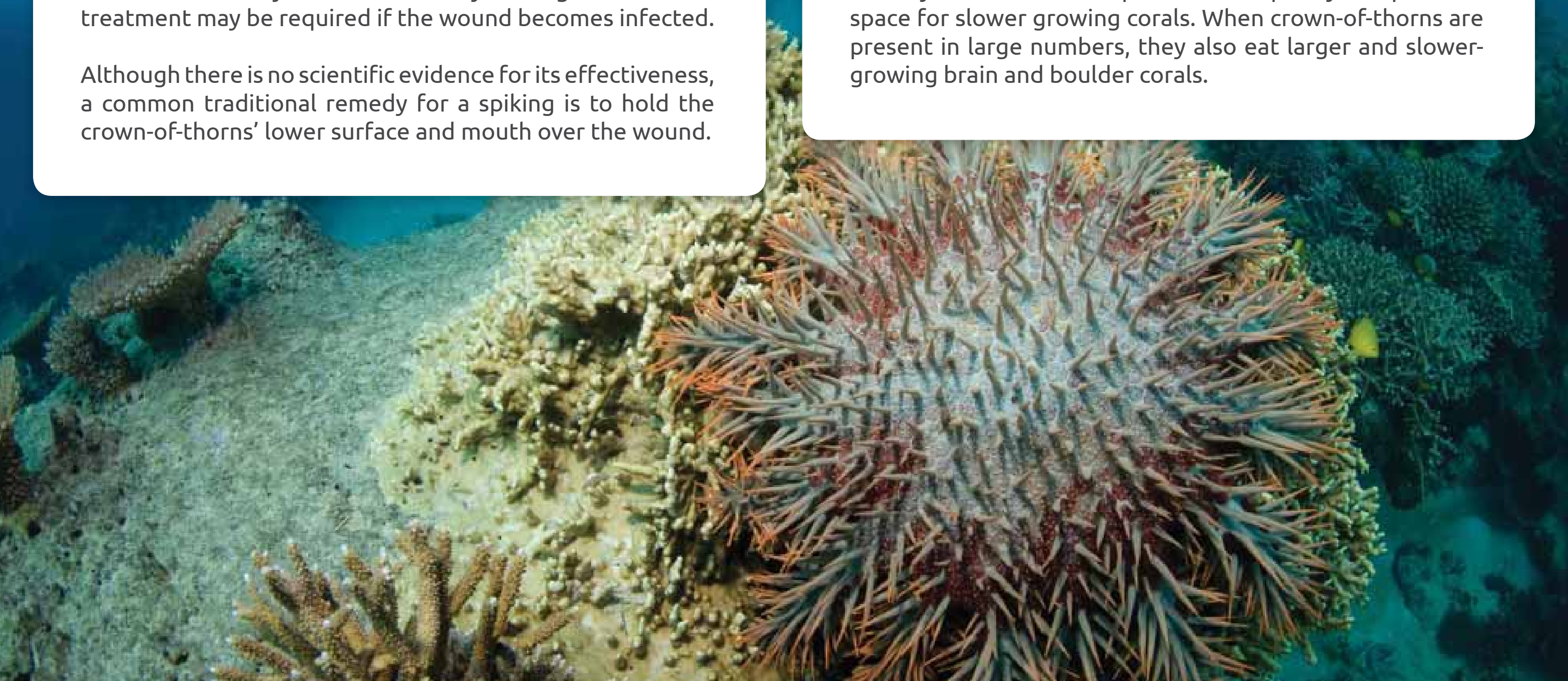
Although there is no scientific evidence for its effectiveness, a common traditional remedy for a spiking is to hold the crown-of-thorns' lower surface and mouth over the wound.

Habitats & Feeding

Crown-of-thorns prefer sheltered areas in lagoons and the deeper water along reef fronts. They move using the large number of small tube feet beneath their arms.

On coral, a crown-of-thorns pushes out its stomach to digest the coral polyps (the small animals that make up corals). After feeding, it moves on leaving the white dead skeleton of the coral.

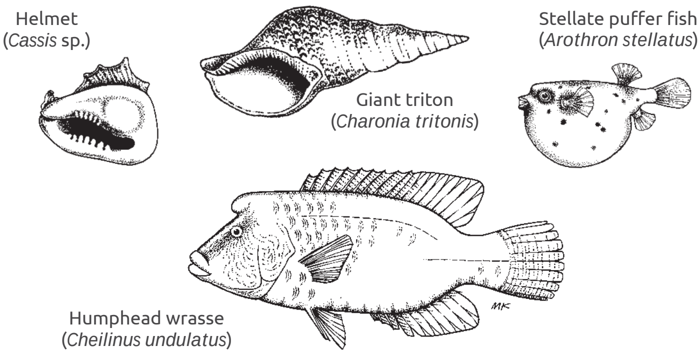
When they are present in low numbers, crown-of-thorns prefer to eat the faster growing branching corals; this allows destroyed corals to be replaced more quickly and provides space for slower growing corals. When crown-of-thorns are present in large numbers, they also eat larger and slower-growing brain and boulder corals.



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

Predators

Predators of crown-of-thorns include large molluscs such as the giant triton and the helmet shell, as well as fish such as the humphead wrasse, and the stellate puffer fish.



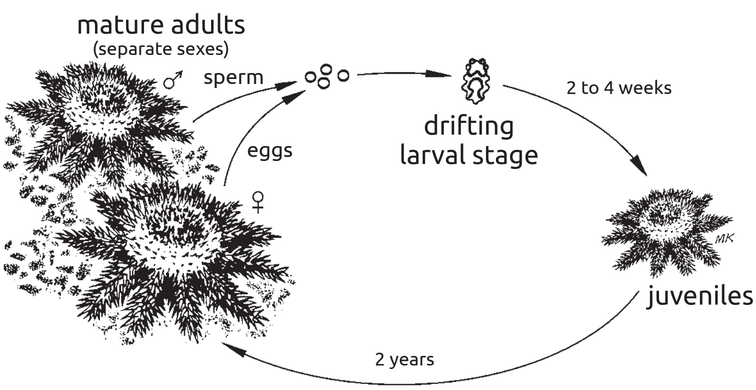
Reproduction & Life cycle

Crown-of-thorns have separate sexes and are able to reproduce at about two years of age when they are about 20 cm in diameter.

Females and males gather in groups and release eggs and sperm into the water through pores on the top of their bodies. A large female can produce many millions of eggs over the breeding season.

The fertilised eggs develop into larvae which spend from two to four weeks drifting in ocean currents. Very few, perhaps only one in a million, survive to settle on reefs, where they change into juveniles within two days.

Initially the juveniles feed on seaweed (coralline algae) but after six months, at a size of about 1 cm, they begin to feed on corals and may live for up to eight years



Management measures & Options

Very large populations or 'outbreaks' of crown-of-thorns will damage large areas of coral. These outbreaks can occur naturally but may also be caused by human activities — such as by allowing sewage to enter the sea and by catching too many of their predators.

Attempts to control outbreaks of crown-of-thorns have included injecting them with chemicals such as sodium bisulphate. However, hand collection of crown-of-thorns is the preferred method of eradication when there is sufficient labour.

Steps that can be taken by a fishing community are as follows:

- **Assess the number of crown-of-thorns.** Numbers of fewer than four individuals seen in a five minute swim in a straight line across a coral reef appear to cause no extensive damage to corals and no action is necessary. However, if numbers are greater than this, immediate action should be considered as follows.
- **Choose the area to be cleared of crown-of-thorns.** A small area, between 2 to 4 hectares, is a realistic target and may include a community's fishing area, a no-take area, an area visited by tourist divers or any area with high coral diversity. If tourists visit the area, their help could be enlisted.
- **Organise a large number of collectors.** People should be available on the assigned day and bring spears or long-handled tongs to collect the crown-of-thorns. Collection by waders may be risky unless the water is very clear — collection by swimmers with diving masks is often safer.
- **Collect crown-of-thorns and transfer them to shore.** Collectors should take care not to damage corals during collection and place them in floating bins or small boats for transfer to shore.*
- **Dispose of crowns-of-thorns on shore.** The crown-of-thorns can be used as fertiliser by placing them in a shallow ditch, covering them with earth and then planting bananas or citrus trees.
- **Outbreaks may be related to high nutrient loads in the sea.** Assistance from relevant authorities should be sought to address any problems with wastewater management and erosion control in the area.

* *Alternatively collectors can place crown-of-thorns in large weighted sugar/rice bags, handling animals carefully so they do not spawn. After being left in the sea for several weeks, the bags are untied and emptied to allow fish to feed on the dead animals.*

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photo by Matthieu Juncker.

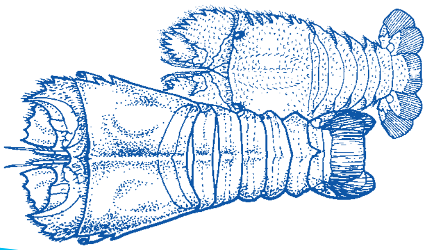
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

Information sheets for fishing communities

#21

Slipper lobsters

(Scyllaridae)



Caledonian slipper lobster
(Parribacus caledonicus)

Flathead lobster
(Thenus orientalis)

Species & Distribution

The crustaceans commonly known as slipper, shovel-nosed or mitten lobsters are related to spiny lobsters (information sheet #13) but have flattened bodies.

Several species are caught as food in Pacific islands and only a representative few are described here. These include the Caledonian slipper or mitten lobster, *Parribacus caledonicus*, which grows to a total length of 180 millimetres and is distributed widely in the western Pacific Ocean.

The Hawaiian or sculptured slipper lobster, *Parribacus antarcticus*, is found in all oceans including the South Pacific Ocean and reaches a size of 200 millimetres.

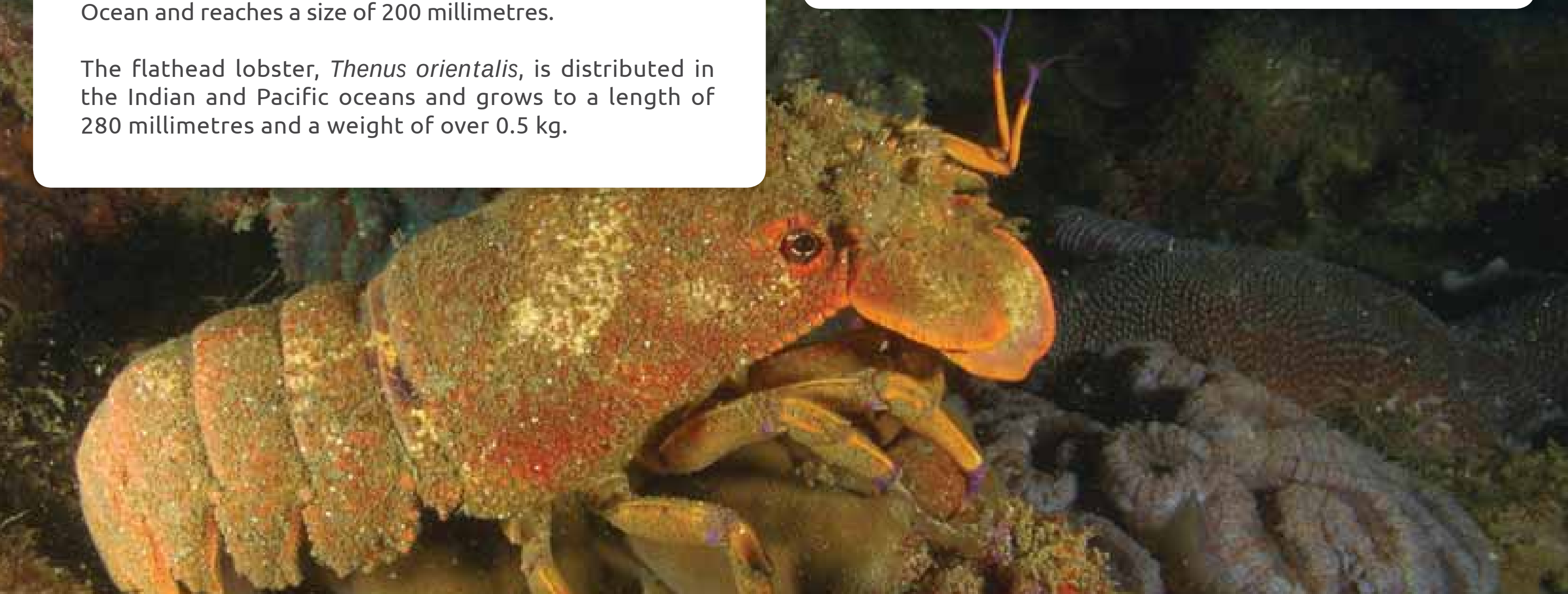
The flathead lobster, *Thenus orientalis*, is distributed in the Indian and Pacific oceans and grows to a length of 280 millimetres and a weight of over 0.5 kg.

Habitats & Feeding

Slipper lobsters are bottom dwellers and live in the shallow water of lagoons and in crevices on reefs.

Many species hunt at night and burrow in sand or hide on reefs during daylight. Some, such as the Caledonian mitten lobster, live in cavities or nests with small openings.

Slipper lobsters eat a variety of molluscs, including limpets, mussels and oysters as well as small shrimps, crabs, worms and sea urchins. Their predators include triggerfish, groupers and octopuses.

