FAO
FISHERIES AND
AQUACULTURE
TECHNICAL
PAPER

520

ISSN 2070-7010

Managing sea cucumber fisheries with an ecosystem approach

Cover photograph:
Underwater photograph of an adult brown sea cucumber *Isostichopus fuscus* (Ludwig, 1875) at Santa Cruz, Galápagos Islands, Ecuador; courtesy Steven W. Purcell.

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2010

ISBN 978-92-5-106489-4

Preparation of this document

This paper was prepared from outcomes of the FAO Technical Workshop on "Sustainable Use and Management of Sea Cucumber Fisheries" held in Puerto Ayora, Galápagos Islands, Ecuador, from 19 to 23 November 2007. The main goal of the workshop was to define the structure and contents of a manual aimed at assisting fisheries managers in deciding regulations and processes for the better management, conservation and sustainable exploitation of their sea cucumber fisheries. The group of experts convened for this purpose consisted of Jun Akamine, Poh Sze Choo, Chantal Conand, Eduardo Espinoza, Kim Friedman, Ruth Gamboa, Jean-François Hamel, Alex Hearn, Jeff Kinch, Alessandro Lovatelli, Priscilla C. Martínez, Annie Mercier, María Dinorah Herrero-Pérezrul, Steven Purcell, Verónica Toral-Granda, Sven Uthicke, Marcelo Vasconcellos and Matthias Wolf. The workshop produced a table of "minimum" and "recommended" regulatory measures and management actions advised for fisheries, depending on the status (abundance and sizes) of wild stocks, scale of fishing activities and technical capacity of the management agency. Working groups at the workshop also canvassed brief points on the definitions, uses, limitations and ways of implementing each measure and action. The draft document produced during the workshop was later developed into the present technical paper by Steven Purcell. This document benefited greatly from editorial comments from Kevern Cochrane, Sven Uthicke, Jean-François Hamel, Annie Mercier, Chantal Conand, Kim Friedman, Jeff Kinch and Veronica Toral-Granda.

The Government of Japan is thanked for generously providing the financial support for the workshop and preparation of this technical paper through the Trust Fund Project GCP/INT/987/JPN on "CITES and commercially-exploited aquatic species, including the evaluation of listing proposals".

Abstract

Sea cucumbers are important resources for coastal livelihoods and ecosystems. At least 60 species are fished from more than 40 countries and most of the harvests are processed then exported to Asian markets. Sea cucumbers generally appear to have slow rates of population turnover and are easily harvested in shallow waters in the tropics. With retail prices of up to USD300–500 per kg (dried), exploitation has often been indiscriminant and excessive. Overfishing in recent years has led to local extinction of high-value species in some localities and prompted closures of many national fisheries to allow stocks to recover and to allow more sustainable management plans to be established. Apart from a few developed countries, only a small number of sea cucumber fisheries are currently being managed sustainably.

Sea cucumber fisheries differ greatly in the scale of the fishing activities, status of stocks and the capacity of the management agency. Consequently, some management measures will be appropriate in some fishery scenarios but not others. This document presents a logical framework to assist fishery managers in choosing an appropriate suite of regulatory measures and management actions and elaborates on the uses, limitations and ways to implement them.

This document contains five main sections. The first provides an overview of the biology and ecology of sea cucumbers, the international market for beche-de-mer market, types of sea cucumber fisheries and their global status (i.e. population abundance). The second section summarizes fisheries management principles and approaches, with an emphasis on the ecosystem approach to fisheries (EAF). The third section provides the "roadmap", by way of instructions, flow diagrams and tables, to lead fishery managers along the path of choosing management measures appropriate to their fishery. The fourth and fifth sections discuss the application of each regulatory measure and management action – with *Examples and lessons learned* boxes to illustrate management problems and potential solutions from various fisheries.

Improved management of sea cucumber fisheries is an imperative. It will be best achieved by applying an EAF, in which multiple regulatory measures and management actions are applied in full consideration of the sea cucumber stocks, the ecosystems in which they live and the socio-economic systems that drive exploitation. The commitment of governments, fishery managers and scientists to develop, apply and strictly enforce EAF will be crucial to sustaining sea cucumber populations for current and future generations.

