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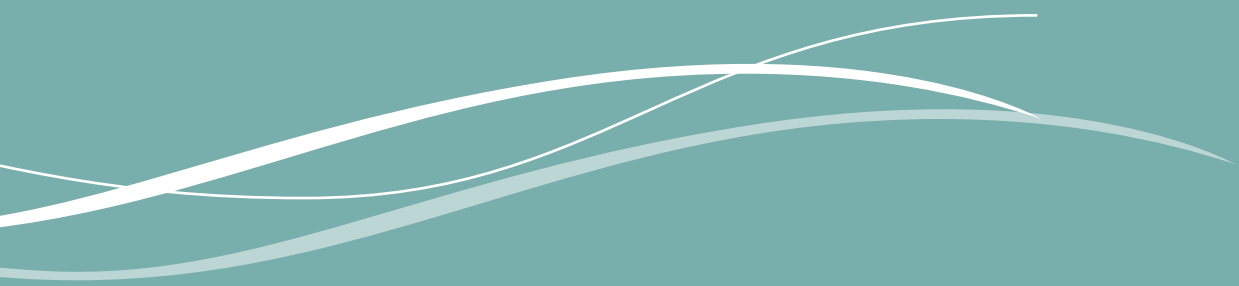
Sea cucumber fisheries:

a manager's toolbox



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K. Friedman, S. Purcell, J. Bell and C. Hair

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Foreword

Sea cucumber fisheries provide an important source of cash income to isolated coastal communities throughout the Pacific islands region through the processing and sale of 'bêche-de-mer'. Regrettably, for many communities these small-scale fisheries no longer yield the benefits they once did due to over-fishing. In areas where there are few other opportunities to earn income, this has resulted in families and, in some cases, whole villages suffering. The over-fishing has been exacerbated by the sedentary nature of sea cucumbers and the ease with which they can be collected from inshore habitats. Although more remote areas once provided some refuge from fishing for these vulnerable animals, this is no longer the case—these areas are now more readily accessed by divers using better boats and underwater breathing apparatus taking advantage of improved access to markets.

In response to the dire condition of many sea cucumber fisheries today, the Australian Centre for International Agricultural Research (ACIAR) convened the 'Papua New Guinea, Pacific Islands and Northern Australia Sea Cucumber Fisheries Management Workshop', held at Motupore Island Research Centre, Papua New Guinea, 20–23 March 2006. This booklet is a direct outcome of that workshop.

Resource managers need appropriate means to tackle the problem of deteriorating fisheries. This 'toolbox' provides them with easy-to-use decision-making tools to establish the status of local sea cucumber fisheries and identify appropriate management responses. In many places where sea cucumbers are collected, drastic and immediate action is needed. Enough sea cucumbers need to be protected to create the viable groups of spawning adults needed to restore and regularly replenish this valuable resource. Practical management systems to rebuild over-fished stocks, and to maintain those that are still in good condition, are also outlined here. This toolbox will be a valuable aid for fisheries managers, scientists, non-government organisations and all those engaged in promoting better use of the region's precious sea cucumber resources.

Peter Core
Chief Executive Officer
ACIAR

Acknowledgments

This toolbox stems from the 'Papua New Guinea, Pacific Islands and Northern Australia Sea Cucumber Fisheries Management Workshop', which was held at Motupore Island Research Centre on 20–23 March 2006. The workshop was supported by funding from the Australian Centre for International Agricultural Research (ACIAR).

Kim Friedman (Secretariat of the Pacific Community), Warwick Nash (WorldFish Center) and Barney Smith (ACIAR) were instrumental in the planning of the workshop. Subsequently, staff at SPC's Reef Fisheries Observatory and Planning Section (Kim Friedman, Johann Bell) and WorldFish Center (Steve Purcell), in conjunction with Cathy Hair (James Cook University), worked to create this toolbox, incorporating many of the ideas that had been discussed.

The other participants in the workshop (and other important contributors) were Dennis Ah-Kee, Mark Baine, Mikkel Christensen, Claudia Hand, Leonie Jenkins, Jeff Kinch, Presley Kokwaiye, Paul Lokani, Neil Loneragan, Alistair McIlgorm, Phillip Polon, Garry Preston, Chris Ramofafia, Tim Skewes, Satarak Taput and Wete Zozingao.

We thank them all for the fruitful discussions that helped us distil their collective thoughts into the indicators for assessing the health of sea cucumber fisheries, the 'best practice' management tools, and the measures needed to rebuild severely depleted stocks that are contained in this toolbox.

Thanks also to Youngimi Choi for work on the illustrations.

SPC
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of the Pacific
Community

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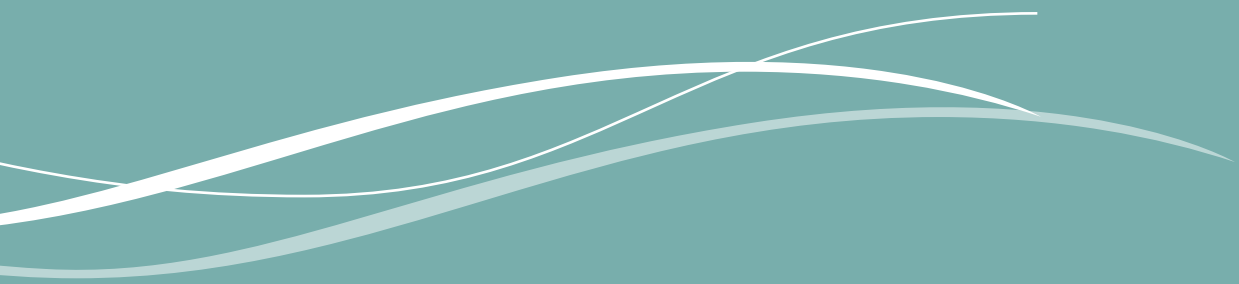


Overview

The way people fish for sea cucumbers is changing rapidly. Traditional methods for catching sea cucumbers, such as gleaning on reefs at low tide or diving in shallow waters, are being replaced by the use of larger boats, diving equipment and bottom dredges. These changes allow fishers to collect most of these slow-moving animals easily, even in remote places and deep-water locations, causing widespread over-fishing of sea cucumbers.

Over-fishing is also being driven by the increasing need for cash in rural areas of the Pacific. Bêche-de-mer, produced by boiling, drying and smoking sea cucumbers, is a valuable commodity, so there are strong incentives for villagers to catch and sell sea cucumbers for income to meet their needs.