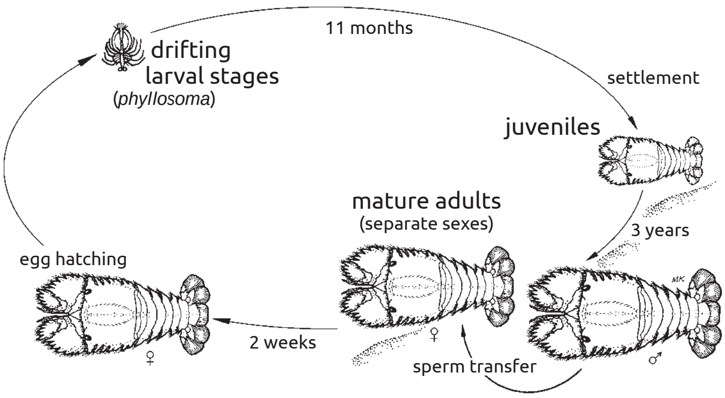


#21 Slipper lobsters (Scyllaridae)

Reproduction & Life cycle

Slipper lobsters have separate sexes and reach reproductive maturity at about 3 years of age.

During mating, a male (|) deposits a sperm packet (or spermatophore) on the underside of a female (~). The female releases up to 100,000 eggs which she carries beneath her body for 2 weeks or more as they develop and change in colour from orange to brown. The eggs hatch into very small floating larval stages which drift in the sea for up to 11 months — less than one in every thousand survives to settle on the sea floor to become a juvenile slipper lobster. And less than one in every hundred juveniles survives to become a mature adult, possibly living for 10 years.



Fishing methods

Slipper lobsters that prefer sandy sea floors, such as *Thenus* are often caught by trawling or by setting baited traps. Those that prefer reefs (including *Parribacus* species) are usually caught at night by hand or by divers, sometimes with underwater breathing apparatus, using spears.

Management measures & Options

Fisheries authorities in several Pacific islands have applied minimum size limits on various slipper lobsters and these are given in the booklet *Size limits and other coastal fisheries regulations used in the Pacific Islands region* (www.spc.int).

Some authorities have banned the taking of soft-shelled slipper lobsters and egg-bearing females. French Polynesia has imposed a closed season (1 November–31 January) presumably to protect breeding slipper lobsters.

Fishing communities could take the following local actions.

- **Ban the use of underwater breathing apparatus. This method of collection, often associated with commercial fishing, may remove all mature slipper lobsters from an area.**
- **Ban the catching of small slipper lobsters. Enforce national minimum size limits if declared; if not, set community size limits based on the same species in nearby countries (use the SPC booklet as a guide).**
- **Ban the catching of slipper lobsters carrying eggs. Female slipper lobsters carry easily visible eggs beneath their bodies. However, this control may be of little use if slipper lobsters are speared.**
- **Ban the export of slipper lobsters.** Although this measure is usually a national one, some communities on small islands have banned the export of lobsters to protect their fishery and to attract tourists.
- **Rotate the catching of lobsters on different areas of reef.** Each area could be fished for one year and then left unfished for a number of years; at least three unfished years would be needed to allow juveniles to grow to maturity.
- **Ban fishing during the spawning season.** The time of egg-bearing may be known to local fishers. If not, observe catches throughout the year and ban fishing for a month or more after females with eggs are first seen.
- **Apply local catch limits.** Bag limits, or catch quotas, may be appropriate if local people are catching slipper lobsters to sell. A catch limit may be set, for example, at 10 slipper lobsters per person per day.

The small larval stages of slipper lobsters drift in the sea for a very long time before settling as juveniles on reefs, often some distance away. This means that an individual community's actions to manage its slipper lobster fishery may not benefit its own fishers. The best solution is for neighbouring communities along a coastline to work together and agree to take the same management measures.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Matthieu Juncker.

The Locally-Managed Marine Area (LMMA) Network

Improving the practice of marine conservation

European Union
Union européenne

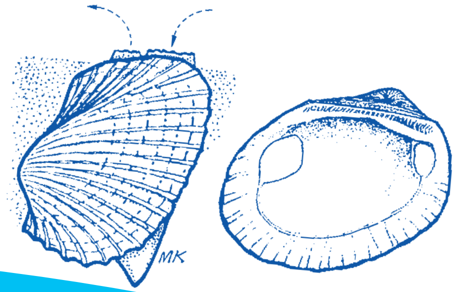
SPC CPS

Information sheets for fishing communities

#22

Ark clams

(*Anadara* sp.)



Antique ark
(Anadara antiquata)

Species & Distribution

Ark clams, or ark shells, are two-shelled molluscs, generally less than 80 mm long, with thick, white to tan coloured shells with strong ridges.

Unlike other clams, ark clams have red blood pigments (haemoglobin), which carry oxygen to their tissues and allow them to live in murky, poorly oxygenated environments.

There are approximately 200 different species of ark clams and those belonging to the genus *Anadara* are distributed across the Pacific.

Habitats & Feeding

Ark clams live in shallow water where they burrow in sandy silt, mud and seagrass beds. In some areas, smaller individuals are more abundant near the shore and larger animals are found in deeper water. Young ark clams may settle in sand and seagrass areas and move to more productive muddy areas as they grow.

Ark clams feed by filtering food material from the surrounding water, which is sucked in one opening and pumped out from the other (the arrows in the drawing of the live clam show water movement). Their predators include fish that snap at flesh exposed between gaping shells, and large fish such as stingrays that can crush the shells with their strong jaws.

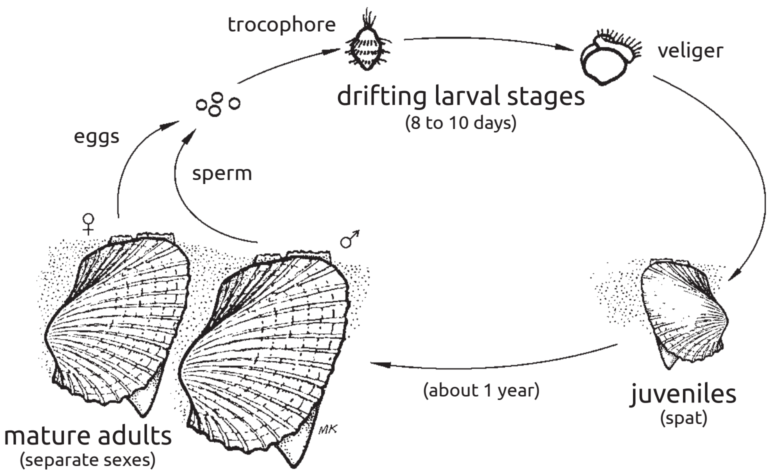
#22 Ark clams (*Anadara* sp.)

Reproduction & Life cycle

Ark clams have separate sexes and reach reproductive maturity when they are about one year old and about 20 mm long.

During spawning, which may occur at the start of the wet season, females (~) release many thousands of eggs into the water and these are fertilised by sperm released by males (|).

Fertilised eggs develop through very small larval stages that drift with ocean currents for eight to ten days. Less than one in a thousand of these larval forms survives to settle on the sea floor as a juvenile (sometimes referred to as spat). And less than one in a hundred of the newly-settled juveniles survives to become a mature adult and live for the six or so years required to reach a maximum size of 80 mm.

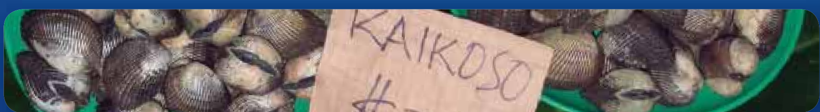


Fishing methods

Ark clams are often collected, or gleaned, by women, who use their toes to feel for the clams or use steel rakes in the muddy sand.

The women usually fish in depths of up to 1.5 metres, where they can stand with their heads above water. The clams are important food items, particularly when the weather is too rough for fishing at sea. In densely populated atolls, they may be the most important source of food.

Like many filter-feeding animals, ark clams accumulate toxins from the surrounding water and those collected in urban areas should not be eaten raw.



Management measures & Options

There are no national management controls placed on the collection of ark clams in Pacific Islands. However, several communities in Fiji are imposing a minimum size limit of 3 cm (measured by using fingers), closures during spawning periods and long-term closures in some areas to protect breeding stocks.

Options for community-based management actions include the following.

- **Ban the use of all fishing methods other than hand gleaning.** Fishers traditionally glean ark shells in water no deeper than 1.5 metres. It is likely that many ark clams live in deeper water and these represent a pool of breeding clams that have the potential to restock shallower collecting areas.

- **Establish closures during the spawning season.** In Fiji, ark clams become ready to spawn at the start of the rainy season (December). This makes it possible to impose closures during the period November to early January to maximise spawning before they are harvested.

- **Establish permanent no-take areas. In these areas, there needs to be a dense population of clams to make reproduction more effective.** The effectiveness of the reserve could be enhanced by the introduction of ark clams from other areas. The small drifting larval stages produced in the reserve are likely to settle as juvenile clams in nearby down-current areas where they can grow and eventually be collected. Protecting breeding stocks of ark clams (*kaikoso*) in Fiji is believed to have increased catches by 200 per cent in nearby fished areas.

- **Work with local authorities to minimise damage to ark clam habitats.** The shallow coastal waters in which ark clams are collected may be polluted by sewage, the runoff of rain from agricultural land, silt from development and turbidity from the mining of beach sand.

If a community's fishing area is large, an alternative to establishing a permanent reserve or no-take area is the introduction of rotational harvesting of ark clams.

- **Establish rotational harvesting.** A community fishing area is divided into a number of smaller areas that are fished in rotation each year. If, for example, there are three small areas, each area would have two years' protection from being fished.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Tahi Govan.

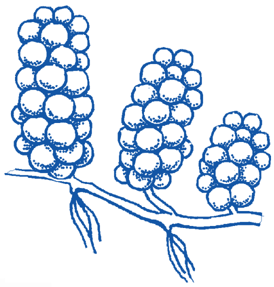
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

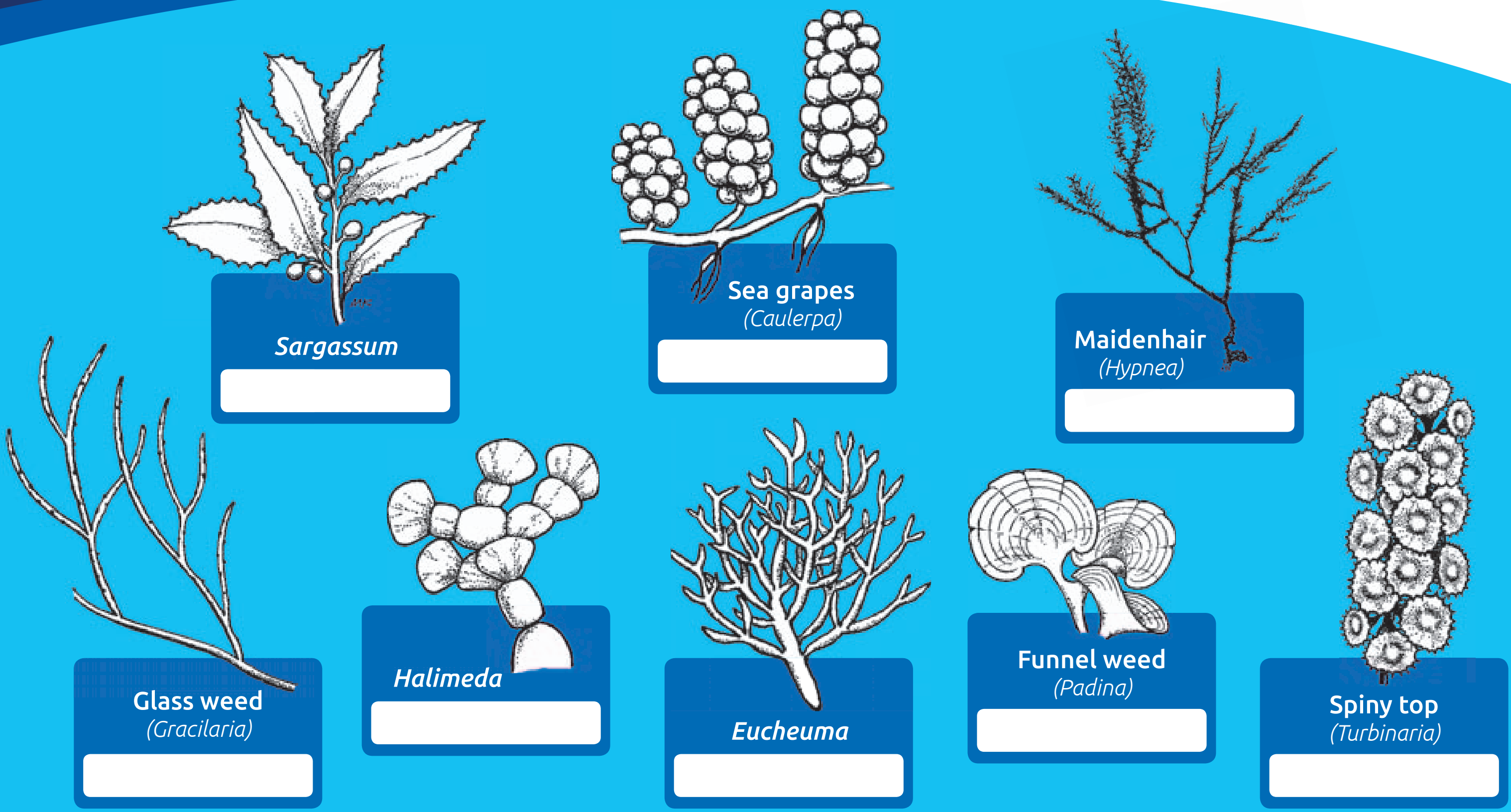
European Union
Union européenne

SPC CPS

#23

Edible seaweeds





Species & Distribution

There are more than 500 seaweeds in the seas surrounding Pacific Islands and perhaps 20 per cent of these are used as food. Only a few are mentioned here but a detailed guide[1] is available from SPC (www.spc.int).