Purcell, S.W.
Managing sea cucumber fisheries with an ecosystem approach.
Edited/compiled by Lovatelli, A.; M. Vasconcellos and Y. Yimin.
FAO Fisheries and Aquaculture Technical Paper. No. 520. Rome, FAO. 2010. 157p.

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Acknowledgements

This publication is based on the outcomes of the FAO international workshop held in the Galápagos Islands, Ecuador, in November 2007 entitled "Sustainable Use and Management of Sea Cucumber Fisheries" and contributions from workshop participants and international scientists.

The Government of Japan is gratefully acknowledged for providing the finanancial means to support the project "CITES and commercially-exploited aquatic species, including the evaluation of listing proposals" (GCP/INT/987/JPN). The funding of this project allowed for the Galápagos workshop and financial support to prepare this document. The Charles Darwin Research Station, Puerto Ayora, Galápagos Islands, is also acknowledged and thanked for hosting the workshop.

Special appreciation is given to the Scientific Steering Committee for this project, comprising Chantal Conand, Annie Mercier, Jean-Francois Hamel, Sven Uthicke and Steven Purcell. These experts provided much of their own time before and after the workshop in guiding the workshop and the formation of this technical paper. Their efforts to proofread drafts of this document and provide editorial comments are greatly appreciated. Thanks are also extended to Kevern Cochrane, FAO Fisheries and Aquaculture Department, who provided valuable guidance and support throughout the implementation of the project.

This document gains special relevance from photographs, example sections and text on "Lessons learned", which were provided by participants of the workshop and other international experts. The source of each contribution is acknowledged accordingly throughout. Workshop participants are acknowldeged in the list of contributors. In addition, we thank the following persons for providing photographs and/or text examples: Lewis Barrett, Garth Cripps, Terence Dacles, Aymeric Desurmont, Mecki Kronen, Marcus Lincoln-Smith, Georgie McKie, Randall Owens, Georgina Robinson, Tim Skewes and Emmanuel Tardy. Ms Tina Farmer and Ms Françoise Schatto, FAO Fisheries and Aquaculture Department, also contributed towards the final production of this document. The graphic layout was prepared by José Luis Castilla Civit.

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Abbreviations and acronyms

ACIAR	Australian Centre for International Agricultural Research
AIMR	Arnavon Island Marine Reserve (Solomon Islands)
AMCA	Arnavon Marine Conservation Area (Solomon Islands)
BC	British Columbia (Canada)
BFAR	Bureau of Fisheries and Aquatic Resources (Philippines)
CC	Consultative Committee
CCC	Coral Cay Conservation
CCRF	Code of Conduct for Responsible Fisheries
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COFI	Committee on Fisheries
CPUE	Catch per Unit of Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEH	Department of Environment and Heritage (Australia)
DoF	Department of Fisheries
DPI&F	Department of Primary Industries and Fishery (Australia)
EAF	Ecosystem Approach to Fisheries
FAO	Food and Agriculture Organization of the United Nations
FMC	Fishing Monitoring Certificate
FPA	Fisheries Prohibited Area
GBR	Great Barrier Reef (Australia)
GBRMP	Great Barrier Reef Marine Park (Australia)
GIS	Geographical Information System
GMR	Galápagos Marine Reserve
GNPS	Galápagos National Park Service
GPF	Governor Permitted Fishery
GPS	Global Positioning System
Harvest MAC	Harvest Fisheries Management Advisory Committee (Australia)
IHSM	Institut halieutique et des sciences marines (Madagascar)
IMA	Inter-Institutional Management Authority
IQs	Individual Quotas
ITQs	Individual Transferable Quotas
IUU	Illegal, Unreported and Unregulated
IVQs	Individual Vessel Quotas
MAC	Management Advisory Council
MASMA	Marine Science for Management (project of WIOMSA)
MFMRD	Ministry of Fisheries and Marine Resources Development (Kiribati)
MMC	Merchant Monitoring Certificate
MPA	Marine Protected Area
MSE	Management Strategy Evaluation
MSY	Maximum Sustainable Yield
NBMP	National Beche-de-mer Management Plan (Papua New Guinea)
NFA	National Fisheries Authority (Papua New Guinea)
NGO	Non-Governmental Organization
NMAC	National Management Advisory Committee
ONETH	Organisation nationale des exploitants des trépangs et holothuries (Madagascar)

