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Report of the

FAO Workshop on Sea Cucumber Fisheries: An Ecosystem Approach to Management in the Indian Ocean (SCEAM Indian Ocean)

Mazizini, Zanzibar, the United Republic of Tanzania, 12–16 November 2012

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Cover photograph: A live specimen *Bohadschia atra*, Chumbe Island, Zanzibar, the United Republic of Tanzania (courtesy of Dr Steven Purcell).

Report of the

FAO WORKSHOP ON SEA CUCUMBER FISHERIES: AN ECOSYSTEM APPROACH TO MANAGEMENT IN THE INDIAN OCEAN (SCEAM Indian Ocean)

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PREPARATION OF THIS DOCUMENT

This report describes the activities and outputs of the workshop entitled “Sea Cucumber Fisheries: An Ecosystem Approach to Management in the Indian Ocean (SCEAM Indian Ocean)”, which was held in Mazizini, Zanzibar, the United Republic of Tanzania, 12–16 November 2012.

This report was prepared by Hampus Eriksson at Stockholm University, Sweden, with contributions and editing from Steven Purcell at Southern Cross University in Australia, Chantal Conand at La Réunion University in France, Nyawira Muthiga at the Wildlife Conservation Society in Kenya, and Alessandro Lovatelli at the FAO Department of Fisheries and Aquaculture, Rome, Italy.

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ABSTRACT

The livelihood opportunity that sea cucumber fisheries provide to many coastal fishers in the Indian Ocean is threatened by widespread overfishing. The five-day SCEAM Indian Ocean workshop was held in November 2012 and brought together fishery managers from 14 countries to provide a forum for sharing knowledge and improving management plans in Indian Ocean sea cucumber fisheries. It followed the format of a similar workshop that was held in the Pacific in 2011. Workshop facilitators first presented background seminars on up-to-date research on fisheries management. The workshop then focused on interactive sessions with workgroup exercises and plenary discussions that helped participants diagnose their fisheries before deciding on appropriate objectives, regulatory measures and management actions. A field day was also included in the agenda to provide hands-on experience in species identification and product processing. The workshop outputs given in this report detail current management practices and constraints in Indian Ocean sea cucumber fisheries and the proposed strategies and research priorities of the participating fishery managers.

RÉSUMÉ

Les pêcheries d’holothuries qui fournissent des revenus substantiels à de nombreux pêcheurs de l’océan Indien sont largement surexploitées. Le groupe de travail de cinq jours, SCEAM océan Indien, a rassemblé des gestionnaires de 14 pays pour partager les connaissances et améliorer les plans de gestion de ces pêcheries dans l’océan Indien. Il a suivi une organisation similaire à celle utilisée pour le groupe de travail océan Pacifique en 2011. Les organisateurs ont d’abord présenté des séminaires de synthèse sur l’état des recherches et la gestion des pêches. Par la suite, le travail a comporté des sessions interactives avec des exercices en groupes, suivis de discussions plénières qui ont aidé les participants dans le diagnostic de l’état de leur pêcherie, avant de décider des objectifs appropriés, des mesures de régulation et des actions de gestion. Une journée de terrain programmée pendant le groupe de travail a permis un apprentissage de l’identification des espèces et des méthodes de traitement des produits. Les résultats du groupe de travail, présentés dans ce rapport, détaillent les conditions actuelles de gestion des pêcheries d’holothuries, et ses contraintes dans l’océan Indien, ainsi que les stratégies proposées et les priorités de recherche pour les gestionnaires qui ont participé à l’atelier.

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The workshop was organized by the Western Indian Ocean Marine Science Association (WIOMSA) and FAO under the FAO/EU SmartFish project of the Indian Ocean Commission. The generous funding support from the Australian Centre for International Research (ACIAR) to cover travel costs for some participants and operating costs of the workshop is gratefully appreciated. Grateful thanks are also given to the Sultanate of Oman, which contributed funds for the workshop operating costs through the Fishery Support Unit within the Indian Ocean Rim Association for Regional Cooperation (IOR-ARC). Thanks are also due to Lilian Omolo and Salum Hamed at WIOMSA for handling the administration of the workshop.