Seaweeds have traditionally been used as food for humans and domestic animals, as medicines, and as garden mulch and fertiliser. All of the plants illustrated above — with the exception of the lime-encrusted *Halimeda,* which plays an important role in the formation of sediment and beach sand — are used as human food or flavourings for food. Sea grapes, glass weed, and maidenhair are widely used as food, and even the tougher plants such as *Sargassum* and funnel weed are used to make tea and soups.

Some non-native species have been introduced into the Pacific. *Eucheuma* and the closely related *Kappaphycus* have been introduced and are farmed in several locations for the extraction of carrageenan, which is used as a thickening agent in products such as toothpaste and ice cream. A non-native species of maidenhair (hooked red seaweed, *Hypnea musciformis*) was deliberately introduced to Kane'ohe Bay in 1974 for farming and spread rapidly throughout Hawaii. In addition to *Eucheuma*, there are several local seaweeds that have potential for farming.

Habitats & Feeding

Other than *Eucheuma*, the species shown above occur naturally and are widely distributed in islands of the tropical Pacific. Some, such as maidenhair and glass weed, are found in sheltered back-reef areas while others, such as sea grapes, thrive in areas where there is more water movement.

Unlike land plants that gain nutrients from the soil through their roots, seaweeds absorb nutrients from the surrounding seawater. Some brown seaweeds, *Sargassum* in particular, grow rapidly when there is an abundance of nutrients in coastal waters, often during the wet season, and smother corals. This is especially a problem when marine animals that eat seaweeds (sea urchins, sea snails and plant-eating fish, such as rabbitfish), have been overfished.

#23 Edible seaweeds

Reproduction & Life cycle

Reproduction in seaweeds varies from species to species and is often complicated.

In the simplest method of reproduction (called asexual reproduction) pieces of the plant break off and develop into new plants. Some pieces become broken off in storms and float long distances before settling and growing. All of these new plants are clones — that is they will be genetically identical to each other and the parent seaweed.

Seaweeds can also reproduce sexually by producing male and female plants called gametophytes which release sperm and eggs into the sea. After the eggs are fertilised they grow into new seaweeds.

Seaweeds can grow very quickly — under favourable conditions, some sea grape species, for example, grow approximately 2 cm each day. Some seaweeds are annual and die in less than a year; others can live for about ten years.

Fishing methods

In Pacific Island countries, the collection and marketing of edible seaweeds is often an activity of women and the work may be shared among family and village groups. In some cultures, particular harvesting sites are used by families for many generations and their locations are kept secret.

Because they are found in shallow water, edible seaweeds are an important food resource when the weather is too rough for fishing at sea. Seaweeds are high in dietary fibres, low in fat and contain many vitamins and minerals.

Management measures & Options

There are no national management controls placed on the collection of seaweeds in Pacific Island countries and management is best left to fishing communities.

Options for community-based management actions include the following.

- **Leave or replant part of each plant. Seaweeds such as sea grapes can regenerate from small parts of the plant left in the place where it was found or placed in nearby crevices in the reef.** Village meetings and workshops could be held to encourage collectors to do this. In Fiji, women collecting sea grapes have traditionally collected only the upright grape-like shoots, leaving the horizontal stalks (or runners) to regenerate.
- **Establish rotational harvesting.** A community fishing area could be divided into a number of smaller areas where seaweeds are collected in rotation. If there are three areas, for example, gathering seaweeds in one area could be banned for two months to allow plants to regenerate. Gathering seaweeds would continue in the other two areas during this time. Each area would be closed for two months in rotation.

[1] *Irene Novaczek (2001) A guide to the common edible and medicinal seaweeds of the Pacific islands. Community Fisheries Training Pacific Series 3A. Supplementary Guide to Seaweeds: Pacific Series 3. USP Marine Studies Programme / SPC Coastal Fisheries Programme.*

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos by Joel Orempuller/IRD & Pierre Laboute/IRD.

The Locally-Managed Marine Area (LMMA) Network

Improving the practice of marine conservation

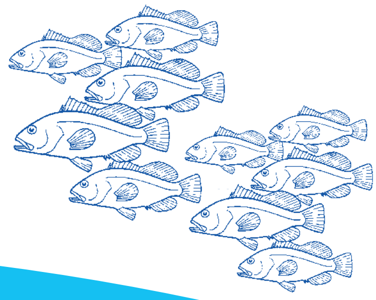
European Union
Union européenne

SPC CPS

Information sheets for fishing communities

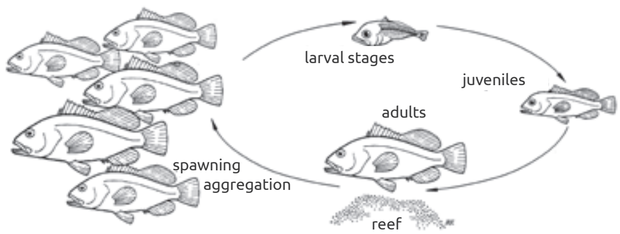
#24

Spawning aggregations



What is a spawning aggregation?

A fish spawning aggregation is a large number of fish gathered together in one place and at a particular time to spawn and produce fertilised eggs. These eggs hatch into larval stages that grow into juveniles and then into adults. As spawning aggregations often occur at the same time each year at the same sites, they are usually very predictable.



Which species form spawning aggregations?

Many species gather together to form spawning aggregations or migrate in large groups to spawning sites. In Pacific Islands, these include groupers, snappers, mullets, parrotfish, trevallies, surgeonfish, rabbitfish, emperors, goatfish and mackerels.

Most fish that form spawning aggregations live in other areas at various stages of their life cycle. The eggs and larval stages of many reef fish, for example, drift beyond the reefs before they move to shallower water and settle on reefs to grow into adults. The spawning aggregations often last for only short periods, from two to seven days, around the full or new moon.

#24

Spawning aggregations

Why do spawning aggregations occur?

The most likely reason that so many different fish gather together to spawn is that aggregations increase the chances of reproduction being successful. Many marine animals, including 96% of all fish, reproduce externally by releasing sperm and eggs into the water.

As males and females may be spread out over large areas, spawning aggregations allow them to gather together in one place. A large concentration of male and female fish in the one area allows mate selection and competition, and increases the chances of sperm reaching and fertilising the drifting eggs.

Another reason could be that spawning sites are situated where currents carry the larval stages to the open sea and away from inshore predators. Or perhaps spawning sites are positioned so that currents carry the larval stages back to the parent populations on home reefs.

What are the risks for aggregating species?

For most species, spawning aggregations are essential for reproduction, and in any one area, the number of aggregations for a particular species is few, so each of these aggregations is important.

When fish aggregate or mass together in large numbers at predictable times and places they become much easier to catch than when they are scattered over large areas. Aggregating fish are easily caught by fishers using nets, handlines with hooks, spears or traps.

Catching fish as they gather in spawning aggregations is destructive as these breeding fish are responsible for producing small fish, many of which will grow and be available to be caught in future years. In many parts of the world, fishing on spawning aggregations has resulted in the total disappearance of some species, and their associated fisheries, from local areas.

How can we manage and protect aggregating species?

Managing fisheries based on fish that form spawning aggregations relies on fishing communities taking a major role. This is because local fishers generally know which species form spawning aggregations and know the times and the sites at which they gather to spawn.

The first step is to hold community meetings to make sure everyone is aware of how important spawning aggregations are in providing fish on a sustainable basis. All local fishers must be present at the meetings as it is necessary to identify all aggregation sites and spawning times to make management more effective.

Fisheries agency staff or NGOs may be involved in facilitating the meetings and in providing technical advice but local fishers may be reluctant to reveal the location of spawning sites to outsiders. Visitors must respect the wishes of the community if they wish to keep the information confidential.

The community meetings should provide answers to the following questions.

- Which species form spawning aggregations? – set priorities to protect species at most risk.
- What is known about the life cycle of the species involved?
- Where do the spawning aggregations occur – how many different spawning sites are there?
- When do aggregations occur – once a year or more often? – at the same time each year? – at what phase of the moon?
- How long does each aggregation last?
- What management measures can be taken?
- How can these management measures be enforced?

The second step is to develop a management plan for aggregating species. The key management action must be to ban, or at least reduce, the catching of fish both travelling to and aggregating at the spawning sites. This would involve stopping or restricting fishing during particular times at particular sites.

If no agreement can be reached on a total ban on catching spawning fish, an alternative but less desirable measure would be to restrict the use of overly-efficient fishing methods; the use of nets, spears and traps could be banned, for example, but the use of baited hooks on lines by a limited number of fishers could be allowed. However, any fishing on spawning aggregations is likely to disturb the spawning fish and make reproduction less successful.

Ideally, protecting fish spawning aggregations should be part of a wider management plan that includes the protection of all life-cycle stages and habitats of the fish. Imposing and enforcing minimum size limits, for example, may be necessary to allow more small fish to grow to sizes at which they can aggregate and reproduce. Management actions for particular species are discussed in other SPC information sheets in this series.

Habitat protection is an important part of any management plan. The creation of community managed no-take areas or fish reserves, for example, may provide protection for habitats on which many species depend and may include the spawning sites of some species.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos: Yvonne Sadovy and Jiro Sakaue, SCRFA (www.SCRFA.org).

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

European Union
Union européenne

SPC CPS

#25

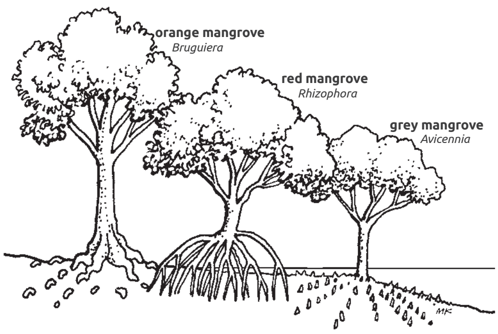
Mangroves

What are mangroves?

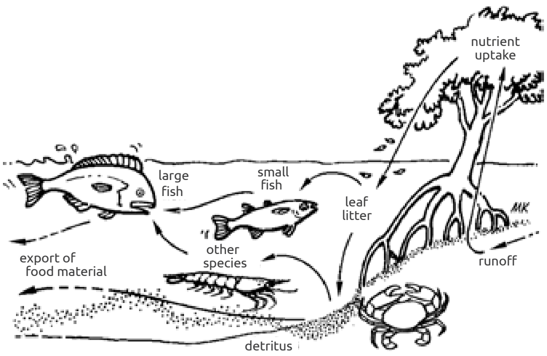
Of the many thousands of different species of trees, only about eighty can exist with their roots in salty water. These specialised but often unrelated trees that live at the edge of the sea are collectively known as mangroves.

As the trees grow in silty waterlogged soils, many have evolved exposed (or aerial) root systems that absorb oxygen as well as support the tree. In the illustration below, the orange mangrove has knee roots that stick up above the silt, the red mangrove has long prop roots that grow down from the trunk, and the grey mangrove has cable roots which send up small pegs or pneumatophores.

The number of mangrove species decreases from west to east across the Pacific — there are 33 different species of mangroves in Papua New Guinea, 25 in the Solomon Islands, 7 in Fiji, and 3 in Samoa. Mangroves do not occur further to the east in countries such as Cook Islands but they have been introduced into Hawaii and possibly Tahiti.



Why are mangroves important?



In relation to the above figure, nutrients dissolved in water running off the land are taken up and used by mangroves. Each year one hectare of mangroves can produce over 18 tonnes of fallen leaves which rot away to form detritus — particles of material, that provide food for many animals, including worms, crabs and some fish. The holes of burrowing crabs allow oxygenated water to reach deep into the mud flats. These smaller animals provide food for many species of larger fish.

Mangroves are also important as nursery areas — places where the young of many marine species can grow in sheltered conditions with abundant food. Food material produced in mangrove areas is transferred to downstream systems and offshore by tides and by migrating fish.

The exposed roots of mangroves trap particles and sediments which gradually build up and extend shorelines. As the mangrove front slowly advances towards the sea, the newly-formed land behind the front fills up with other plants. Mangroves are effective at trapping sticky clumps of sediments mixed with nutrients (called flocs) that can smother small corals.

Mangroves also protect the land against sea level rises as well as from storms and cyclones which are predicted to become intense with global warming.

#25 Mangroves

How do mangroves reproduce and spread?