PMAC	Provincial Management Advisory Committee
PMB	Participatory Management Board
PROCFish/C	Pacific Region Oceanic and Coastal Development Project – Coastal Component
QBFP	Queensland Boating and Fisheries Patrol
QPWS	Queensland Park and Wildlife Service
RAP	Representative Areas Program
SAR	Special Administrative Region
SCUBA	Self Contained Underwater Breathing Apparatus
SFA	Seychelles Fishing Authority
SFAC	Sea-area Fishery Adjustment Commission (Japan)
SLG	Special Law of the Galápagos
SMR-PAMB	Sagay Marine Reserve-Protected Area Management Board (Philippines)
TAC	Total Allowable Catch
TAD	Transport Authorization Docket
TROM	Target Resource-Orientated Management
TURF	Territorial Use Rights in Fisheries
UAE	United Arab Emirates
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UVC	Underwater Visual Census
VMS	Vessel Monitoring System
WIO	Western Indian Ocean
WFC	WorldFish Center
WIOMSA	Western Indian Ocean Marine Science Association

Executive summary

Sea cucumbers fulfil an important role in marine ecosystems and support fisheries that provide a significant source of employment and income to coastal peoples. From both an ecological and socio-economic perspective, the long-term sustainability of sea cucumber fisheries is of great importance to coastal communities. Unfortunately, sea cucumber stocks have been overfished in many countries as a result of ever-increasing market demand, uncontrolled exploitation and/or inadequate fisheries management.

The status and present management of sea cucumber fisheries was recently reviewed in five large regions of the world (Toral-Granda, Lovatelli and Vasconcellos, 2008) (Section 2.3 and 2.4). Tropical fisheries contribute most to global captures and involve many species (often 10 to 35) with varied ecological and biological traits. These fisheries are often artisanal or small-scale, typified by fishers gleaning on sandflats or free-diving on shallow reefs and have operated for more than a century, albeit in a boom-and-bust fashion. In many developing countries, fishing by women and children is significant. Sea cucumbers are sometimes eaten locally, whereas the majority are boiled, dried and exported to the distribution hubs in Asia.

Overexploitation in many tropical fisheries has left stocks depleted and fishers have shifted to low-value species, leading to serial depletion. The collapse of breeding stocks has led to recent moratoria (fishing bans) being placed in fisheries of Costa Rica, mainland Ecuador, India, Mayotte (France), Panama, Papua New Guinea, Solomon Islands, mainland Tanzania, Tonga, Vanuatu and Venezuela. Fisheries agencies of tropical countries often lack the technical capacity and resources to develop and adapt complex management regulations and/or to enforce them stringently.

In contrast, most sea cucumber fisheries in temperate waters are industrialized, recent, single-species and involve large boats with sophisticated gear to harvest from deep waters. They also have the benefit of greater technical capacity in the management agencies.

In addition to these disparities, fisheries in each region differ in the governance structure of the management systems. Because sea cucumber fisheries differ on so many levels, it is impossible to prescribe a "one-size-fits-all" solution to improve their sustainability. What is needed, therefore, is clearer information about the utility of various management tools and a framework for deciding which of them to choose for a particular fishery scenario.

A workshop of the Food and Agriculture Organization of the United Nations (FAO) in the Galápagos in November 2007 brought together scientists, sociologists and fishery managers to canvass guidelines for improved management of sea cucumber fisheries. As an output of that workshop, this technical paper is designed to help develop improved and effective management strategies. The Code of Conduct for Responsible Fisheries (CCRF) calls on managers to use the best scientific information available and implement a precautionary approach in the absence of insufficient data (Section 3.1). An ecosystem approach to fisheries (EAF) should be applied, whereby the stock is managed with objectives to also preserve ecosystem integrity and biodiversity and to address the value and use of the resource by a range of stakeholders (Section 3.3).

This technical paper provides decision support through a logical framework, or "roadmap", for planning the most appropriate regulatory measures and actions for implementing management, given the characteristics of the fisheries (Section 4). The regulatory measures and actions include a range of controls and various ancillary measures from stock surveys and socio-economic surveys to strategies that support

local-scale management. Lessons from a diverse array of fisheries illustrate uses and limitations of the proposed regulatory measures and actions.