Sea cucumbers are also prone to over-fishing because of their biology. Many species grow slowly and, due to natural variability, populations are likely to have both good and poor breeding years. This means that it can take a long time for stocks to be replenished after heavy fishing.

The widespread over-exploitation of sea cucumbers is leading to a collapse of stocks. Sea cucumbers are sedentary marine invertebrates that shed their eggs and sperm into the water column. When they are over-fished below a certain (threshold) density, they cannot reproduce effectively because the males and females are too far apart for fertilisation to be successful. When this happens to any species of sea cucumber, it will eventually disappear from an area, taking the livelihoods of coastal villagers with it.

This toolbox is designed to help managers and fishers check the ‘health’ of their sea cucumber fishery. It also summarises management measures that can be used to maintain the condition of healthy fisheries and restore those that have been damaged.

The need for better management

Historically, boats from Asia visited Pacific countries to trade for bêche-de-mer, but the visits were irregular and often separated by long periods of time. This meant that stocks of sea cucumbers usually had time to recover before the next visit, and there were areas in each country that

remained unfished. Today, the situation is very different, with many of the coastal villages in the Pacific having an agent for businesses that buy bêche-de-mer. Fishers now harvest more frequently over wide areas and can sell bêche-de-mer all year round. Stocks that are over-fished have little chance to recover.

In an ideal world, fishers would stop harvesting sea cucumbers when their densities became too low, allow the stocks to recover, and then start fishing again. Recent studies show that this is not happening in many places. On the contrary, fishers often harvest sea cucumbers to local extinction. In Egypt the sea cucumber fishery collapsed completely in 2002 after only 4 years of heavy fishing. At Chuuk Atoll in the Federated States of Micronesia stocks of sea cucumber fished intensely in the late 1930s had still not recovered 50 years later. In Papua New Guinea too, some stocks have disappeared after the local breeding populations were depleted.

Protecting the vitality and value of sea cucumber fisheries requires a conservative management approach. The benefits of good stewardship will be regular harvests, greater biodiversity, healthier coastal and reef ecosystems, and economic benefits for current and future generations.

How to use this toolbox

This toolbox has four sections.

Section 1 asks how familiar you are with your fishery. It illustrates the life cycle of sea cucumbers and some of the species you might find in your area.

Section 2 helps you to check the 'health' of your fishery. You will be asked a series of 'indicator questions' that, taken together, will help define the condition of the stocks. Each indicator is accompanied by case studies and a guide on how to obtain the information you need to answer the question. At the end of the six questions, you can review all your answers at the decision stage to identify the general condition of the fishery.

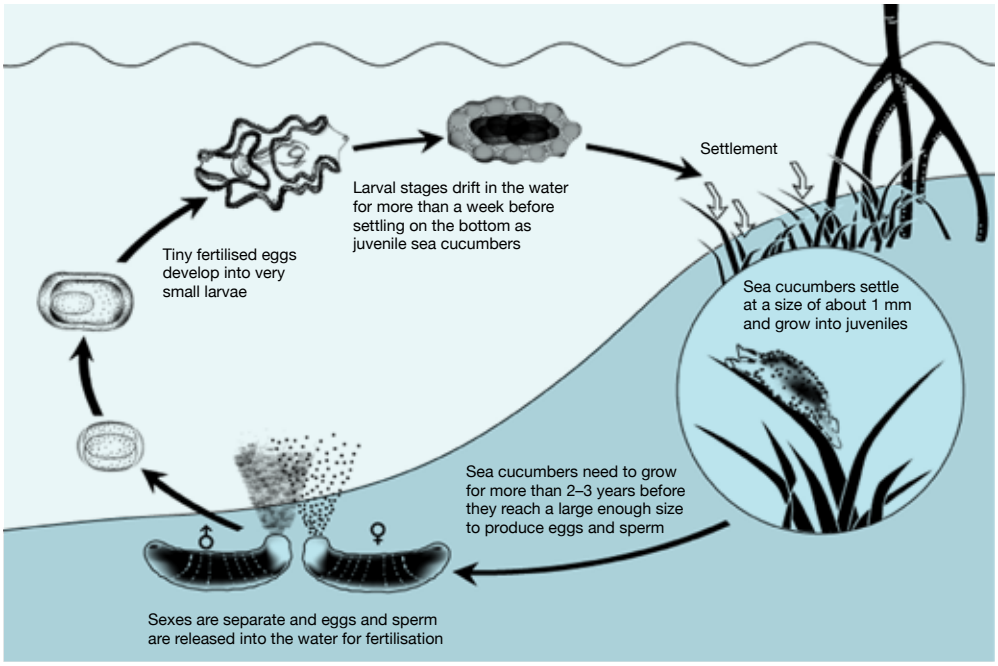
Section 3 and **Section 4** provide 'best practice' management options for maintaining sustainable harvests from a healthy fishery or restoring a severely depleted one.

There is a reference information list that provides contacts for management and scientific advice, as well as details of literature and websites for further reading.