Insects and birds attracted to the flowers of some mangrove species transfer pollen from male to female reproductive parts; other trees may be pollinated by the wind. While still attached to the tree, the seeds sprout to form seedlings, or propagules, which fall into the water. These drift and those that settle in suitable shallow water become upright and sprout roots before growing into a new tree.

Why are mangroves disappearing?

Half the world's mangroves have been lost in the last century. In Pacific Islands, mangroves are used for firewood and building materials. But most mangroves have been destroyed by reclamation and clearing land for housing development as well as by changes in water quality.

Coastal road construction, which has prevented the mixing of tidal seawater with nutrient-rich fresh water from the land, has also caused the loss of many mangroves. Rubbish dumps in mangrove areas have released oil and heavy metals into the sea; oil films have suffocated mangrove roots and heavy metals have reduced photosynthesis.

How can we manage and protect mangroves?

To protect existing areas of mangroves, governments must limit coastal development and reduce pollution — the following actions are needed.

- **Enact and enforce regulations to prevent the removal of, or damage to, existing mangroves.**
- **Ensure that pollution from rubbish dumps, farms and industry is minimised.**
- **Require an environmental impact assessment for all new development to ensure that disruption to coastal areas is minimised.**
- **Ensure that large pipes or tunnels are installed under coastal roads to allow the mixing of tidal seawater and freshwater runoff.**
- **Create buffer zones between coastal development and mangrove areas.**

Coastal communities could safeguard mangroves by including them in a community-managed Marine Protected Area. Although protecting existing mangroves is the most urgent task, it may be desirable to restore an area by planting mangrove seedlings. However the following questions should be considered before starting a restoration programme.

- **Why are there no mangroves in the area at present? Is the area unsuitable? Are the waves and currents too strong? If so, the planting of mangrove seedlings is likely to fail.**
- **If there were mangroves in the area before, why did they disappear? Were they cleared? Or else, what conditions caused them to die? Can conditions be improved?**
- **Why hasn't the area recovered naturally by seedlings drifting to the area? Are the currents unfavourable or have they changed? Or are conditions not right for mangroves?**

Approval from local government authorities may be necessary for a community to undertake the planting of mangrove seedlings. Advice can be sought from local authorities, NGOs or regional organisations.

The protection and restoration of mangrove areas may be supported by communities allowing fee-paying tourists to view mangroves from canoes or from special boardwalks built through mangrove areas.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet.
Photos: Anton Bielousov, Jason and Phil's 1stPix.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
European Union
Union européenne
SPC CPS

#26

Seagrasses

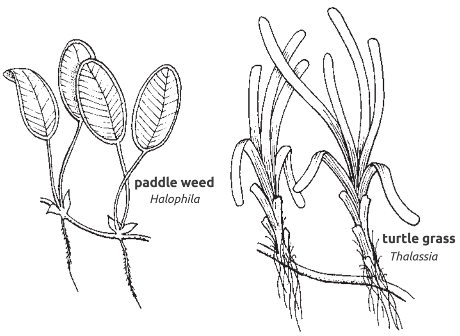
What are seagrasses?

Seagrasses are relatives of flowering land plants that moved to the sea between 50 and 100 million years ago. The only plants in the sea before this were the seaweeds (marine algae).

Seagrasses are not true grasses but they have a similar structure. They have leaves attached to a short upright stem and creeping horizontal stems or rhizomes. Seagrasses obtain nutrients mostly through root systems like their land-based relatives, rather than from the water like seaweeds.

The leaf blades are long and grass-like in most species but are shaped like broad paddles in the species shown at the left of the illustration below.

The western Pacific Ocean has 13 of the 60 or so species of seagrasses in the world. Because seagrasses require strong sunlight they grow in shallow water — commonly just below low tide on reef flats and sandy lagoons and between tides on muddy banks.



How do seagrasses reproduce and spread?

Seagrasses have small flowers that are fertilised by pollen, not carried by insects, birds or wind as in land plants, but carried by currents in the sea. In addition, seagrass pieces can break off to drift and grow in other suitable places. Seagrasses can spread rapidly by means of their network of horizontal stems that send up shoots to form vast beds resembling underwater fields or meadows.

Why are seagrasses important?

Seagrasses provide food and shelter for many marine animals. Green turtles, dugongs, some fish and sea urchins eat seagrasses. And many more species graze on the fine hair-like seaweeds (epiphytes) that grow on seagrass leaves. The leaves eventually rot away to form detritus — particles of material that provide food for a much wider range of marine species.

Seagrasses absorb nutrients through their roots and therefore recycle material that would otherwise be trapped in the substrate. Besides being highly productive areas, seagrass beds provide sheltered nursery areas in which the juveniles of many marine species live and grow before moving elsewhere as adults.

Beds of seagrass trap sediments that would otherwise smother corals. And in doing so, they extend shorelines and protect coasts from wave action and erosion.

Seagrasses also use carbon dioxide (CO_2) dissolved in seawater and therefore have the potential to reduce ocean acidification (ocean acidification refers to the uptake of excessive carbon dioxide from the atmosphere, some of which reacts with the water to form carbonic acid. This increasing acidity can effect coral formation and other structures based on calcium carbonate). Seagrasses account for about 15% of the ocean's carbon storage.

#26 Seagrasses

Why are seagrasses disappearing?

Almost 30% of seagrass beds around the world have been lost since records began. Reduced water clarity from coastal development and the runoff of nutrients from houses and farms, as well as land reclamation, have caused the loss of seagrass beds in many Pacific Islands.

Coastal construction and port development produces silt that reduces light penetration and sometimes smothers seagrass beds. In some cases, the removal of mangroves has allowed silt to affect nearby seagrass beds.

Nutrients from sewage and fertilisers cause very small floating plants (phytoplankton) to increase in numbers and reduce the amount of sunlight reaching the seagrasses. In addition, nutrients result in seagrass leaves becoming overgrown with mats of small seaweeds which also block sunlight.

Climate change is also likely to affect the distribution of seagrasses. Rising seas may provide more shallow water areas in which seagrasses can spread.

In the Caribbean, entire seagrass beds have been lost due to the overgrazing of seagrasses by population explosions of species such as sea urchins. The sea urchins increased in numbers because their predators, trigger fish, were removed by overfishing.

How can we manage and protect seagrasses?

To protect seagrass beds, action is required on a national scale to manage coastal zones. However, some of the following actions could be undertaken by coastal communities.

→ Monitor water quality and the extent of seagrass beds

Government environmental authorities should monitor water quality at key locations around the coast, particularly to detect high silt and nutrient loads. Baseline maps of seagrass beds, completed with the aid of coastal communities, will allow the detection of any changes in their distribution.

→ Raise awareness of the importance of, and threats to, seagrasses

In spite of the importance of seagrass beds in providing fish habitats and in protecting coasts, they receive less publicity than mangroves or coral reefs. Public education programmes should stress their importance and identify actions that communities can take to protect them.

→ Reduce nutrients and other pollutants entering coastal waters

Sediments and nutrients running off the land into coastal waters can be reduced by planting shrubs and trees on riverbanks and by maintaining mangroves on shorelines.

Sustainable agricultural practices should be directed at minimising erosion and the runoff of fertilisers and animal waste. Farm animals must be kept away from places where their waste can enter rivers that flow to the sea.

→ Control coastal development

The government should require an environmental impact assessment for all new development to ensure that disruption to coastal areas is minimised. Zones of shrubs, trees and coastal vegetation, especially mangroves, should be left and maintained around rivers and on coasts.

→ Protect seagrass areas

Many species of fish use seagrass beds for shelter and food when they are small and move out to the reefs as adults. Several commercially important species, such as sea cucumbers, rely on seagrass beds as juveniles. Therefore including both seagrass areas and coral reefs in the design of marine protected area networks will allow many species to complete their life cycles.

→ Restrict fishing on species that control the numbers of seagrass grazers

As a precautionary measure, protect species such as triggerfish that keep seagrass grazers such as sea urchins under control.

→ Restore seagrass beds

Seagrass beds can be restored by transplanting mature plants from healthy donor beds in the same way that mangrove areas are restored. However, this is usually very expensive and has had limited success in other places; advice should be sought from local and regional authorities.

The first priority must be to improve environmental conditions, particularly water quality. If conditions are improved, natural regeneration may make transplanting unnecessary.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos: Nashworld and Rian Tan (www.wildsingapore.com).

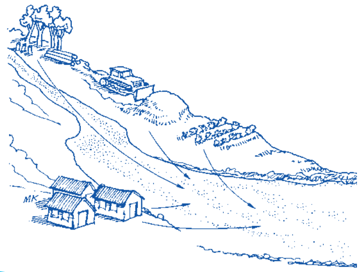
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

European Union
Union européenne

SPC CPS

#27

Nutrients and sediments

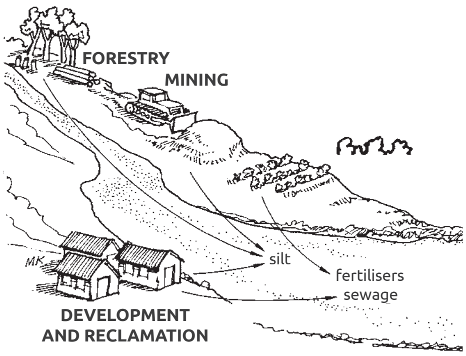


What are nutrients and sediments?

A nutrient is any substance that is needed by a plant or animal for food. Nutrients are therefore required by all living things. In relation to the effects on coastal waters, we are mainly concerned about nutrients that are dissolved in or are carried by water.

Silt consists of small particles that can be carried in water and may settle on the sea floor as sediments.

Nutrients and silt are present in most coastal waters and problems occur only when these are present in large quantities. Rain washes nutrients and silt from the land into the sea and rivers, a process often referred to as runoff.



Where do nutrients and sediments come from?

Soils in Pacific Islands are generally shallow. When trees and shrubs are removed and the land is cleared for buildings or farms, the bare soil has no natural protection. Rain washes the fine material from the soil as silt down hillsides into the sea. Silt comes from many sources including runoff from reclamation, development, mining, agriculture and forestry.

Human and stock waste is called sewage, which contains bacteria and viruses as well as nutrients. Sewage enters coastal waters from farms, overflowing septic tanks and inadequate sewerage systems.

#27 Nutrients and sediments

What problems do large quantities of nutrients and sediments cause?

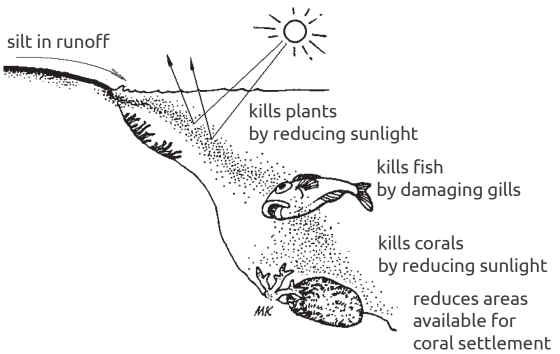
Many marine organisms are affected by nutrients and sediments, but none as much as coral reefs. This is because coral reefs only grow in clear, sediment-free waters. Microscopic plants, called zooxanthellae, which live inside the coral's tissues, need sunlight to produce food that is shared with the corals.

Besides preventing sunlight reaching corals, silt settles on the seafloor as sediments. These sediments may cover hard surfaces making them unsuitable for places where new corals can settle and grow. Large amounts of silt in the water can also affect fish by cutting their delicate gill tissues.

Excessive nutrients, most often from fertilisers and sewage, cause plants to grow rapidly. In some lagoons, seaweeds may grow faster than corals and take up spaces that new corals could have occupied. Small plants (called epiphytes) cover seagrass leaves and prevent sunlight reaching them. Dense mats of seaweed may grow over hard corals and some bacteria from sewage causes a coral disease called White Band Disease.

As large quantities of plants die and rot away, bacteria use up the oxygen dissolved in the water. This effect, called eutrophication, can cause the death of many marine species including fish.

Large quantities of nutrients can also allow very small drifting plants (phytoplankton) to increase in large numbers or blooms. Some of these, called harmful algal blooms (or HABs), are dangerous to marine life and humans and include those responsible for the fish poisoning called ciguatera.



How can we control nutrients and sediments in coastal waters?

Excessive loads of sediment and nutrients in runoff and in coastal waters are mainly due to the poor management of land-use.

Ideally, government authorities should work with farmers, developers and communities to promote more sustainable land-use practices in what is often called Integrated Coastal Zone Management. Some possible actions are listed below.

→ Improve the disposal of sewage

Waste water from sewage treatment plants and overflows from septic tanks (underground tanks in which sewage is decomposed by bacteria) must not be allowed to enter rivers or coastal waters. In some cases, bananas and other crops have been planted near outfalls and overflows where they absorb these nutrients before they reach the sea.

→ Reduce runoff from farms

Water running over farms often contains chemicals to kill weeds and pests as well as nutrient fertilisers such as nitrogen and phosphorus. Plants and crops can be planted in flat areas around a hillside in contour farming (see illustration). The flat areas or terraces can be edged by trees to reduce the risk of erosion, land slip and water siltation.