H. Eriksson is grateful to the Department of Ecology, Environment and Plant Sciences at Stockholm University, Sweden, for its support during the planning, organization and reporting of the workshop. S.W. Purcell thanks Southern Cross University and its National Marine Science Centre, Australia, for administrative support to enable the co-organization and co-facilitation of the workshop.

ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
ASCAM	Advances in Sea Cucumber Aquaculture and Management
BDM	bêche-de-mer
BMU	beach management unit
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPUE	catch per unit effort
EAF	Ecosystem approach to fisheries
EIO	Eastern Indian Ocean
FAO	Food and Agriculture Organization of the United Nations
FRP	fibreglass reinforced plastic
GPS	Global Positioning System
HDI	human development index
IHSM	Institute of Fisheries and Marine Sciences (Madagascar)
IUCN	International Union for Conservation of Nature
IUU	illegal, unreported and unregulated (fishing)
KCDP	Kenya Coastal Development Project
MAC	management advisory committee
MASMA	Marine Science for Management
MFW	Minister of Fish Wealth (Yemen)
MPA	marine protected area
MPRH	Ministry of Fishery and Marine Resources (Madagascar)
MSY	maximum sustainable yield
NARA	National Aquatic Resources Research and Development Agency (Sri Lanka)
NCFC	National Coastal Fisheries Corporation (Yemen)
NGO	non-governmental organization
ONET	Organisation des Exportateurs de Trepangs (Madagascar)
SCEAM	Sea Cucumber Fisheries: an Ecosystem Approach to Management
SPC	Secretariat of the Pacific Community
SWIOFC	Southwest Indian Ocean Fisheries Commission
TAC	total allowable catch
TSZ	Tanzanian shilling
TURF	territorial use rights in fisheries
UVC	underwater visual census
WIO	Western Indian Ocean
WIOMSA	Western Indian Ocean Marine Science Association

EXECUTIVE SUMMARY

Across the Indian Ocean, sea cucumber fisheries that serve the Asian dried seafood market are showing signs of significant decline by unsustainable exploitation rates. This situation is worrying because sea cucumbers provide a substantial opportunity for income to people and countries in the region. This undesirable situation can, at least partly, be attributed to insufficient management. To assist sea cucumber fisheries managers in decision-making, the Australian Centre for International Agricultural Research (ACIAR) and FAO have developed pragmatic manuals. The ACIAR manual provides a "managers toolbox" by outlining six indicators that assist in identifying the status of a fishery, and the FAO manual provides a "roadmap" for decision-making about management measures. While these manuals have been widely distributed throughout the tropical world, it was identified that a more hands-on approach was needed to guide managers through the implementation of these manuals. This need was met through the development of a workshop series called "Sea Cucumber Fisheries: an Ecosystem Approach to Management (SCEAM)". The first workshop focussed on Pacific sea cucumber fisheries and was held in Fiji Islands in 2011. This document reports the SCEAM Indian Ocean workshop, held in Zanzibar, the United Republic of Tanzania, in November 2012. Workshop participants were identified and selected on the principle that they had to be managers or senior officers with an intimate knowledge of the fishery in their country. Other criteria were that they could actively contribute to the workshop and be able to influence management change in their fishery following the workshop. Eighteen participants from 16 countries were invited. Fifteen participants from 13 countries attended the meeting owing to three last-minute cancellations.

Prior to the workshop, all participants submitted a data form about their fishery. The information from these forms revealed, among other things, the diversity of fishery operations targeting sea cucumbers in the region and how there are different management needs and capacities in the countries. During the workshop, participants were initially presented introductory seminars on up-to-date research and the ecosystem approach to management in sea cucumber fisheries. The workshop then built on interactive sessions of group discussions and exercises to facilitate learning. After being guided through the ACIAR "toolbox" in a seminar, the participants worked in groups to review the six indicators in the manual to assign a status to their fishery. In this exercise, ten fisheries were classed as overfished or depleted. Only two fisheries were moderately exploited or better. Based on the status that was defined for the fishery, the participants were then guided through the FAO "roadmap" and, in workgroups, decided what regulatory measures and management actions are appropriate for their fishery based on the assigned status. In these exercises, emphasis was placed on the importance of interpreting the manuals in the context of the fishery operations and institutional system in their country. The manuals do not give definitive answers to the problems, but help guide the manager through decision-making. In an exercise to define management objectives, the highest-ranked management objective among the participants was to "maintain/restore abundances of sea cucumbers for future generations".