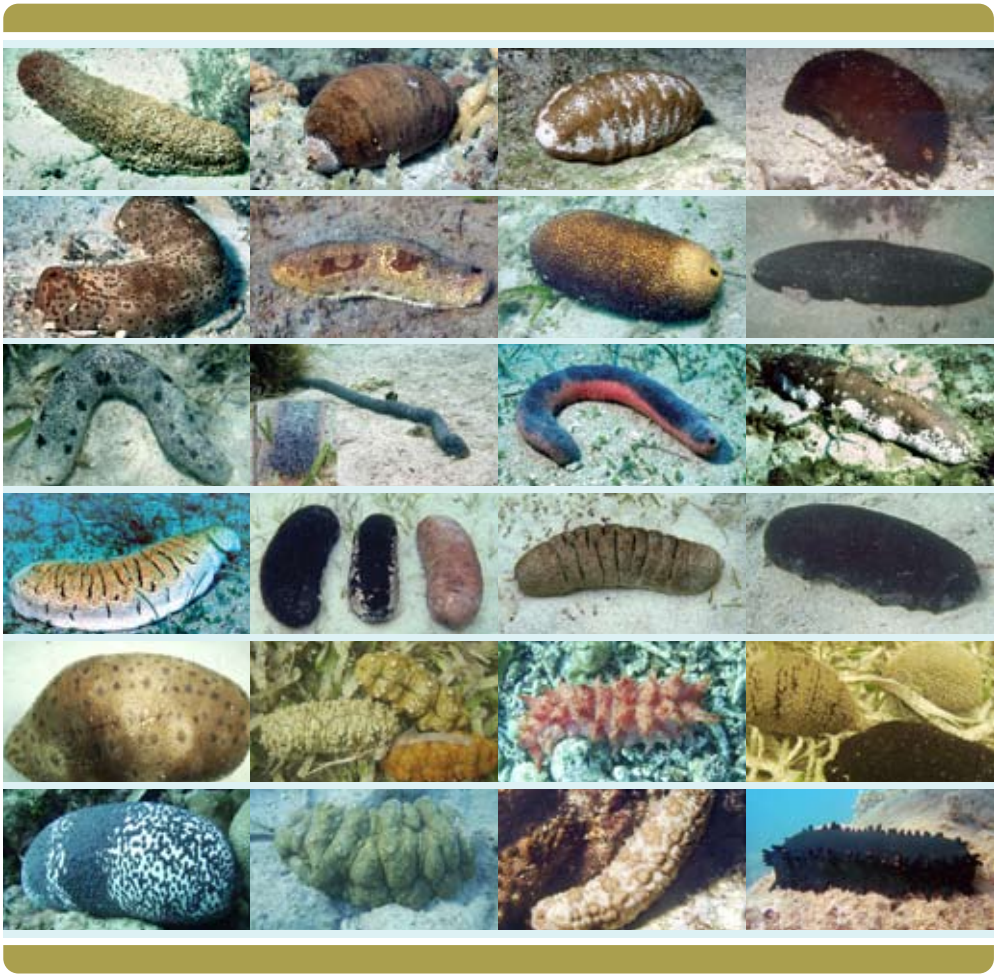
Do you know your fishery?

Before you start the 'health check', you should make sure you can answer the following general questions about your fishery. You will then be ready to answer the more specific indicator questions in Section 2.

- How do sea cucumbers live, reproduce and grow?
- Do you understand the 'natural factory' (the life cycle in the diagram below) that allows breeding adults to supply new generations of sea cucumber to local waters?



Life cycle of sea cucumber (based on sandfish example)
Source: adapted from Battaglene (1999)

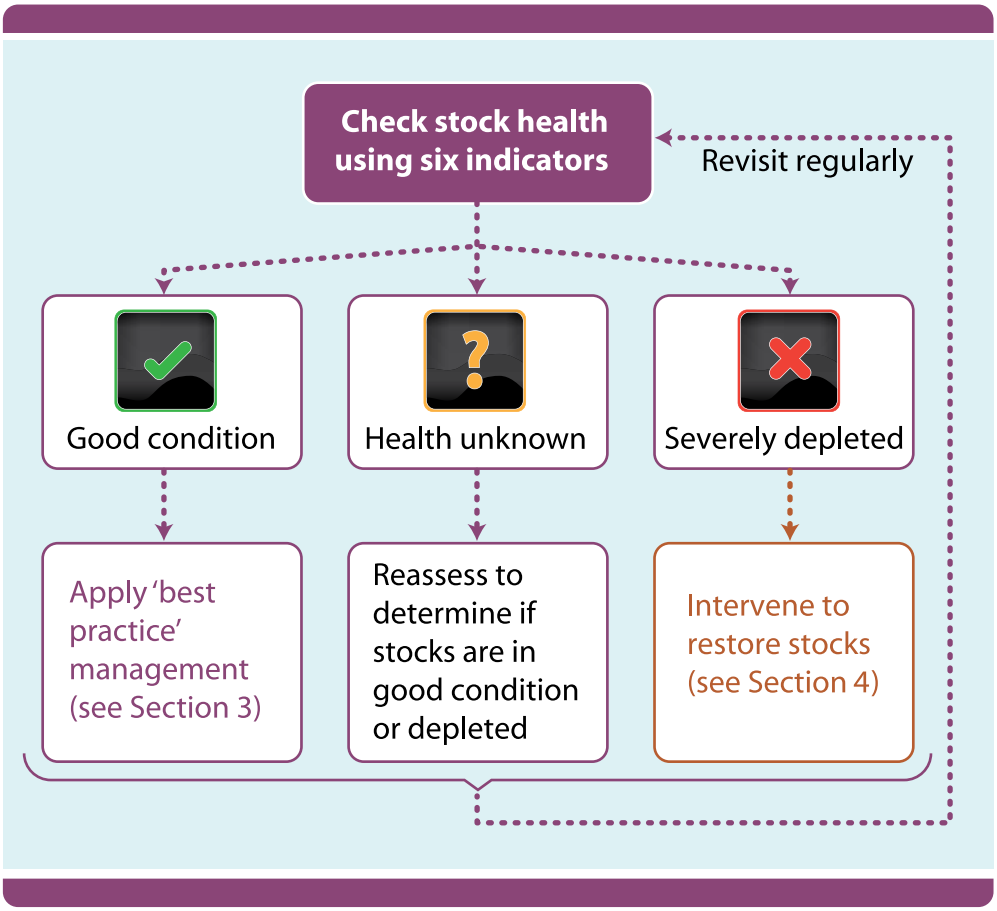


For an illustrated poster of sea cucumber species from the tropical Pacific, see Purcell et al. (in press).

- Which species are harvested?
- What areas do they come from?
- How are they caught?
- Who catches them?
- Which species have declined in abundance?
- Where do they live—on the reef, in deeper water, in mangrove or seagrass habitats?
- Are they high-value or medium-value species?
- How does the money earned from selling sea cucumbers benefit communities?
- What management 'tools' are in use? Are they working?

How healthy is your fishery?

Use the steps in the flow chart below to check the health of your sea cucumber fishery.



INDICATOR 1 – Presence of breeding groups

Are there still areas where adult sea cucumbers remain protected near the main fishing grounds?

Yes – For each of the main species in my fishery, there are still some relatively dense populations on reefs or in lagoon areas.

No – There are few, if any, relatively dense patches of each species in my fishery.

Importance of this indicator

Sea cucumbers reproduce by releasing their eggs and sperm into the water column. The eggs develop into microscopic larvae that drift in currents for weeks. The tiny juveniles then settle into shallow coastal habitats where they can hide from predators and grow into adults. This is the 'natural factory' that produces new generations of sea cucumbers and replenishes stocks (see diagram in **Section 1** and **Section 3.2** for more information on the life cycle of sea cucumbers).