→ Ban sand-mining from beaches

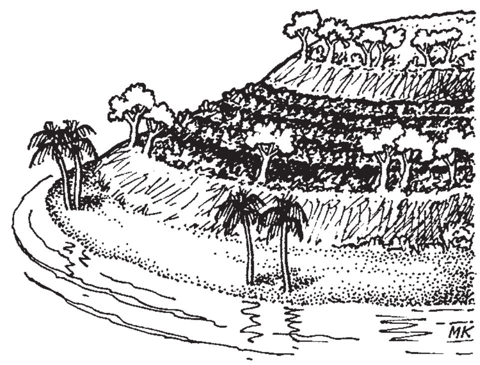
In some Pacific Islands, sand is mined from beaches and this causes erosion of the shoreline and plumes of silt in coastal waters.

→ Protect or plant bands of shrubs and trees near rivers and along the foreshore

Shrubs and trees near rivers and along the foreshore should be protected and bare areas replanted. Natural vegetation, including mangrove trees at the sea's edge, prevents erosion as well as nutrients and sediments from reaching the water.

→ Install temporary sediment fences around construction sites in coastal areas

Construction and reclamation sites in coastal areas should include sediment fences of material with small meshes laid along the contours of the land. Bales of hay or sugar-cane straw have also been used to capture silt before it enters the sea.



Contour farming, in which cultivation is on terraces edged by trees, reduces the risk of erosion, land slip and water siltation.

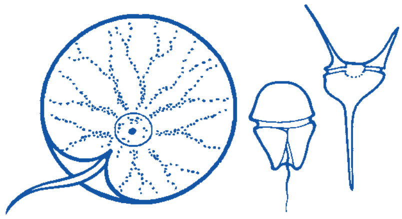
This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet.
Photos: Sekundo and Clement Larrive.

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

European Union
Union européenne

SPC CPS

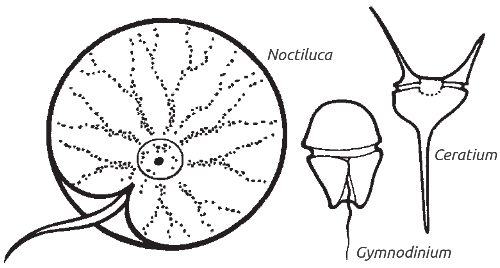
Harmful algal blooms



What are algal blooms?

The sea, particularly near the coast, contains many very small drifting plants called phytoplankton. The illustration below shows some highly magnified examples of one important group, the dinoflagellates — the one on the left, *Noctiluca*, is unusually large (about 1 mm) and is often responsible for the trail of sparkling lights that can be seen behind a boat moving at night.

Most of these small drifting plants are harmless and are important in providing food for many other marine species. But sometimes their numbers increase dramatically. This is referred to as an algal bloom.



What are harmful algal blooms?

A few types of phytoplankton produce strong toxins or poisons and when their numbers increase it is referred to as a harmful algal bloom or HAB.

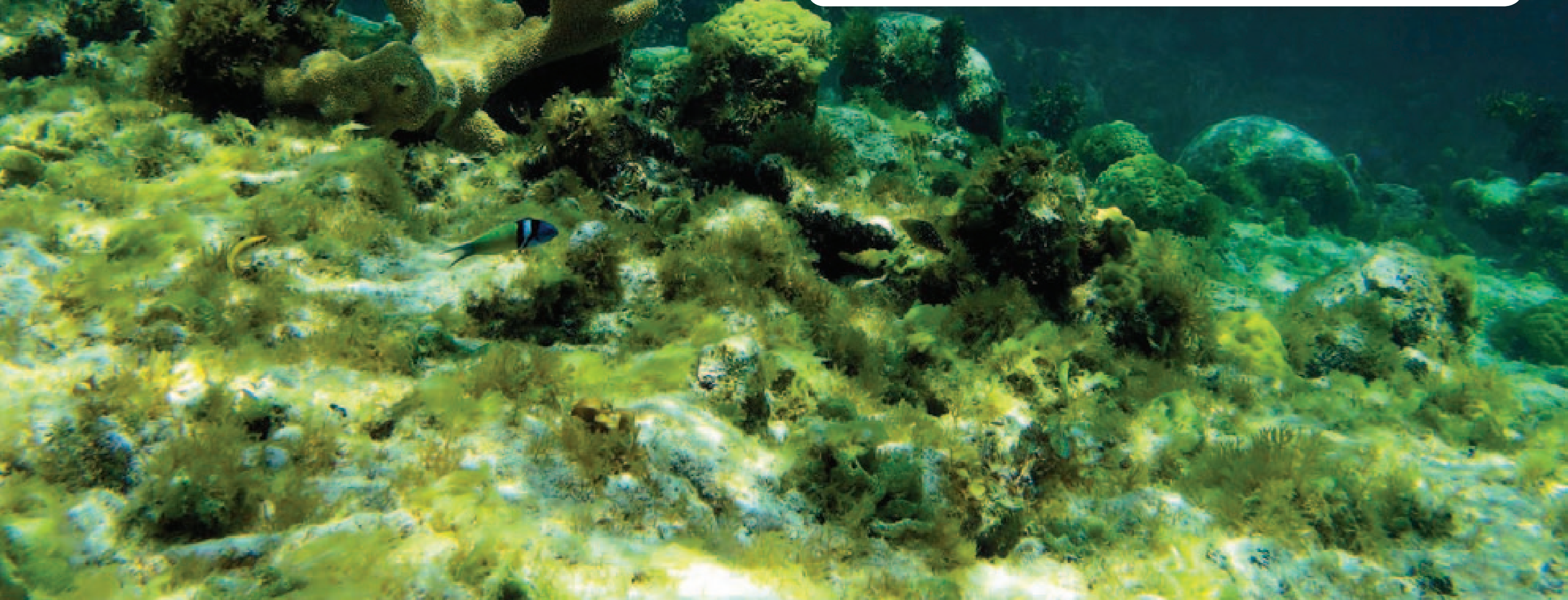
Members of the group illustrated at left (dinoflagellates) are often involved in harmful algal blooms that kill fish and shellfish either directly, by producing toxins or clogging gills, or indirectly, by decreasing the amount of oxygen in the water.

What causes harmful algal blooms?

Like all plants, phytoplankton need sunlight and nutrients to grow and increase in numbers. Nutrients are substances that are used as food by animals and plants. The two critical nutrients for phytoplankton, nitrogen and phosphorus, are usually present in very low concentrations in seawater.

However in certain circumstances, nutrients in coastal waters increase dramatically, causing harmful algal blooms. In Pacific Islands, high loads of nutrients may be related to the following events:

- The wet season causing nutrients to be washed off the land (runoff)
- Cyclones resulting in coastal damage, heavy rains and increased runoff
- Release of nutrients from corals after the use of dredges or explosives
- Runoff of nutrients in fertilisers from farms and sewage from stock and humans



#28

Harmful algal blooms

What are the effects of harmful algal blooms?

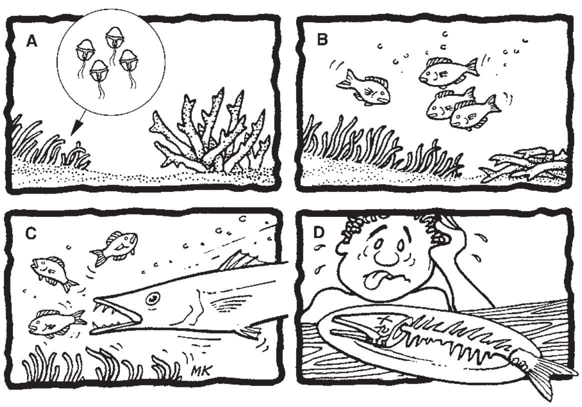
Harmful algal blooms cause a variety of human illnesses. Some toxic phytoplankton are filtered from the water as food by shellfish such as clams, mussels and oysters. People eating these shellfish suffer from a condition known as paralytic shellfish poisoning, which results in numbness, vomiting and even death.

A few harmful algal blooms produce toxins that affect people who are just swimming and walking on the shoreline. One type of toxic phytoplankton (*Karenia brevis*) has affected local residents and beachgoers who breathed its toxins in spray from the sea. Effects include tingling, dizziness, lung irritation and coughing.

Ciguatera fish poisoning is caused by perhaps the most common harmful algal bloom in Pacific Islands. The figure below shows a cartoon used to raise community awareness. The sequence of events shown is as follows:

1. Toxic phytoplankton (perhaps several different species including *Gambierdiscus toxicus*) are normally associated with seagrass beds.
2. Increased nutrients (for example, released from damaged corals) cause the toxic phytoplankton to increase greatly in abundance. Small grazing fish feeding on the seagrass concentrate the toxins in their bodies.
3. Larger fish feeding on the smaller fish gain even higher concentrations of the toxins. Through the food chains, the toxins reach dangerous levels in some emperors, red snappers, barracudas, moray eels, large spanish mackerels and others.
4. People eating affected fish suffer from ciguatera and experience numbness, muscle pains, and a curious reversal of temperature sensations (cold objects feel hot to touch). In extreme cases, death occurs through respiratory failure.

The possibility of fish being toxic because of ciguatera causes severe marketing problems. Unfortunately, and in spite of widespread folklore on the subject, there is no reliable, cheap test to determine whether or not a particular fish is toxic before consumption. One common belief is that toxic fish can be recognised by exposing a fillet of the fish to flies — the flesh is regarded as poisonous if the flies avoid it. Another belief is that a toxic fish can be recognised by placing a silver coin on the flesh — if the coin turns black, the flesh is not safe to eat. Unfortunately these tests, and many other widely trusted ones, do not work.



How can we reduce the number of harmful algal blooms?

The number of some types of harmful algal blooms can be reduced by controlling the amount of nutrients entering coastal waters. Human and stock sewage appears to be the major source of nutrients in cases where there are poor sewerage systems — this is particularly so in atolls where groundwater and lagoons can easily become contaminated.

Waste water from sewage treatment plants and overflows from septic tanks (underground tanks in which sewage is decomposed by bacteria) must not be allowed to enter rivers or coastal waters. In some cases, bananas and other crops have been planted near outfalls and overflows where they are believed to absorb these nutrients before they reach the sea. Alternatively, human and farm animal waste can be composted — a process in which the material is allowed to decay before being used as a fertiliser for growing plants.

Shrubs and trees near rivers and along the foreshore should be protected and bare areas replanted. Natural vegetation, including mangrove trees at the water's edge, use at least some nutrients before they reach the sea.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet. Photos: Nashworld and Richard Johnson.

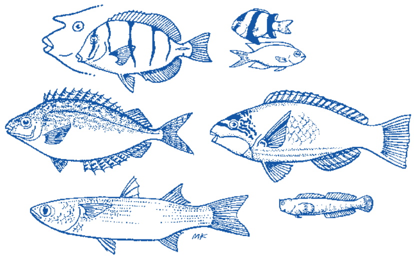
The Locally-Managed Marine Area (LMMA) Network

European Union
Union européenne

SPC CPS

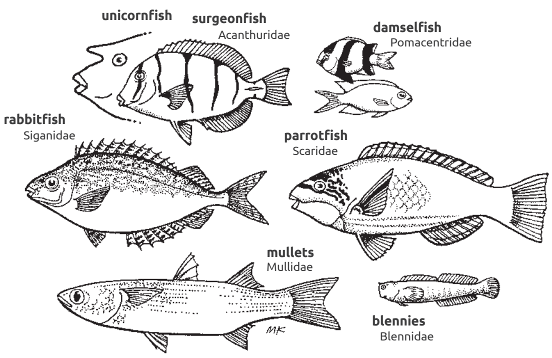
#29

Plant-eating fish



Plant-eating fish

Fish that eat plants are called herbivores and are said to be herbivorous. On coral reefs, plant-eating fish include parrotfish, damselfish, rabbitfish, unicornfish and surgeonfish. Herbivores that are less noticeable, because they are small and often live in burrows, include the blennies. Mullets are less often associated with coral reefs but may form large schools over seagrass beds in lagoons and shallow coastal areas.



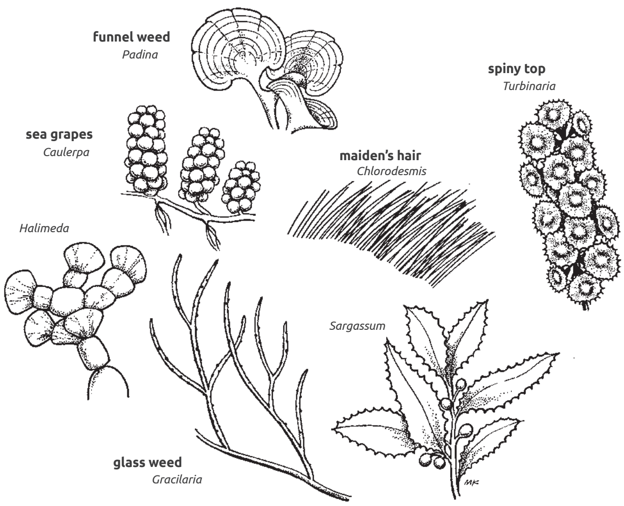
Feeding on plants

Many fish eat a wide range of seaweeds, and some specialise in eating particular ones; some common seaweeds are shown in the illustration below.

Rabbitfish and surgeonfish feed on the turf-like mats of maiden's hair that grow on hard surfaces. Some fish such as damselfish are territorial — that is, they aggressively defend a territory containing patches of seaweed. Convict surgeonfish swarm across reefs while they graze and appear to use their large numbers to frighten off the small damselfish. Unicornfish as well as surgeonfish eat the brown seaweeds including funnel weed, *Sargassum*, and spiny top.