Plenaries and discussions following the workgroups were an important component of the workshop process. Here, barriers or management challenges identified by participants were discussed. During the final plenary session, key priority research areas to aid management, and training needs to facilitate monitoring and enforcement of regulations, were identified. The regional/subregional movements (fishers and trade) were frequently stated as a challenge that undermined national management, and governance structures that facilitate regional cooperative management were suggested to tackle this challenge. Training needs included identification manuals for live animals (targeting management agencies and researchers) and products (mostly for customs monitoring and enforcement). A major benefit of the workshop was that managers from the region met and shared discussions on common issues. In the post-workshop satisfaction forms, all of the participants responded that the activity had been useful for them – emphasizing that the workshop format helped to guide fishery managers through existing publications and connecting science with policy. Please refer to Annex 5, where country reports authored by the participants are presented.

RÉSUMÉ EXÉCUTIF

Dans l'océan Indien, les pêcheries d'holothuries, pour le marché asiatique de produits marins séchés, montrent actuellement des signes de déclin important, dus à des taux d'exploitation non soutenables. Cette situation est préoccupante, car les concombres de mer procurent une source de revenus substantielle pour les hommes et les pays de la région. Cette situation indésirable peut être, en partie, attribuée à une gestion insuffisante. Pour aider les gestionnaires des pêches dans leur prise de décision, ACIAR et la FAO ont réalisé des manuels pragmatiques. Le manuel d'ACIAR offre une «boîte à outils du gestionnaire», qui définit six indicateurs pour identifier le statut d'une pêcherie; le manuel FAO fournit une «feuille de route» pour aider aux décisions sur les mesures de gestion. Alors que ces manuels ont été largement diffusés dans le monde tropical, il a été identifié qu'une approche plus pratique restait nécessaire pour guider les gestionnaires dans l'utilisation de ces manuels. Ce besoin a été satisfait par l'organisation d'une série de groupes de travail intitulés: *Pêcheries d'holothuries: une approche écosystémique pour leur gestion (SCEAM)*. Le premier atelier, focalisé sur les pêcheries du Pacifique tropical ouest, s'est tenu à Fidji en 2011. Le document présent synthétise l'atelier SCEAM de l'océan Indien, qui s'est tenu à Zanzibar, République-Unie de Tanzanie, en novembre 2012. Les participants ont été identifiés et sélectionnés sur leur fonction de gestionnaire, ou de cadre supérieur, ayant une bonne connaissance de la pêcherie de leur pays. Des capacités à contribuer activement au groupe de travail et à influencer les changements ultérieurs dans la gestion de leur pêcherie ont aussi été déterminants dans ce choix. Sur les dix-huit personnes invitées de seize pays, quinze représentants de quatorze pays (à cause de trois défections de dernière minute) ont participé à l'atelier.

Avant le groupe de travail, tous les participants ont rempli une fiche sur leur pêcherie. Ces fiches ont révélé, entre autres, la diversité des opérations de pêche dans la région, ainsi que la variété des besoins en gestion et de capacité des pays. Au début de l'atelier, les participants ont assisté à des séminaires introductifs sur les recherches actuelles et sur l'approche écosystémique pour la gestion des pêcheries d'holothuries. Ensuite, des sessions interactives ont visé à faciliter les discussions de groupe et à proposer des exercices. Après avoir suivi la présentation du guide d'ACIAR dans un séminaire, les participants ont travaillé en groupes sur les six indicateurs du manuel afin de définir le statut de leur pêcherie. Dans cet exercice, dix pêcheries ont été classées «surexploitées» ou «épuisées». Seules deux pêcheries étaient modérément exploitées. En se basant sur ce statut, les participants ont ensuite été guidés sur la feuille de route de la FAO et ensemble ils ont choisi les mesures de régulation et les actions de gestion appropriées à leur pêcherie. Dans ces exercices, l'accent a été mis sur l'importance de l'interprétation des manuels dans le contexte des opérations de pêche et du système institutionnel du pays considéré. Les manuels ne donnent pas de réponses définitives aux problèmes, mais aident le gestionnaire à la prise de décision. Dans un des exercices pour définir les options de gestion, l'objectif prioritaire retenu par les participants a été: «maintenir/restaurer l'abondance des holothuries pour les générations futures».