Some areas with relatively dense numbers of adults (e.g. >100 individuals per ha in the case of sandfish) are needed to produce enough eggs to make the natural factory work. Otherwise, spawning adults cannot find each other easily and fertilisation of the eggs is poor. The areas where dense patches of sea cucumber are likely to occur are in marine reserves or 'taboo' areas where fishers tend not to harvest.

Case study (Australia)

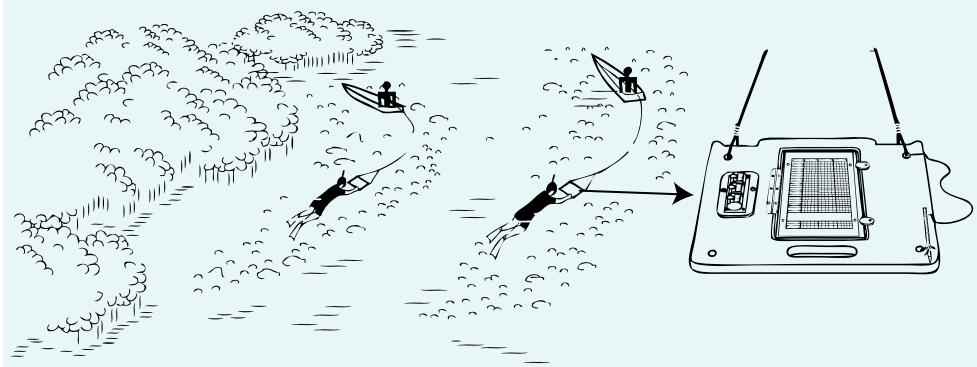
Even sea cucumber fisheries managed with ample resources, such as the one on Australia's Great Barrier Reef (GBR), have been over-fished. To prevent over-exploitation of sea cucumbers and the many other commercial fish species on the GBR, the authority responsible protected 30% of the reef from fishing. This measure will help ensure that dense patches of sea cucumber are protected as breeding groups to replenish fishing grounds.

Case study (New Caledonia)

Along the main island of New Caledonia (La Grande Terre), there are now few sites outside marine reserves and areas under strict customary protection that have high densities of sea cucumber. However, the fishery is still reasonably productive, indicating that the protected places contain enough adults to replenish stocks of sea cucumber regularly.

Finding the information

- The best way to verify this indicator is through rapid underwater visual censuses of sea cucumbers. This can be done using a 'manta technique' to estimate population densities over broad areas within the fishery (see figure below). A snorkeller is towed behind a boat and uses a hand-held 'manta board' as a writing slate to record information.
- Interview fishers to ask them if they know where sea cucumbers can still be found in high densities.
- Seek help with surveys from the Secretariat of the Pacific Community (SPC) and non-government organisations (NGOs) because they are often well placed to advise and conduct surveys.



Manta board surveys can be conducted along coastal and lagoon reefs to determine sea cucumber densities.

INDICATOR 2 – Fishing gear used

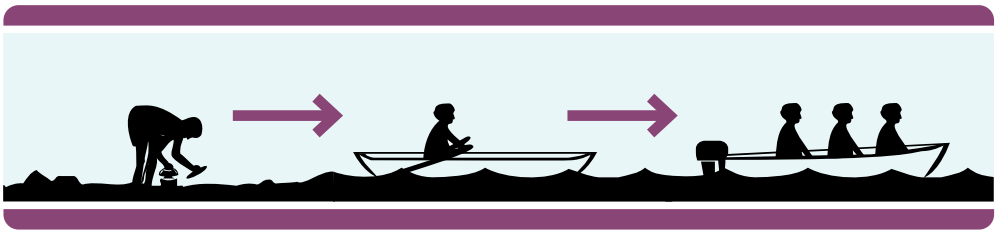
Are small-scale, traditional fishing methods mostly used to harvest sea cucumbers?

Yes – Fishery methods have not changed—they are generally small-scale and active mostly in shallow water.

No – Fishery methods are more motorised and organised—they use new gear and are more active in deeper water.

Importance of this indicator

Fishers have changed their methods from wading in the shallows to the use of sail and paddle canoes, and dinghies with outboard motors. This has resulted in greater coverage of the area where sea cucumbers live, more regular fishing, access to remote areas and the capacity to transport greater catches. Loss of much larger numbers of sea cucumbers from many areas as a result of this increased fishing pressure reduces the chances of adults remaining at densities high enough for effective reproduction. When sea cucumbers are 'thinned out' by over-fishing, they are not always able to find mates to breed with during the spawning season.



Changes in fishery methods

Case study (Solomon Islands)
Traditionally, sea cucumbers were harvested in Solomon Islands by gleaning at low tide or by free diving with 'eye glasses' (a mask). However, over the past 10 years, diving at night with torches, and the use of 'bombs' (a small spear below a lead weight tethered to a line and float), hookah and dredge nets, have increased catches both across the country and down to greater depths. The use of hookah has also claimed the lives of divers and increased the incidence of decompression sickness. Even repeated deep diving on snorkel can be fatal as it can cause divers to 'black-out'.

Finding the information

- Make independent observations of the equipment and types of boats used by fishers.
- Determine what proportion of fishers still use traditional methods and fish from simple canoes or the shore.

INDICATOR 3 – Sea cucumber abundance

Are the abundances of sea cucumbers in the fishery stable?

Yes – Fishers are finding sea cucumber as easily as they did years ago.

No – Fishers and agents are having difficulty finding sea cucumbers.