The roadmap directs managers to firstly categorize their fishery based on the scale of the fishing activities, status of stocks and the capacity of the management agency (Section 4). Simple indicators can be used to gauge the stock status in the absence of underwater (fishery-independent) stock surveys. This categorization leads to recommended sets of regulatory measures and actions for implementing management, which are each explained in separate sections. The formal process of developing this paper, through the Galápagos workshop, established a set of best-practice management measures applicable to most fisheries. It also identified situation-specific measures that may be used in some cases (Section 8.3).

Besides the external factors, the life-history traits of holothurians make them especially vulnerable to overfishing, which poses a great challenge to fishery management (Section 2.1). They can have low or infrequent recruitment, high longevity and density-dependent reproductive success. Most sea cucumber fisheries fall in the class of "S-Fisheries": small-scale, spatially-structured, targeting sedentary stocks (Section 3.5). Classical fisheries models to estimate maximum sustainable yields (MSY) of stocks are not applicable in these types of fisheries (see Section 5.4).

The most important actions for fisheries managers are sociological in nature, pointing that management of sea cucumber fisheries must embrace social science more strongly than in the past. This can be achieved with greater involvement of stakeholders and capacity building of local-level institutions (Sections 6.2.1, 6.2.2 and 6.6).

Fisheries with healthy or fully-exploited stocks of sea cucumbers should apply a broad suite of management regulations and actions, in harmony with an EAF. Agencies with adequate capacity for developing management plans and enforcement should strive for best practice by adopting all recommended regulatory measures and actions for implementing management, where appropriate (Section 4). Agencies with modest capacity should at least apply a minimum set of the most important and simple of these. Regardless of whether the fishery type is industrialized or small-scale, the management plan should comprise at least the following minimum regulations (i.e. regulations imposed on fishers, processors and traders) and actions (by the manager):

Regulations	– Minimum legal size limits (Section 5.1) – Gear limitation (Section 5.2) – Permanent Marine Reserves, excluded from fishing (Section 5.7.1) – Place-based or user-based access rights to fish (Sections 5.3 and 5.7.3) – Licensing, monitoring and reporting along the market chain (Section 5.5)
Actions	– Conduct fishery-independent stock surveys (Section 6.1.2) – Conduct fishery-dependent surveys of catch and effort (Section 6.1.3) – Conduct socio-economic surveys (Section 6.1.4) – Educate and communicate with stakeholders (Section 6.6) – Improve the quality of processing through training (Section 6.7)

Some regulatory measures, such as rotational fishing closures and individual transferrable quotas (ITQs), will be easiest to implement in fisheries with relatively few fishers and strong capacity for planning, monitoring and compliance (Sections 5.7.2 and 5.4). Quotas have been difficult to enforce in developing countries (Section 5.4). ITQs have merit for building greater sense of responsibility in fishers for the sustainability of stocks but, again, encounter limitations in developing countries with thousands of

village-based fishers. Alternatives such as territorial use rights in fisheries (TURFs) for whole fishing communities may be a solution (Section 7.7.3).

Fully-exploited fisheries need more regulations, and managers need to take more actions, to circumvent the depletion of breeding stocks. The additional measures include gear limitations, the establishment of management advisory committees and support to institutional arrangements for local-scale management (Sections 5 and 6). Management agencies with greater technical capacity and human resources should apply further regulations and carry out more actions, specific to the fishery scenario. The uses, constraints of implementation and alternatives of these complimentary measures are discussed at the end of this technical paper (Section 8.3).

Depleted fisheries need to be managed quite differently in order to restore breeding populations. Moratoria (fishing bans) should be imposed across the fishery and trade should be closely monitored (Section 5.6.2). Managers also need to monitor stocks and communicate with actors along the market chain. Restocking should only be considered as a last resort to rebuild breeding populations and only for agencies with the technical capacity to develop and conduct responsible restocking programmes (Section 6.8). Recent sea ranching and sea farming programmes may improve wild fisheries by routinely creating dense breeding populations in coastal habitats.