Les sessions plénières et les discussions tenues à la suite des sessions de travail, ont été un élément important de l'atelier. Les obstacles ou les défis identifiés par les participants ont été classés et discutés. Pendant la session plénière finale, les thèmes de recherche prioritaires pour aider la gestion, et les besoins de formation pour permettre la surveillance et l'application des règlements, ont été identifiés. Les déplacements régionaux/sous régionaux (pêcheurs et marchés) sont souvent apparus comme des problèmes déstabilisants la gestion nationale. Des structures de gouvernance facilitant une gestion régionale coopérative seraient à mettre en œuvre. Les besoins en formation comprennent des manuels d'identification des animaux vivants (à l'usage des agences de gestion et des chercheurs) et des notices (essentiellement pour les services des douanes et d'exécution des règlements). Un bénéfice majeur du groupe de travail a été la rencontre des gestionnaires et leurs discussions sur des sujets communs. Dans les fiches de satisfaction, remplies à l'issue de l'atelier, tous les participants ont répondu que cette réunion leur a été utile, en insistant sur son organisation qui les a guidés sur les publications existantes en reliant la science à la politique. Il est conseillé de se référer à l'Annexe 5, qui présente les rapports nationaux des participants.

BACKGROUND

1. Sea cucumbers are harvested throughout the world to produce a dried product of its body wall known as “bêche-de-mer” or “trepang”. This product is traded as a luxury food item on the Far East Asian dried seafood market. The high commercial value, the ability to store the product without refrigeration, and the ease of collection in shallow waters make sea cucumber fisheries important sources of income for at least three million fishers in the world (Purcell *et al*., 2013). In the period 2000–2010, African and Asian countries in, and bordering, the Indian Ocean exported nearly 23 000 tonnes of dried sea cucumber to recipient markets, predominantly in Asia (FAO, 2012a). However, the reliability of catch tonnage is challenged by the fact that some countries do not record or report all catches, and clandestine shipments of products are common (Eriksson, de la Torre-Castro and Olsson, 2012). Decline of sea cucumber resources through widespread overfishing is now affecting coastal communities, and potentially coastal ecosystems, around the world (Toral-Granda, Lovatelli and Vasconcellos, 2008). In the Indian Ocean, nearly half of the documented sea cucumber fisheries appear to be operating at unsustainable levels of exploitation with substantial signs of decline (Conand, 2008). In the Comoros, Egypt, Mauritius, Mayotte, Tanzania and Yemen, fisheries have been closed and moratoria placed on exports in an attempt to curb overfishing and uncontrolled harvests. The dire situation of these fisheries, coupled with their importance to people in rural and marginal areas, captures the need to reform management plans and systems to make them more sustainable towards viability of exploitation rates.

2. In the Western Indian Ocean, the recently completed MASMA sea cucumber project (Marine Science for Management programme funded by the Western Indian Ocean Marine Science Association – WIOMSA) was the first concerted effort in the region to gain a comprehensive understanding on a range of aspects relating to this resource (Conand and Muthiga, 2007). This project was well received in the region and brought together researchers from a number of locations and disciplines. Nearly 20 publications, a number of academic theses, oral presentations and posters at symposiums, and two workshops were produced under this project (www.wiomsa.org/masma).

3. At a global scale, FAO has supported the development of improved management systems for sea cucumber fisheries through a multifaceted programme. Two outputs from the programme have been a technical manual on the ecosystem approach to managing sea cucumber fisheries (Purcell, 2010) and a condensed guidebook on putting the approach into practice (FAO, 2010). The documents provide a “roadmap” for developing and implementing better management of sea cucumber fisheries, and complement a previous “toolbox” manual developed by the Australian Centre for International Agricultural Research (ACIAR) (Friedman *et al*., 2008). These manuals have been distributed widely already (see Figure 1). However, the task still remains to assist fisheries agencies to use these manuals to design new and practical management plans to save or restore sea cucumber fisheries. To meet this need, in 2011 FAO commissioned a regional workshop in the Pacific entitled “Sea Cucumber Fisheries: An Ecosystems Approach to Management in the Pacific (SCEAM Pacific)” with the support of the Secretariat of the Pacific Community (SPC), ACIAR and Southern Cross University. At the workshop, which was held in Nadi, Fiji, fishery managers and senior fishery officers from 13 Pacific countries and territories worked through the principles within the ACIAR and FAO manuals to produce sets of management measures and actions for each fishery (FAO, 2012b).