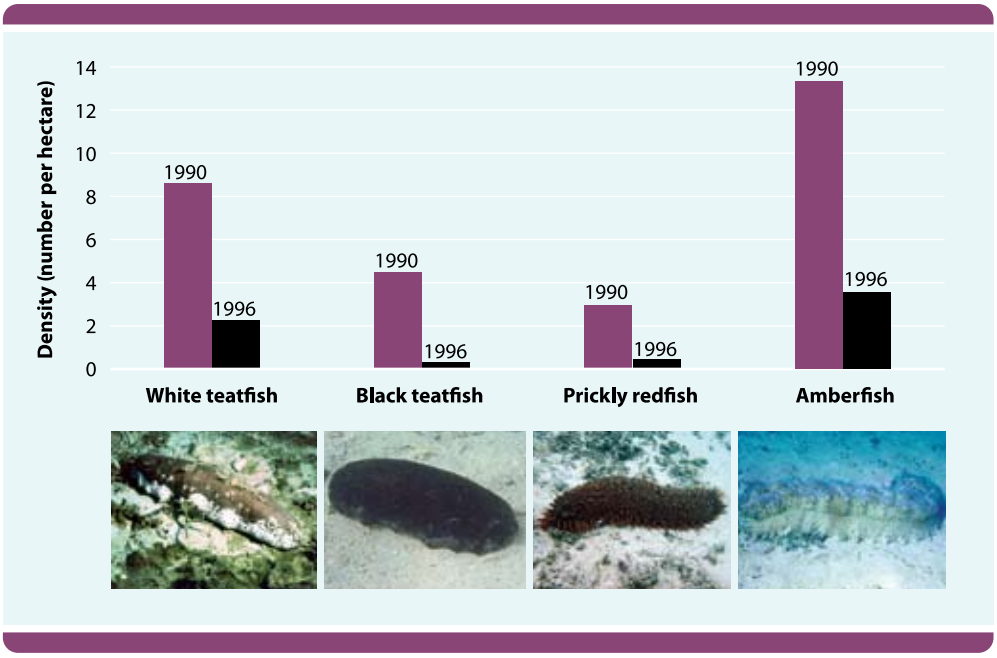
Importance of this indicator

Over-fishing of valuable sea cucumbers is being reported from many countries in the Pacific. In some cases (e.g. in Tonga, Samoa, Australia, Vanuatu and Solomon Islands) it is so severe that fisheries have been closed to allow stocks to recover.

Large declines in abundance and related fishery closures cause hardship to communities who rely on sea cucumbers for income. When abundance falls to very low levels, fishers may need to wait for many years until stocks are healthy enough to replenish themselves regularly and support some fishing again.

Case study (Tonga)

Unsustainable heavy fishing between 1990 and 1996, which reduced the density of several species of sea cucumber (see graph right), caused managers to close the fishery in 1997. It remained closed for more than 10 years.



Decrease in density of sea cucumbers in Tonga following heavy fishing between 1990 and 1996

Finding the information

- Interview fishers about their past and present catch rates and use this information to compare historical and current catch per unit effort.
- Use any past and recent data on the density of the main species from surveys, and any records from exports, to determine if there have been any local depletions.

INDICATOR 4 – Ratio of species abundance

Are high-value and medium-value species still abundant and well represented in catches?

Yes – High-value and medium-value species are relatively abundant and make up a significant proportion of the catch or exports.

No – Most of the sea cucumbers caught are low-value species.

Importance of this indicator

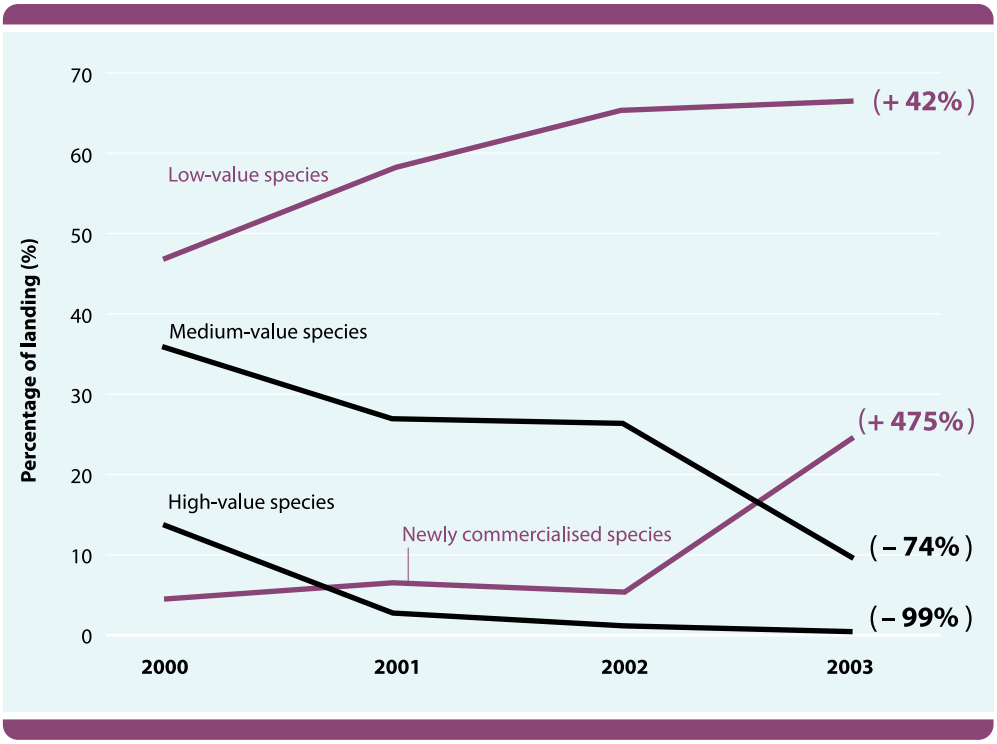
In healthy fisheries high-value species (e.g. sandfish, black teatfish, white teatfish) and medium-value species (e.g. blackfish group, surf redfish, prickly redfish) represent at least one-quarter to one-half of the total catch. If populations of these species are over-fished, fishers turn to lower value or 'new' species (e.g. greenfish, elephant trunkfish, leopardfish (tigerfish), brown sandfish, lollyfish, chalkfish) or need to use scuba or hookah methods to fish deeper. Changes in the composition and relative abundance of species are therefore a good indicator of over-fishing.

Case study (Papua New Guinea)

In Papua New Guinea the high- and medium-value species have been progressively over-fished in recent decades. There are now at least 26 species of sea cucumbers harvested, mostly of low value.

Case study (Solomon Islands)

A similar trend is reported from Solomon Islands (see graph right). The number of species exported increased from 15 in 1988 to 32 in 2004, with the additional species being of low market value. The original and 'newly commercialised' low-value species dominated catches prior to the fishery being closed recently. As a result, the price per kilogram of bêche-de-mer exported has declined steadily.



Variation in ratio of value groups of sea cucumber exported from Solomon Islands between 2000 and 2003

Finding the information

- Check bêche-de-mer export records to look for trends in the number of each species caught and its proportion of total exports.
- Use underwater visual censuses to determine the proportion of high-value and medium-value species of sea cucumbers at important fishing grounds.