International agreements to control the trade of sea cucumbers have advantages and disadvantages (Section 6.3.2). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) may be beneficial for deterring illegal fishing and trade of sea cucumbers and for conserving threatened species. CITES listing could also help in standardizing trade names and codes. Lack of political will is a major impediment to CITES listing and endorsement from countries. The key concerns are that CITES listing of sea cucumbers would raise administrative costs of monitoring and reporting and would spur exporters to trade illegally.

There are many gaps in our current knowledge of sea cucumber biology and fisheries. Nonetheless, this technical paper stresses that uncertainty should not prevent the development of operational management strategies that aim to maintain or rebuild the productive capacity of sea cucumber fisheries. Management must also preserve the biodiversity values of fishery ecosystems and safeguard the long-term social and economic benefits to local communities. Fisheries are connected to ecosystems on one end and to socio-economic systems on the other. Commitment of collaboration, constructive dialogues among responsible partners, and participation of fishermen and local communities in the management process are essential to the long-term sustainability of sea cucumber fisheries.

This paper is intended for a wide audience of users: fishery managers, policy officers, development and enforcement agents, educated fishers and special interest groups, and therefore have minimal technical details. Those who wish to know more about the technical details should consult the references cited herein.

Background

From ancient times, fishing has been a major source of food for humanity, a source of cultural identity and a provider of employment and economic benefits to those engaged in this activity. However, it was realized that living aquatic resources need to be properly managed if their contribution to the nutritional, economic and social well-being of the growing world's population was to be sustained.

The 1982 United Nations Convention on the Law of the Sea provided a new framework for the better management of marine resources. The new legal regime of the oceans gave coastal States rights and responsibilities for the management and use of fishery resources within the areas of their national jurisdiction, which cover 90 percent of the world's marine fisheries.

World fisheries have become a dynamically developing sector of the food industry and many States have taken advantage of new opportunities by investing in modern fishing fleets and processing. It became clear, however, that many fisheries resources could not sustain an often uncontrolled increase of exploitation.

Clear signs of overexploitation of stocks, modifications of ecosystems, significant economic losses, territorial disputes among fisher groups and international conflicts on management and trade threatened the long-term sustainability of fisheries and their contribution to food supply. Therefore, the nineteenth session of the FAO Committee on Fisheries (COFI), held in March 1991, recommended new approaches to fisheries management. These embraced conservation and environmental, as well as social and economic, considerations. FAO then developed the concept of responsible fisheries and elaborated a Code of Conduct to foster its application.

Subsequently, the Government of Mexico, in collaboration with FAO, organized an International Conference on Responsible Fishing in Cancún in May 1992. The Declaration of Cancún endorsed at that Conference was brought to the attention of the United Nations Conference on Environment and Development (UNCED) Summit in Rio de Janeiro, Brazil, in June 1992, which supported the preparation of a Code of Conduct for Responsible Fisheries.

The twentieth session of COFI in 1993 examined the proposed framework and content for such a Code. The Code was formulated to be interpreted and applied in conformity with the relevant regulations of international laws and conventions. The development of the Code of Conduct was carried out by FAO in consultation and collaboration with relevant United Nations (UN) agencies and other international organizations, including non-governmental organizations (NGOs).

The Code of Conduct for Responsible Fisheries consists of five introductory articles: Nature and Scope; Objectives; Relationship with Other International Instruments; Implementation, Monitoring and Updating and Special Requirements of Developing Countries. These introductory articles are followed by an article on General Principles, which precedes the six thematic articles on Fisheries Management, Fishing Operations, Aquaculture Development, Integration of Fisheries into Coastal Area Management, Post-Harvest Practices and Trade, and Fisheries Research. As mentioned, the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas forms an integral part of the Code.

The Code is voluntary. However, certain parts of it are based on relevant rules of international law. The Code also contains provisions that may be or have already been given binding effect by means of other obligatory legal instruments amongst the Parties.

The twenty-eighth session of the Conference in Resolution 4/95 adopted the Code of Conduct for Responsible Fisheries on 31 October 1995. The same Resolution requested FAO *inter alia* to elaborate appropriate technical guidelines in support of the implementation of the Code. This technical paper has been developed in this context.