4. The workshop satisfaction forms from SCEAM Pacific indicated that this was a successful format for helping agencies decide on management regulations and actions for implementing an ecosystem approach to fisheries (EAF) for their sea cucumber fisheries (FAO, 2012b). A strategy was developed to hold workshops in the SCEAM format in each major region of the tropical world. Shortly after the SCEAM Pacific workshop had been held in November 2011, FAO and WIOMSA partnered to organize the SCEAM Indian Ocean workshop.

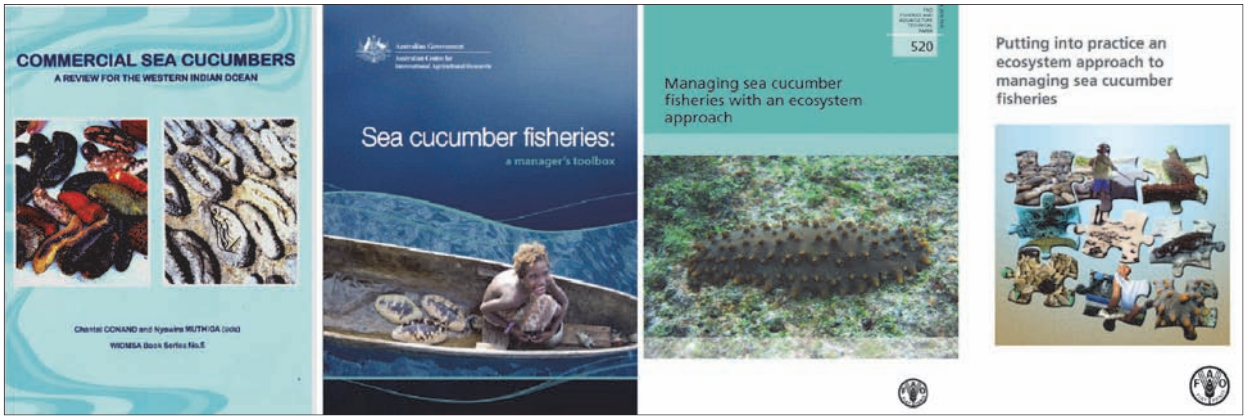


Figure 1. Covers of relevant reports and manuals in order left to right: Conand and Muthiga, 2007; Friedman *et al*., 2008; Purcell, 2010; and FAO, 2010. See reference list for full citation and links to free downloads.

OBJECTIVES OF THE WORKSHOP

5. The aim of the workshop was to provide a platform for implementing change in management systems through mentoring managers through tailored strategies for sea cucumber fisheries in the Indian Ocean. Embedded within this aim were the objectives to:

i. provide a forum for group sharing of experiences and lessons learned of sea cucumber fisheries management;

ii. train and mentor Indian Ocean fisheries managers in applying an ecosystem approach to managing sea cucumber fisheries;

iii. apply the ACIAR sea cucumber fishery manager's toolbox (Friedman *et al*., 2008) and the FAO roadmap (Purcell, 2010; FAO, 2010) in the context of each workshop participant's fishery;

iv. facilitate learning to support development of new plans, or revisions, to sea cucumber fishery management plans where needed;

v. collate and analyse current information from Indian Ocean sea cucumber fisheries on management practices and constraints.

ORGANIZATION OF THE WORKSHOP

Preparation

6. The workshop broadly followed the format of the SCEAM Pacific workshop (FAO, 2012b), with some modifications due to the increased time available for the workshop. FAO and WIOMSA partnered as organizers of the workshop, with WIOMSA taking on the administrative role and FAO the role of coordinating the technical facilitators and the workshop steering committee. This committee was responsible for identifying participants, and developing the workshop agenda and work programme in March 2012. The members of the steering committee used existing networks to identify and approach potential participants. The organizers evaluated the curriculum vitae of potential participants based on their suitability to attend the workshop. There was a considerable amount of work related to this task, and the identification of participants in the Indian Ocean was perceived as more tedious than in the Pacific. In order to enhance visibility, identity and recognition in the Indian Ocean, a logotype was developed for the workshop.