INDICATOR 5 – Size of sea cucumbers

Are large-sized sea cucumbers still caught? Is mostly 'A' grade bêche-de-mer produced?

Yes – For most species, large-sized individuals are caught and sold.

No – For most species, small sizes dominate catches and exports.

Importance of this indicator

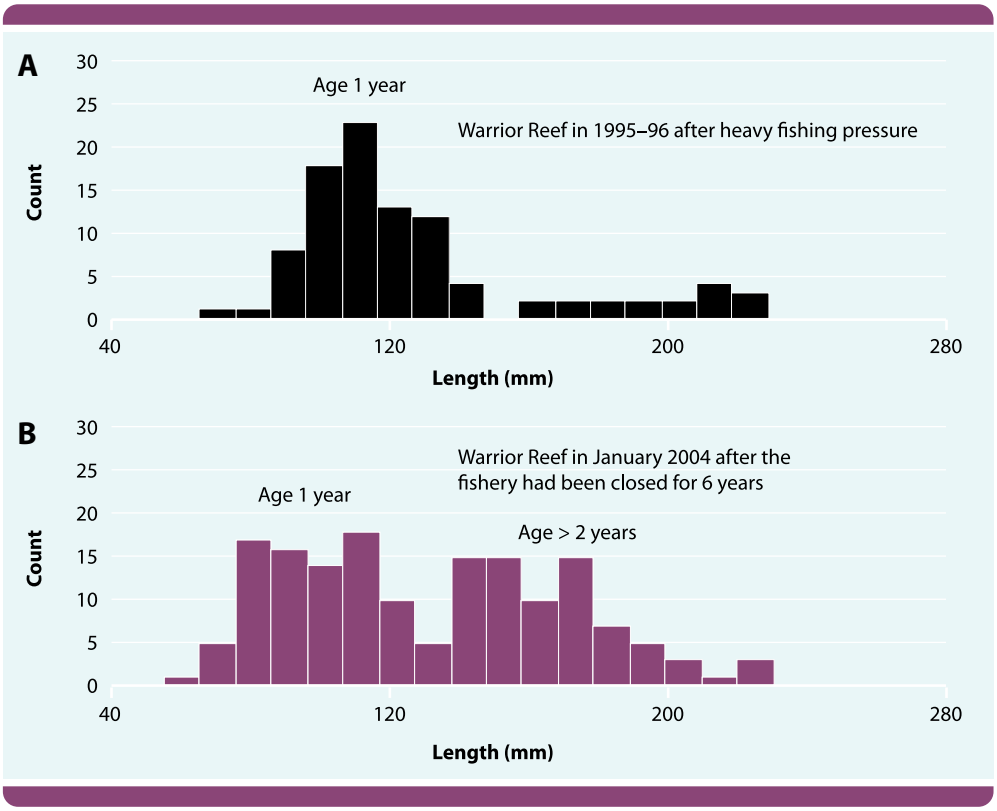
One of the first signs that sea cucumbers have been over-fished is that the large animals disappear from catches. When this happens, fishers are no longer maximising their potential sustainable earnings because large sea cucumbers are needed to produce 'A'-grade bêche-de-mer. If the majority of sea cucumbers is not left in the water to reach adult size, replenishment of the stock is unlikely to occur.

Sea cucumbers processed as bêche-de-mer—large-sized 'A'-grade bêche-de-mer is seen at left.

'A'-grade bêche-de-mer produced from sandfish would comprise up to 15 pieces to the kilogram (kg). Examples of 'A'-grade product (based on dry weight) for other species would be 2–3 pieces per kg for white teatfish, 3 per kg for black teatfish and prickly redfish, and up to 20 per kg for surf redfish, curryfish and stonefish.

Case study (Warrior Reef, Torres Strait)

After 3 years of unsustainable fishing pressure on sandfish at Warrior Reef, most of the larger, mature animals had been removed (graph A below). In 2004, after the fishery had been closed for 6 years, the population had a higher proportion of mature animals (graph B).



Population length profile of sandfish recorded at Warrior Reef in 1995–96 and 2004. Source: T. Skewes

Finding the information

- Examine export records to see if there has been a decrease in the proportion of 'A'-grade product.
- Measure the average size of each species in representative catches each year and examine the trends.

INDICATOR 6 – Profit to fishers

Do the benefits from the fishery flow mainly to fishing communities?

Yes – Local people do the fishing and the processing of sea cucumbers into bêche-de-mer.

No – People in villages are not the main ones profiting from the fishery. Fishing is done mainly by groups of divers on wages. Villagers usually sell sea cucumbers to agents who process them.

Importance of this indicator

In traditional communities the majority of the local people who fish for sea cucumbers process them into bêche-de-mer themselves. This spreads income throughout the village.

If fishers begin to sell their catch to other people to process, there is the risk of over-fishing because they then need to catch more sea cucumbers to make the same amount of money that they did by processing their catch themselves. A similar situation arises when villagers join larger crews to fish for sea cucumbers on wages.

Case study (New Caledonia)

Since 2002, fishing practices in New Caledonia have evolved to be dominated (in terms of total catch) by organised fishing businesses. They operate from large boats for week-long trips and use teams of divers to collect sea cucumbers. Offshore reefs, previously too remote to fish, are particularly targeted. Commonly, the boats return to harbour with many tonnes of salted sea cucumbers from 1 week of fishing. Some artisanal fishers have also been encouraged by processors to sell their catch to them as salted product, which eliminates the value-adding component of processing locally.

Finding the information

- Determine where sea cucumbers are being processed.
- Maintain a record of sea cucumber fishers so you know how many participate in the fishery.
- Contact agents or bulk processors and find out if freshly collected, salted or dried sea cucumbers are bought.
- Use questionnaires and interviews to determine what proportion of the income from bêche-de-mer goes to the fishers and how much goes to processors and exporters.

Transition from artisanal to industrial processing. Left: artisanal sea cucumber fishers with home-dried bêche-de-mer. Right: racks of bêche-de-mer being sun dried at a processing plant.

DECISION STAGE

What do your answers from the six indicator questions tell you about the 'health' of your fishery?