With their parrot-like beaks, some parrotfish excavate in coral rubble and others feed on a variety of seaweeds including turfs and the hard (calcified) *Halimeda* and corals. When they graze on corals they also digest coral tissue.

Some fish eat both plants as well as animals and are called omnivores; mullets for example feed on small animals when young and on plants when they are adults.



#29 Plant-eating fish

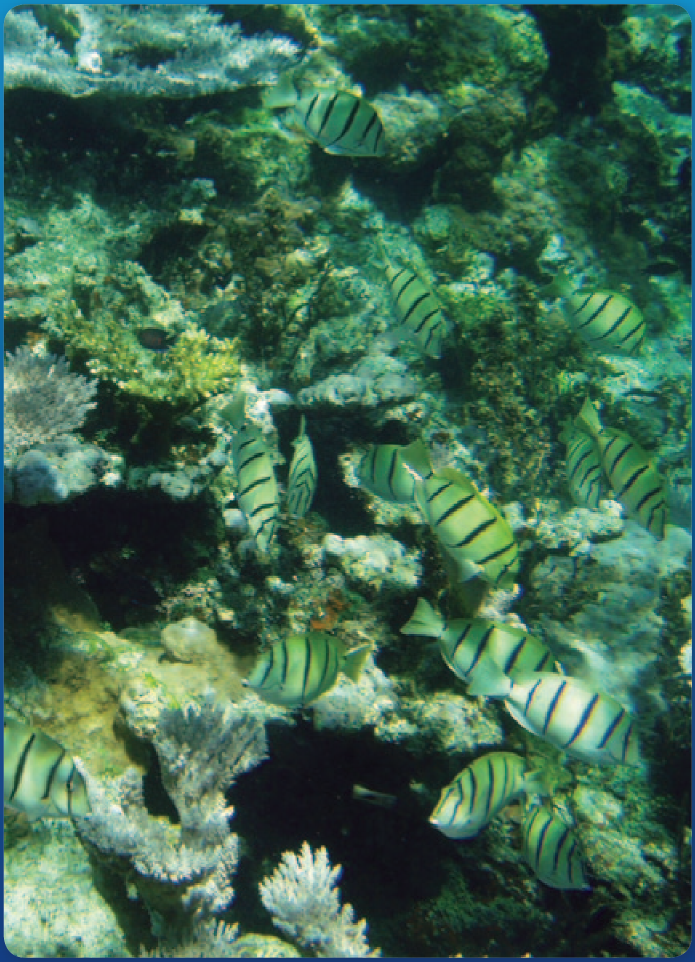
The importance of herbivores

Plants are primary producers — that is, they create food directly from sunlight, carbon dioxide and nutrients in the water. Fish and other animals that eat plants become food for carnivorous or meat-eating fish such as snappers, groupers and trevallies. Plant-eating fish, therefore, provide an essential link between plants and the important and often larger food fish.

However, in addition to their importance in food chains, plant-eating fish are vital to the health and survival of coral reefs. As most plants grow much faster than corals they will quickly establish themselves on any bare surface. In the absence of plant-eating fish, seaweeds will:

- → occupy spaces where corals could have settled,
- → outgrow corals and deprive them of essential sunlight, and,
- → damage corals by scraping against them.

Coral reefs provide habitats and food for the marine life that fishing communities rely on for seafood. If seaweeds are allowed to replace corals, the reefs will not support the same variety of seafood species. This is happening in many places in the world and is usually caused when the numbers of plant-eating fish have been severely reduced by heavy fishing.



Management measures & Options

With assistance and advice from local government authorities, NGOs or regional organisations, community members could discuss the following questions.

What is the health of nearby coral reefs? A reef that has extensive stands of large seaweeds may be at risk — that is, it may be in the process of shifting from a reef of corals to a reef of plants. Healthy coral reefs have only small patches of turf and a few large seaweeds.

If the reef is dominated by large seaweeds, what are the causes? Although increased nutrients, say from human or animal sewage, may be partly responsible, the most likely cause of excessive plant growth is the over-fishing of plant-eating fish.

Have the numbers of key herbivorous species changed? Local fishers will know whether or not the time needed to catch, say, a basket of parrotfish or a string of surgeonfish has changed. If it takes longer to catch a particular species than it did in the past, it is likely that numbers have been decreasing.

To protect coral reefs, management activities should focus on protecting plant-eating fish. The following are some key actions.

→ Reduce fishing on plant-eating fish:
Actions could include banning the use of spears to catch parrotfish and surgeonfish at night (see Information Sheet 4 in this series). The use of SCUBA for spear-fishing should be banned at all times.

→ Ban, or at least reduce, fishing on spawning fish:
Many plant-eating fish, including surgeonfish, parrotfish and rabbitfish form spawning aggregations (see Information Sheet 24). In these species it is important to ban, or at least reduce, fishing on spawning fish.

→ Establish marine reserves:
Marine reserves (or no-take areas) in which fishing is banned will allow the numbers of fish to increase. Grazing fish, particularly parrotfish, will increase the areas available for corals to settle — such grazing in marine reserves has been found to double the numbers of corals settling on hard surfaces.

Having large numbers of different herbivores feeding on different seaweeds is essential for the health of coral reefs and assists what is called reef resilience — the ability of a reef to return to its initial condition after being badly affected by factors such as cyclones, coral bleaching events and outbreaks of crown-of-thorns. Without herbivores, algae will quickly dominate the space and coral communities may not recover.

This information sheet has been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options. Please refer to guide book for an explanation of terms used in this information sheet.
Photos: Richard Ling and Rian Tan (www.wildsingapore.com).

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

European Union
Union européenne

SPC CPS

Community-managed no-take areas in fisheries management

The purpose of this leaflet is to assist fishing communities, and people working with them, in establishing and managing no-take areas.

1. What are no-take areas?

Generally, no-take areas are ones in which fishing is banned. They may be known as reserves or closed areas, or as *ra'ui*, *tambu*, *tabu* and other local names that have been used by fishing communities in the Pacific for many hundreds of years.

A **permanent no-take area** is one that is permanently closed to fishing.

A **periodically fished no-take area** is one that is closed to fishing for periods that vary from a few months to several years.

Other variations include periodically closed areas in which fishing is banned at particular, and usually short, times, often to protect breeding stocks or spawning aggregations of marine species.

2. What are the purposes of no-take areas?

Permanently closed no-take areas provide long-term protection for ecosystems, habitats and the species they support. The expectations are that species in permanent no-take areas will grow, breed and spread to adjacent fishing areas where they can be caught.

In no-take areas that are periodically fished, the expectations are similar. While the areas are closed, fish will grow and breed. And when opened to fishing, people can make improved catches of larger fish inside the managed area.

3. How can no-take areas increase catches?

In Figure 1, the no-take area is represented by the heavy circle. Fish in the no-take area spawn and produce small larval stages that either: A) settle and remain in the no-take area or B) drift with the currents to settle and grow outside the no-take area. C) Juveniles and adult fish also move out of the no-take area as spillover, perhaps due to crowding.

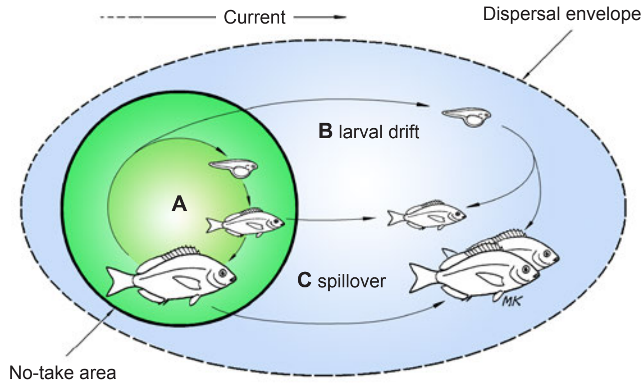


Figure 1. Larval stages produced in a no-take area (green circle) may either A) settle within its boundaries or B) drift within a dispersal envelope stretching down current. C) Juveniles and adults from the no-take area also spill over into nearby areas (adapted from King, 2007. Fisheries biology, assessment and management. Wiley Blackwell, UK).

4. Where, and how big, should a no-take area be?

A no-take area, whether permanently closed or occasionally fished, is likely to improve catches but not equally for all species and not always very quickly. Although in general, bigger no-take areas are likely to be more beneficial, the position of them is perhaps more important than size. Here are some general points.

a) **Position the no-take area so that it includes different habitats.** During their lifecycle, many species use more than one habitat. The more corals, seagrass beds and mangroves in a no-take area, the more effective it will be (Figure 2). Except for a few species, such as sea cucumbers and some clams, an area of bare sand or coral rubble will be unsuitable for a no-take area.

b) **Position the no-take area near other key habitats.** The no-take area should be as near as possible to other key habitats, even if they are unprotected. There is some evidence that small no-take areas based on reefs are more successful when positioned close to seagrass beds or mangroves.

c) **Position the no-take area in a place that is critical for important species.** These areas may include feeding sites, breeding areas, spawning aggregation sites and nursery areas for particular species.

d) **Position the no-take area in a place where it can be watched.** It will be necessary for members of the community to protect or guard the closed area.

e) **Position the no-take area so that currents flow towards the fishing area.** These currents may assist in carrying larval stages into the fishing area (Figure 2). Currents along a coast or inside a coastal lagoon often move back and forth but there is usually a net movement in one direction (in the absence of traditional knowledge or scientific information this can be determined by following the path of some weighted, plastic, drink bottles over several tidal cycles and during different moon phases). It must be recognised that larval movements are often more complicated and may be related to spawning times that coincide with particular tides.

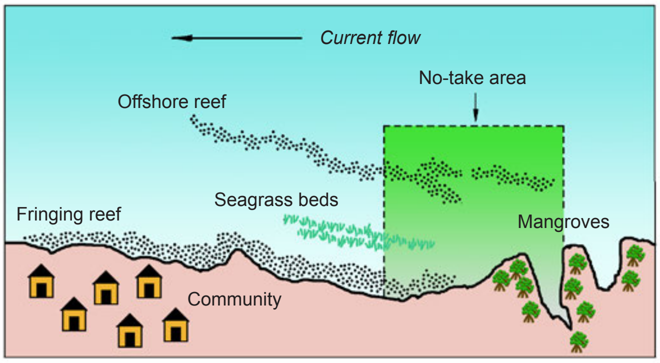


Figure 2. An idealised situation in which a fishing community has positioned a no-take area to include parts of an offshore reef, a fringing reef, seagrass beds and a mangrove area. The no-take area is also positioned up-current where the net movement of water will distribute drifting larval stages to the community's fishing area.

f) **If a large no-take area is not possible, plan for a smaller one.** Even small no-take zones will benefit less mobile species such as octopuses, clams and some reef fish. However, it will be less effective in protecting species that move over large territories or feeding ranges. Some fish, such as mullets, that make long migrations along the coast will not benefit from a small no-take area.

g) **Work with neighbouring communities to establish a network of no-take areas.** If only small no-take areas are possible, plan to establish many small no-take areas like those in Samoa or on Fiji's Coral Coast. A network of no-take areas, about ten kilometres apart, may maximise the linking of larval sources with suitable settlement areas.

h) **Consider establishing more than one no-take area, each with different aims.** If there were two adjacent but separate areas, for example, one could be established as a permanent no-take area and the other periodically harvested in a controlled manner.

i) **Don't expect immediate results.** Many species take a long time to grow to maturity and reproduce. This time will vary from species to species (see information sheets).

j) **Don't expect the no-take area to work equally well for all species.** Species with larval stages that drift in the sea for short times (such as Trochus) are likely to settle near the no-take area. However, those with larval stages that drift for longer times (such as lobsters) may settle some distance away from the community's fishing area. A rough illustration of the potential distance that larval stages could travel is given in Figure 3, based on a net larval movement of 50 metres per day — this figure is for illustrative purposes only; the larval stages of some fish can detect and actively move to particular reefs to settle, and there is some recent scientific evidence that the larval stages of many species do not move as far as previously thought.

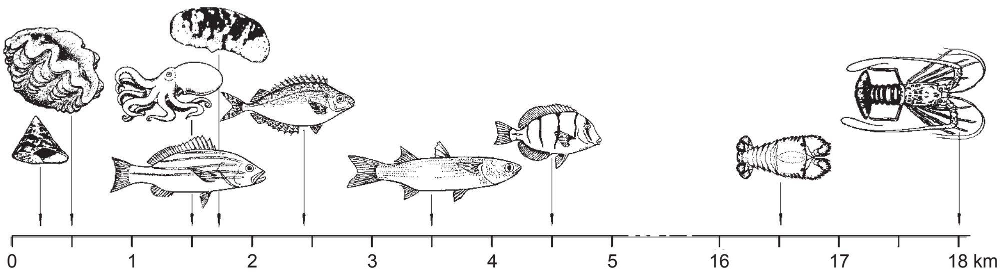


Figure 3. The relative potential distance (km) that larvae could drift before settling as juveniles. Based on a movement of 50 metres per day.