INDICATORS		✓	✗
1	Presence of breeding groups	☐	☐
2	Fishing gear used	☐	☐
3	Sea cucumber abundance	☐	☐
4	Ratio of species abundance	☐	☐
5	Size of sea cucumbers	☐	☐
6	Profit to fishers	☐	☐

Mostly ticks – Stock status is good
No drastic action required.
Review and implement 'best practice' management advice **(Section 3)**.

Mostly crosses – Stocks are severely depleted
Immediate and strong action required.
Implement advice from **Section 4** to protect remaining breeding populations of sea cucumbers. Use **Section 3** as a reference for general management.

Not sure?
Immediate action required.
Follow advice from **Section 4**. Assume stock is depleted until you are sure about the answers to the toolbox indicators.

‘Best practice’ management

The following management tools provide practical management options for maintaining sustainable harvests from a healthy fishery.

3.1 Communicate with all stakeholders

Good management of sea cucumber fisheries depends on cooperation of all stakeholders, including fishers, processors/buyers, exporters, conservation bodies, government bodies, surveillance staff and NGOs.

Managers should help communities understand how the ‘natural factory’ that produces sea cucumbers works (see life cycle figure in **Section 1**) and the effects of over-fishing. Communities can then see for themselves how the production cycle can be broken, and how to modify fishing to sustain their livelihoods.

Regular communication with fishing communities to reinforce these messages and discuss practical local management arrangements is essential.

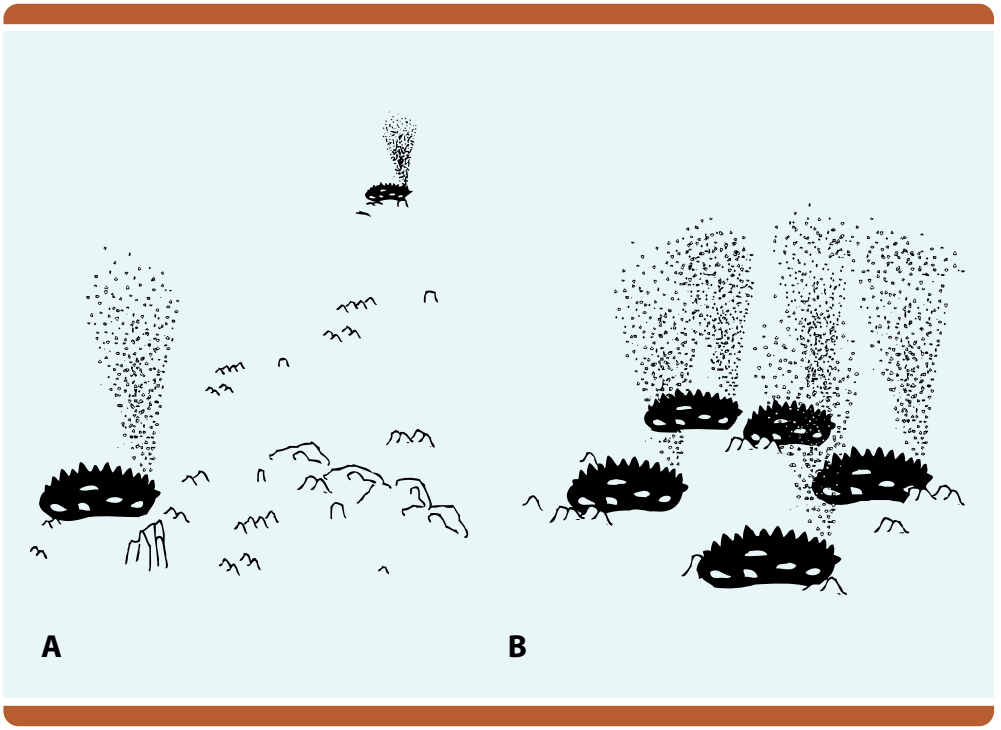
ACTION NEEDED

- **Identify all stakeholders** in local sea cucumber fisheries and establish relationships with their representatives.
- **Organise meetings with all stakeholders** to discuss how best to assess and manage their fishery.
- **Train fisheries staff, extension officers and NGOs** in how to help communities understand how the ‘natural factory’ produces sea cucumbers, and the effects of over-fishing.
- **Produce simple information resources** such as posters and booklets to help educate communities. (Useful extension materials are often available from SPC, SPREP and other regional organisations—see last page for contacts.)
- **Inform high-level decision-makers** as soon as concerns arise, and provide them with as many solutions as are possible.

3.2 Protect spawning adults

The 'natural factory' that produces sea cucumbers will break down if mature adults are too far apart to reproduce successfully. Over-harvesting to such levels will cause local fisheries to collapse.

The steps that managers and stakeholders can take to maintain sea cucumbers at the densities needed for successful reproduction are set out below.



Sea cucumbers are separate male and female individuals. If adults are too far apart (A), they cannnot reproduce successfully. They need to be in close proximity for successful breeding (B).

ACTION NEEDED

- **Declare and enforce no-take zones** in areas where sea cucumbers are known to spawn to protect adequate numbers of adults. If permanent no-take zones are difficult to establish, use temporary or rotational fishing closures for periods of 5–10 years instead. The larvae produced in no-take zones will replenish nearby fishing grounds. Ask scientists to advise on the number and size of no-take zones needed (see last page for contact details).

- **Apply minimum size limits** to sea cucumbers outside no-take zones so that they can reproduce before they are harvested. Size limits also help fishers earn more for each sea cucumber they catch (see **Section 3.4**). Size limits should be applied to processed (dried) product at export gateways but fishers should also be provided with corresponding size limits for live animals so that they know which ones to collect. Ask scientists to recommend the appropriate live size (length or weight) limit for each species and then estimate the corresponding size limit for well-processed bêche-de-mer produced from each species.
- **Inspect all exports of bêche-de-mer** to check that they comply with size limits. Impose heavy penalties (including loss of export licence) on exporters who break the rules. Limit the number of enterprises licensed to export to make it easier to inspect all bêche-de-mer leaving the country.
- **Restrict fishing methods** for sea cucumbers. Ban the use of compressed air (scuba and hookah) and small dredge nets. Work with communities to limit, where necessary, night fishing with lights and the use of weighted spears ('bombs'), to protect vulnerable species. These restrictions will help maintain the natural 'refuges' of species created by their distribution and behaviour.

3.3 Promote high-quality processing

The Asian market for bêche-de-mer is very discerning and involves different grades and prices. The best prices are paid for 'A'-grade bêche-de-mer, which is well-processed and presented product of a large size. Fishers will maximise their earnings if they produce 'A'-grade bêche-de-mer because it fetches a higher price per kilogram.

On the other hand, fishers will receive only a fraction of the potential value of their resources if they catch small animals and/or process sea cucumbers poorly. In the worst case scenario, poor-quality bêche-de-mer will be rejected by buyers and the fisher will earn nothing.

ACTION NEEDED

- **Inform fishers about how the markets for sea cucumbers operate.**
- **Arrange training** for fishers in how to process sea cucumbers to produce 'A'-grade bêche-de-mer (see images below). Seek assistance for this training from SPC's Coastal Fisheries Programme and major processors—see last page for contacts.
- **Provide up-to-date price information for different grades of bêche-de-mer** to empower fishers to negotiate fair prices (contact SPC's Coastal Fisheries Programme for regional price lists).

The difference between well-processed (A) and poorly processed (B) bêche-de-mer has a marked effect on its value. Here are leopardfish (tigerfish) (A) and blackfish (B) either correctly (left examples) or poorly (right examples) processed. Photos: E. Aubry and R. Ram

3.4 Develop and implement management plans

The arrangements outlined in this section should be assembled by stakeholders into simple management plans that they all support. The management plans should be implemented at scales that are realistic both for the 'natural factory' that produces the target species of sea cucumbers and for existing systems of local governance.

In addition to identifying how best to appropriately implement the measures outlined in **Sections 3.2 and 3.3**, management plans should specify how to achieve the following outcomes.

Limit access to the fishery. Governments need to confer 'ownership' of resources on the people who harvest them. This will give fishers incentives to collect sea cucumbers in ways that maximise their financial benefits over the long term. Customary marine tenure (CMT) provides the framework for 'ownership' of coastal fisheries resources throughout much of the Pacific. Where CMT is breaking down, communities should be encouraged to strengthen these traditional systems. Where CMT does not operate, managers should develop other ways of dedicating access to coastal areas to local fishing communities.

Safeguard the interests of all fishers in the country. Sea cucumbers in one area may supply larvae to replenish stocks fished by distant communities, and vice versa. All fishers should agree to national regulations (e.g. size limits) designed to sustain sea cucumbers in all areas.

Monitor catches and stocks. Exporters should be required to provide information on the numbers and sizes (or weights) of each species of sea cucumber they buy from each of the main fishing areas. Underwater visual censuses and other indicators (**see Section 2**) should also be used to monitor the status of stocks.

Ensure compliance with size limits and requirements to supply information. This is the single most powerful tool for managing sea cucumber fisheries. Staff from national fisheries agencies must inspect every shipment of bêche-de-mer exported to ensure that it conforms to the size limits. They must also collect the information required from exporters on the number and size of each species. Compliance can be achieved by charging a substantial security deposit for an export licence and confiscating both the deposit and the licence if the rules are broken.

Develop triggers for management interventions. Agreement must be reached on threshold levels for all indicators of the status of a fishery, and the actions to be taken if indicators fall outside these levels. If and when a pre-agreed threshold level is reached, it should 'trigger' the appropriate

management measure. An example of a threshold might be an agreed percentage decline in the average size/weight of an important species in catches from a designated fishing area. A local community example might be the time that fishers take to make reasonable catches. Once the pre-agreed size/weight decline is identified, or the agreed fishing time is exceeded, it is evident that depletion of the fishery is occurring. This should trigger appropriate remedial action, e.g. temporal and spatial closures, until stocks recover in the depleted areas.

Restoration of severely depleted stocks

The following management tools provide practical management options for restoring severely depleted fisheries.

4.1 Situations where some spawning of animals is still thought to be possible

ACTION NEEDED

- **Explain to communities the urgent need to stop all harvesting** of the target species.
- **Impose a moratorium (ban) on exports of over-fished species**, either for the whole country or for just the over-fished areas, provided there will be compliance with local bans. The moratorium should last until the stocks have increased to the level required to reopen the fishery.
- **Conduct regular surveys to determine when target species are restored** to levels where they can be harvested again. Use underwater surveys and interviews with fishers to do this. Seek assistance from scientists to interpret the information.
- **Before reopening the fishery**, ensure that all relevant components of 'best practice' management (**Section 3**) have been put in place. Otherwise, over-fishing will reoccur.

4.2 Situations where densities are too low for any effective spawning, or where no recovery occurs following an extended moratorium

In such situations the measures described in **Section 3** and **Section 4.1** will not help restore production because the sea cucumbers will still be too sparse for mates to find each other and reproduce. Managers and stakeholders must either accept that the fishery has been lost (probably for several decades) or take more active steps to rebuild it.

ACTION NEEDED TO REBUILD A FISHERY

- **Place some of the remaining sea cucumbers from each species group close together in no-take zones** to form spawning aggregations. Each aggregation should have 20–50 individuals placed 2–5 m apart. This technique is still unproven but is expected to be successful in rebuilding stocks for species usually found at high density (e.g. sandfish, surf redfish). These aggregations should only be made in areas where fishers used to catch these species, to ensure the animals have suitable conditions for growth and reproduction.
- **Consider using restocking methods** to form spawning aggregations in no-take zones if the target species is so rare that only a few specimens can be found. Seek advice from scientists to: 1) decide whether it is responsible to collect adults from a stock at another location and translocate them to your area to rebuild a breeding group, and 2) assess the feasibility and cost of hatchery-based restocking activities to re-create spawning populations at a number of locations. (Note that hatchery technology currently exists for only a couple of species, is expensive and has a variable rate of success when juveniles are placed in the wild.)

Reference information

Key contacts for management and scientific advice

Secretariat of the Pacific Community (SPC), Coastal Section, Reef Fisheries Observatory;
email: reeffishobs@spc.int

The WorldFish Center - PO Box 438, Honiara, Solomon Islands;
email: worldfish-solomon@cgiar.org

Other information

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SPC. Sea cucumber booklet is accessible at:
<www.spc.int/coastfish/Fishing/BDM_HdBook18/HdBook18E.htm>.

SPC. Sea cucumber identification guides (cards) are accessible at:
<www.spc.int/coastfish/Fishing/BDM-ID/BDM-IDcards.htm>.

Websites

PROCFish_COFish projects
www.spc.int/donors/procfish/proc_coastal.html

Reef Fisheries Observatory of SPC's Coastal Fisheries Programme
www.spc.int/coastfish/Sections/reef/index.htm

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