5. How can we manage our no-take area?

A no-take area requires support and management by the community. If everyone agrees to the establishment of a no-take area and understands the reason for it, the ban on fishing in the area is more likely to be respected. The area must be clearly marked so that everyone is aware of its boundaries and those who break the no-take rules should be penalised by the community.

Although there are long-term benefits in having a permanent no-take area, many are opened for fishing periodically. Some of these are deliberately established for periodic fishing — some for special occasions, including weddings, funerals and fund-raising. The temptation to open the area or even poach fish is great, particularly when people see that more fish have appeared in the area (fish jumping at night is commonly reported).

Uncontrolled fishing after an opening of a no-take area can be devastating. This is especially so if the area is opened for long periods and is fished by a large number of people. Not only will large numbers of mature fish be caught or flee from the area but habitats, particularly corals, may be trampled and destroyed, depending on the harvesting methods used. In the worst case, the area may be so badly affected that it is no longer effective as a no-take area.

The following options may help reduce the impact of opening no-take areas.

a) **Make the no-take area either closed permanently or opened infrequently.** Benefits are more likely if the closure is permanent or at least lasts for extended periods. Frequent opening of an area will disturb sea life and may damage habitats.

b) **Keep the opening of a no-take area as short as possible.** Limit fishing to half a day or less and ensure that everyone knows the opening and closing time.

c) **Restrict the number of fishers allowed in the reserve during any opening.** Fewer people will cause less damage. Fishers should be from the local community.

d) **Allow only selected species to be taken.** Allow only the catching of fast-growing species or a limited number of slow-growing species.

e) **Restrict the catch of some of the largest fish.** Openings often remove the largest, most productive fish from the area. As egg production is related to fish volume, large fish produce a disproportionately larger number of eggs; if a female fish is allowed to double in size, the number of eggs produced increases by approximately eight times (Figure 4).

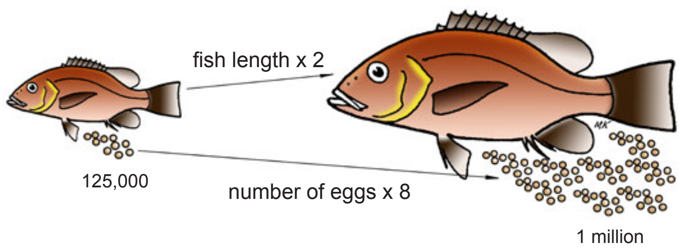


Figure 4. If a fish doubles in size, the number of eggs produced increases by approximately 8 times.

f) **When opening, restrict the types of fishing gear that can be used.** Some fishing methods, such as nets, cause more damage than other methods, such as line fishing from canoes or boats.

g) **When opening, limit the amount of fish taken.** Set a modest catch target, or quota, and collect only the amount of fish needed. Agree to re-instate the ban once the targeted amount has been reached.

h) **Consider the timing of openings.** Avoid opening the area when important species are breeding or gathering to spawn.

6. How do we know if our no-take area is successful?

Whether or not a management action, such as establishing a no-take area, is beneficial can be judged by the time or effort it takes for the same number of people to catch a certain amount of seafood; for example, the time taken to catch a string of fish, a basket of clams, or a number of lobsters.

If this fishing time is decreasing, the numbers of fish or other species are most likely increasing and the no-take area is likely to be working well.

If this fishing time is increasing, the no-take area is not working successfully. In this case, different or additional management measures are needed. The following questions can be discussed at community meetings.

a) **Are all people in the community aware of the no-take area and its rules?** Do individuals understand the purpose of the no-take area and comply with bans on fishing? If not, discuss ways in which the situation can be improved.
b) **Is the no-take area too small or poorly positioned?** See Section 4.
c) **Is the no-take area affected by pollution?** Pollution by silt and sewage is a common cause of habitat degradation in Pacific islands.
d) **Are areas and habitats outside the no-take area degraded?** Individuals produced in the no-take area may rely on nearby habitats, such as nearby seagrass beds and mangroves, to complete their lifecycles.
e) **Are more people going fishing?** If more people are catching and selling fish, the existing no-take area may not be able to replace the numbers of fish caught. Eventually, there will be a need for restrictions on catches and the number of people fishing.

No-take areas (whether permanently closed or periodically harvested) are one way of managing a fishery. They can be regarded as an important tool in a toolbox of management controls, some of which are listed in the *Guide to information sheets on fisheries management for communities*, available from SPC.

SECRETARIAT OF THE PACIFIC COMMUNITY
BP D5 • 98848 NOUMEA CEDEX • NEW CALEDONIA
Telephone: +687 26 20 00
Facsimile: +687 26 38 18
Email: cfpinfo@spc.int
http://www.spc.int/fame

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
Email: info@lmmanetwork.org
http://www.lmmanetwork.org

This leaflet has been prepared by Michael King with information and comments supplied by Mike Batty, Lindsay Chapman, Ian Bertram, Hugh Govan, Simon Albert, Etuati Ropeti, Being Yeeting, Kalo Pakoa, Aymeric Desurmont, Maria Sapatu, Simon Foale, Ron Vave, Toni Parras, Jovelyn Cleofe, Alifereti Tawake, Wendy Tan, Stacy Jupiter, Pip Cohen, Tom Brewer, Tevi Maltali, James Comley, Victor Bonito, Magali Verducci, Julien Grignon, Semisi Meo and Michael Guilbeaux.

Community resource management

A **resource** is something that is valuable and is used by people. Marine resources include fish, shellfish and other sea-life. These resources and where they live (their **environment**) are part of an **ecosystem** where all living and non-living things interact with each other.

The main aim of **marine resource management** is to ensure that the use of these resources is sustainable. This means that we must manage human activities to protect the environment, both on land and sea. What happens on land will affect things that live in the sea. Marine ecosystems and seafood species are affected by forestry, farming, mining, uncontrolled development and wastes from towns and villages.

The need for the broad management of land and sea has sometimes been called a ridge to reef approach or an ecosystem approach. It is this broader style of resource management, which includes the management of land, water and living resources, that this brochure is based on.

A community with strong leadership can develop resource management without outside assistance. However, communities and government authorities or NGOs working together (sometimes called **co-management**) will make the process easier and more effective.

European Union
Union européenne

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation

SPC CPS

The essential elements of **community marine resource management** are given below.

1. Ensure that the community is aware, concerned and willing to take action

A community must have an **awareness** of the value of its marine resources and have a **concern** for existing problems. It must be prepared to take the **actions** necessary to manage its marine resources; it must also be prepared to work with the government if problems are beyond local control.

If this is not the case then co-management will fail. As the key stakeholder, the community must be the main driver of the process.

Community readiness must be assessed at the very outset – at the first meeting with community leaders.

- If the assessment is negative, support would be better given to a more willing community.
- If the assessment is positive, the procedure of developing co-management should be discussed and the opportunity given for community members to ask questions. Then continue with the following steps.

2. Agree on the key goals – the desired results

Goals must be set by the community even if developed with advice from a facilitator. An example of a narrow but important goal would be '*to ensure that catches of seafood continue to be sufficient to feed our community.*'

A broader goal would be '*to manage the land, water and living things in order to provide continuing food and other resources for the community.*'

The goal, or goals, must be widely agreed on by the community and consistent with national policies. Ideally, relevant government departments should be consulted and participate in initial meetings with the community.

3. Agree on a management plan with the actions or steps needed to achieve the goal

Although the process will be different in different countries, an important common theme must be to ensure **wide community involvement**.

It is important to involve different sectors of the community, including women's groups, clan representatives or family heads, owners and rights-holders of the different areas and fisher groups to ensure the widest community participation. This is the time to discuss the community actions and rules that are needed to achieve the goals.

It is important to encourage people to discuss their problems (related to the key goals) and to propose solutions. Useful information will include traditional knowledge and scientific information (as contained in the *SPC Information Sheets* in this series).

There are many ways to encourage people to join in discussions including theatrical performances, role-playing, resource mapping, and by using audience participation techniques such as constructing problem/solution trees and others (problem/solution trees and the Locally-Managed Marine Area (LMMA) techniques are described in the 2010 SPC/FAO/Nature Conservancy publication 'A community-based ecosystem approach to fisheries management; guidelines for Pacific Island Countries' – http://www.spc.int/FAME/en/fame-digital-library).

The main outcome must be agreement on the problems and solutions before deciding on the required actions and who is responsible for carrying them out. These can be recorded as an action plan or a **Community Resource Management Plan**. This plan, written in the local language, represents an important document to remember the agreements and rules as well as to show outsiders.

4. Identify or establish a small group to make the management plan work

Although community resource management is ideally supported by all people in the community, there needs to be some smaller group of people to take charge of the planned actions. This group may be thought of as a committee to administer the required actions and monitor progress. It also may need to penalize people who break management rules.

An existing group may be used or a **Community Resource Management Committee** could be established. The community may be made up of cultural leaders, or people appointed by them, or they could be elected by the people. The committee should include representatives from women's groups and fishers' groups. Ideally, it should also include representatives of the co-managers, either from government authorities or NGOs. They must meet regularly and work hard to keep the momentum of community resource management going.

5. Do it! – apply the actions in the management plan

Actions, rules or **tools** are used by community managers to achieve the goal. For example the community may choose to ban catching spawning fish and to ban certain types of destructive fishing.

To protect marine ecosystems they may decide to plant trees around a nearby river to prevent erosion, to protect mangrove areas, and to protect an area of coral reef by declaring a **Marine Protected Area**.

These are just some examples of tools that can be used – different ones may be used to achieve the same goal.

6. Check to see that actions are being carried out

It is necessary to monitor and assess how community resource management is functioning. This means seeking answers to questions such as the following.

- → Does the Community Resource Management Committee meet regularly?
- → Does it have the support of community leaders? - the church? - the people?
- → Do people respect the community rules established by the committee?
- → Does it enforce the community rules and regulations that have been agreed to?

7. Check to see if the plan is working

It is also necessary to monitor and assess if the applied actions and tools are achieving (or at least progressing towards) the intended goal. If this is not the case then different actions must be applied.

This may mean seeking answers to questions similar to the following ones.

- → Is the fish reserve working? Are numbers of fish increasing?
- → Is the ban on fishing with nets increasing the numbers of fish?
- → Is the tabu on catching certain species resulting in a greater number of fish?
- → Are catches improving, or at least not decreasing?

If the management measures taken are not working then some other measures will have to be taken. This is what is called 'adaptive management' – trying some sensible management measure and then seeing if it works; if it's not achieving results then it must be modified or other management measures should be tried.

Continuing support

In theory, if a community is managing its marine resources and there are visible benefits, community resource management will be self-sustaining. However, in practice, communities may find regular consultation with outside agencies useful for years to come.

If an outside agency is involved it may take years of regular visits to a community to ensure that co-management continues. Therefore, an exit strategy that involves a gradual withdrawal is better than an abrupt ending of support and encouragement for a community.

Extending community resource management to other communities

To extend the benefits to other communities, the co-managers or implementing agency should ensure that there is extensive media coverage for the first fishing communities to establish community resource management.

Radio interviews with key players from the first village are good ways of getting other communities interested. If modest funds are available, sponsoring exchange visits between communities with resource co-management and communities that are interested in establishing it is one of the most effective ways of extending the programme.

Regardless of legislation or enforcement, the responsible management of marine resources will only be achieved when fishing communities themselves see it as their responsibility.

SECRETARIAT OF THE PACIFIC COMMUNITY
BP D5 • 98848 NOUMEA CEDEX • NEW CALEDONIA
Telephone: +687 26 20 00
Facsimile: +687 26 38 18
Email: cfpinfo@spc.int
http://www.spc.int/fame

The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
Email: info@lmmanetwork.org
http://www.lmmanetwork.org

This leaflet has been prepared by Michael King with information and comments supplied by Mike Batty, Lindsay Chapman, Ian Bertram, Hugh Govan, Simon Albert, Etuati Ropeti, Being Yeeting, Kalo Pakoa, Aymeric Desurmont, Maria Sapatu, Jeff Kinch Simon Foale, Ron Vave, Toni Parras, Jovelyn Cleofe, Alifereti Tawake, Wendy Tan, Stacy Jupiter, Pip Cohen, Tom Brewer, Tevi Maltali, James Comley, Victor Bonito, Magali Verducci, Julien Grignon, Semisi Meo and Michael Guilbeaux.

Destructive fishing

All fishing is destructive in some way. The removal of any marine species, particularly in large numbers, will affect the complex web of connections between all marine species. And most fishing methods catch other unwanted species referred to as by-catch.

Although fishing always affects the marine environment and ecosystems to some degree, some fishing gear and fishing methods are just too destructive and their use must be controlled.

Fishing can be regarded as destructive if it ...

- causes physical damage to nearby areas, say by digging up the sea floor or breaking coral
- kills a large number of species in addition to the ones being fished.
- is so efficient that not enough fish are left in the sea to reproduce

The last listed point is a difficult one. Most fishers want to fish as efficiently as possible. However, some fishing gear and methods are overly efficient – a small mesh net set across a gap in the reef, for example, may catch all fish attempting to swim through the passage.

The major aim in all fisheries management is to make fisheries sustainable. That is, to make sure that fisheries will still be there to provide seafood for our children and their children. We must always leave enough fish in the sea to reproduce and provide fish for the future. And, of course, we must look after the places in which fish live; we must take care of the environment – the coasts, mangrove areas and reefs. And, as what happens on land will affect what happens in the sea, we must control run-off containing sediments and wastes.

The following is a list of damaging fishing gear and methods used in Pacific Islands.

Explosives such as dynamite

Explosives such as dynamite (often obtained from mining operations, road works and even police) are used for fishing in some Pacific Islands. 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 are many times more damaging to small animals, such as fish larval stages and coral polyps, than they are to large fish. Although the use of explosives is illegal, the practice may be tolerated in isolated communities in which the illegally caught fish are shared. A cartoon used to make the public aware of the long-term damage done by using explosives for fishing is shown at right.

When you want a coconut
you don't chop down the whole tree

So, when you want a fish,
DON'T kill the whole reef
People who use dynamite and chemicals
to kill fish are destroying our reefs.
They are also destroying our future.

All communities should support the national government in preventing the use of explosives for fishing.

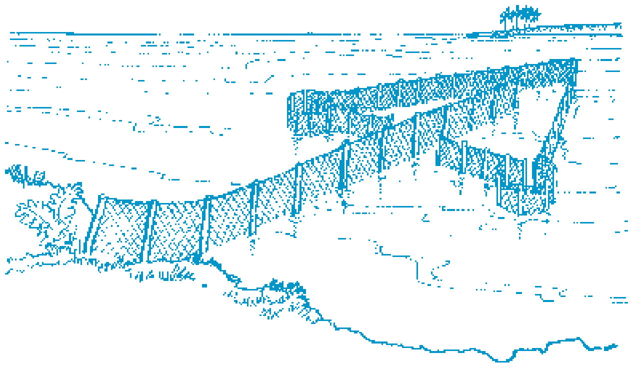
Toxic chemicals

In some countries, commercially available poisons such as bleach (sodium hypochlorite) are used to catch fish. Bleach may be poured into pools that have been isolated at low tide to stun and capture small coral fishes. The bleach will also kill all other small animals, including corals, with which it comes into contact.

All communities should ban the use of chemicals for fishing; government should require that warnings are placed on containers of bleach.

European Union
Union européenne
The Locally-Managed Marine Area (LMMA) Network
Improving the practice of marine conservation
SPC CPS

Fish traps and fences



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.

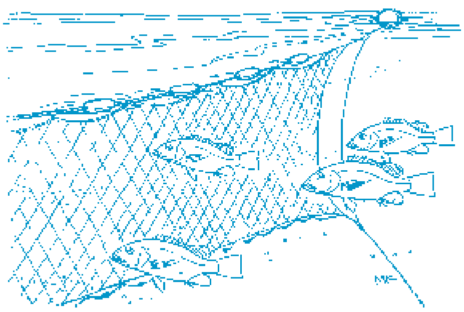
Fence traps usually consist of a fence or wall built at right-angles from shore-lines and reefs to guide migrating coastal fish into a large retaining area. When fish meet the fence they swim along it until they reach the retaining area from which it is difficult to escape. Designs are often traditional and vary between regions.

All communities should limit the number of fence traps that can be built in their adjacent fishing areas.

Although originally made from stone or coral blocks by an entire community working over many months, such traps are now usually made from modern materials such as wire-mesh netting as shown in the figure. Now each community may have several family-owned fence traps. The excessive use of fence traps has resulted in the loss of fish stocks such as mullet in Tonga. Some communities in Samoa have limited the number of fence traps that can be built in their adjacent fishing areas.

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, and are anchored in shallow water.

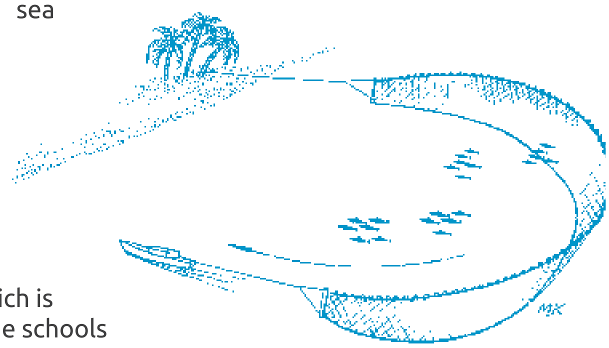


Problems occur when gill nets are set across narrow reef passages, channels or the mouths of rivers. In these cases, no fish will be able to pass the nets. This method of fishing is particularly damaging in cases where nets are set to catch fish swimming to a spawning aggregation site (see *SPC Information Sheet 24*).

All communities should place conditions on where gill nets can be used. Minimum mesh sizes have been set by many governments.

Gear that is dragged across the sea floor

Fishing nets that are dragged across the sea floor are more damaging to the environment than nets that are left in one position. Trawl nets are towed behind fishing boats to catch species such as prawns in Papua New Guinea and Hawaii. These nets catch large numbers of different marine species and can damage large areas of the sea floor.



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, although in many cases, 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). However it is used, a seine net will catch most fish in its path and can damage coral and beds of seagrass.

All communities should place conditions on where beach seines can be used and require minimum mesh sizes.

Fish drives

A fish drive 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.

All communities should ban fish drives or at least limit the number of places where they can take place.

Fish herding and scaring may also be used 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. Such fish drives often cause considerable damage to the sea floor and corals.

Picking by hand or gleaning

The collection of marine animals and seaweed in lagoons or on the reef flat at low tide is a common way of fishing, particularly for women and children. A variety of species are 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.

All communities should ban the breaking of coral to catch fish.

Gleaning is an important method of obtaining food, particularly when the weather is too rough to go to sea. Although individual catches are often small, the collective catch made by many fishers is often large and the combined impact on the intertidal areas can be damaging. In some countries, people deliberately smash corals to catch sheltering fish – some Samoan communities have banned this destructive method of fishing called *fa'amo'a* and *tuiga*.

Poisonous plant material

Poisonous plant material is traditionally used to catch fish. Plants used include the climbing vine, *Derris*, and the fish poison tree, *Barringtonia asiatica*.

All communities should ban the use of plant poisons for fishing.

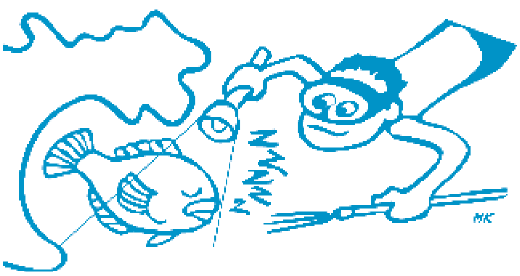
Derris is a climbing plant belonging to the pea family. Its roots can be ground to produce rotenone, a poison that can kill insects and fish. Rotenone or derris powder is believed to be extremely toxic and damaging to the environment.

The fish poison tree grows in mangrove areas and, as the water-resistant fruit drifts on ocean currents, it is distributed widely across the Indian and Pacific oceans. The seeds, which contain the poison saponin, can be ground to a powder and used to stun or kill fish. A photograph of a tree is shown and its large pinkish-white flower and seed are shown in the inset.

Pastes from these plants are used in various ways. Fishers may drive the fish into the shelter of a preselected coral head where two or three parcels of poisonous material have been placed.

Spear-fishing at night

Spear fishing is a common method of fishing in many Pacific Islands and can be a method that causes little harm to species or the environment. However, the availability of cheap underwater torches has allowed fishers to go fishing with spears at night. This method of fishing is particularly devastating to fish that sleep in the corals and in shallow reef areas.



At night some fishes such as parrotfishes sleep in crevices or holes after wrapping themselves in a transparent covering or cocoon of mucus. The mucus may repel parasites or hide the scent of the fish from night-time predators. These sleeping fish are very easy to spear and in some cases large parrotfishes have been removed from entire lagoons. The loss of plant-eating fish such as parrotfishes has resulted in corals being replaced by seaweeds on some reefs (see SPC information sheet 29).

All communities should ban the use of spears for fishing at night and reduce fishing on plant-eating fish.

Destructve fishing

Traps, nets and ghost fishing

Several types of fishing gear continue to fish after being lost or abandoned. Even without bait, some traps continue to trap fish and gill nets can continue fishing for many years after they are lost. This type of fishing is called 'ghost fishing' and is of concern in many parts of the world.

> All abandoned fishing gear should be removed from lagoons and the water's edge.

To prevent 'ghost fishing' by lost traps, some authorities insist that traps are made from material which rots away after being left in the water for a long time. Gill nets made of plastic material (monofilament nylon) do not rot and remain in the sea for a very long time, sometimes rolled up into a ball that entangles marine life.

Use of underwater breathing apparatus

The use of underwater breathing apparatus, or SCUBA gear makes some fishing too efficient. In some cases, for example, entire reefs fronts have been stripped of lobsters by divers using underwater breathing apparatus and sea cucumbers have been collected from deeper water. Some governments have banned the use of underwater breathing apparatus either for all fishing or for catching lobsters.

> All fishing communities should ban the use of underwater breathing apparatus for fishing.

Illegal fishing

In the Pacific, foreign fishing vessels have been involved in illegal fishing of fish, sea cucumbers, trochus and giant clams. Illegal fishing is damaging in that the fishers involved do not respect national and local rules on fishing.

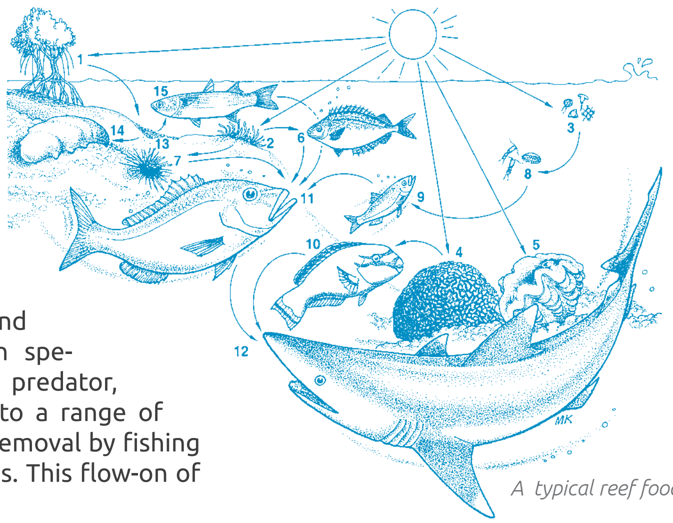
> Communities should report all cases of illegal fishing to government authorities.

Destructive fishing is not only due to the use of modern materials – some traditional fishing methods are also damaging. 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.

But populations are growing at close to 4% per year in some island countries – this means that their populations will double in less than 20 years. If it is hard to get enough seafood to feed people now, just imagine how hard it will be to do so in 20 years.

Removing particular species from an area will always have consequences. This is because every species is part of a complex food web – a very simplified one is shown below. In the absence of fishing, the species present are in some sort of balance even numbers of individual species may vary naturally from year to year.

Removing any species in large numbers, say by heavy fishing, will affect the balance, sometimes in unexpected and disastrous ways. Each species is likely to be a predator, prey and competitor to a range of other species and its removal by fishing will have consequences. This flow-on of the effects of removing a species from an ecosystem has been called 'trophic cascades' by scientists.



A typical reef food web

Two examples are the indirect effect that fishing can have on seagrasses and coral reefs.

In some cases entire seagrass beds have been lost due to the overgrazing of seagrasses by population explosions of sea urchins. The sea urchins increased in numbers because their predators, trigger fishes, were removed by overfishing.

Corals are kept healthy by the actions of the plant-eating fishes that keep large seaweeds from competing with corals for space. The growth of seaweeds has become a problem in cases where many plant-eating fish, including parrotfishes, unicorn fishes and surgeonfishes, have been removed from the area.

Many non-fisheries issues including land reclamation, sedimentation, eutrophication, and pollution are most important in their impacts on marine ecosystems and fish stocks. This suggests that we need to manage fisheries on a much broader basis than just by looking after fish. Besides controlling destructive and overly-efficient fishing methods, we need to take action to protect mangroves, seagrass beds, coral reefs – all places on which fish depend. This broad approach is described in the SPC brochure 'Community resource management.'

This leaflet, the guide and information sheets have been prepared by Michael King with information and comments supplied by Mike Batty, Lindsay Chapman, Ian Bertram, Hugh Govan, Simon Albert, Etuati Ropeti, Being Yeeting, Kalo Pakoa, Aymeric Desurmont, Maria Sapatu, Simon Foale, Ron Vave, Toni Parras, Jovelyn Cleofe, Alifereti Tawake, Wendy Tan, Stacy Jupiter, Pip Cohen, Tom Brewer, Tevi Maltali, James Comley, Victor Bonito, Magali Verducci, Julien Grignon, Semisi Meo and Michael Guilbeaux.

Guide & Information sheets for fishing communities

These guide and information sheets have been produced by SPC (**www.spc.int**) in collaboration with the LMMA Network (**www.lmmanetwork.org**) to assist people working with fishing communities in providing advice on appropriate fisheries management options.

Secretariat of the Pacific Community
BP D5 - 98848 Nouméa Cedex - New Caledonia
Telephone: +687 26 20 00
Facsimile: +687 26 38 18
E-mail: cfpinfo@spc.int

The Locally-Managed Marine Area (LMMA) Network

European Union
Union européenne

SPC CPS

Guide & Information sheets for fishing communities

SPC
Secretariat of the Pacific Community

2011

Information sheets

Guide