7. During June and July 2012, the identified participants were sent a letter of invitation including a detailed prospectus of the workshop (Annex 1). In September, once all identified participants had confirmed their participation, a pre-workshop package was sent out containing a fishery data-form, a provisional workshop agenda, and a document for participants to state their pre-workshop expectations. In this e-mail participants were also queried whether they could give a ten-minute presentation of their fishery. Participants were also requested to complete a fishery data-form on how their fishery was operating and on various aspects of its management. Information from the data-form was summarized and reported to the workshop in November. All documentation was prepared by the workshop steering committee with input and approval by the organizers.

Scope

8. The focus of the workshop preparation was to identify and invite relevant staff in nations that have, will soon have or have recently had an operating sea cucumber fishery in the Indian Ocean. The workshop was intended for sea cucumber fisheries managers, senior fishery officers, and staff intimately involved in sea cucumber fisheries in each of the Indian Ocean target countries. Only potential participants from this region that met the requirements were considered and invited to the workshop.

Strategies

9. The number of participants was intentionally kept small, with one representative from each of the participating countries. It was anticipated that this strategy with smaller workgroups would facilitate a greater involvement and higher uptake of information by participants in the workshop. It was also expected that this strategy would also increase the quality of the workshop output.

PROGRAMME, VENUE AND PARTICIPANTS

Programme and venue

10. The workshop was held at Zanzibar Beach Resort, Mazizini, Zanzibar (the United Republic of Tanzania). This venue was selected because previous successful workshops had been arranged there by WIOMSA. The workshop programme was built around eight sessions that encompassed theoretical presentations by facilitators, plenary discussions and practical workgroup sessions where participants worked through the ACIAR and FAO manuals. The title and scope of the sessions are summarized in Table 1 and the detailed workshop agenda can be found in Annex 2.

Participants

11. The workshop targeted fishery managers or senior fishery officers. Eighteen participants from 15 countries were identified and invited to the workshop (Figure 2; Annex 3). In addition, Zanzibar and Rodrigues were invited although they are part of Tanzania and Mauritius, respectively. Last-minute cancellations by Rodrigues, Mozambique and Eritrea precluded other representative for those countries from attending. Participants were selected by the organizers based on how well they met the following criteria:

i. They had an intimate knowledge of the sea cucumber fishery within their country.

ii. They were in a position to influence management changes.

iii. They were able to contribute strongly to the workshop discussions and outputs.

Table 1. Summary of the workshop programme by day and session

Day	Scope	Activity
1	Introduction to the workshop, the fishery situation in the Indian Ocean and to sea cucumber fisheries management	**Session 1:** *Global and regional overviews* These presentations focused on exposing the participants to recent global and regional projects relating to sea cucumber fisheries management. **Session 2:** *Managing, assessing and monitoring sea cucumber fisheries* This session followed the logical structure of the FAO publication 520 (Purcell, 2010) presenting the ecosystems approach to management. In detail presentations exposed participants to management measures and actions, and the information required for understanding fishery status and making decisions on these measures and actions.
2	Background presentations, status assessments and management indicators	**Session 3:** *Indian Ocean sea cucumber fisheries presentations* This session was opened by a presentation summarising the pre-workshop fishery data-forms. Afterwards, participants from eight countries (Egypt, India, Kenya, Madagascar, Seychelles, Yemen, Sri Lanka and the United Republic of Tanzania) made presentations on the status and management challenges of their fisheries. **Session 4:** *Assessments of sea cucumber fisheries using the ACIAR toolbox* This was the first practical session where participants identified the status of their fisheries using indicators in the ACIAR sea cucumber fishery manager's toolbox (Friedman *et al*., 2008). The participants were divided into three workgroups with one facilitator per group. In the workgroups the participants used the logical system of indicators to identify the status of their fishery.
3	Field day	During the field day, participants surveyed an intertidal seagrass area and snorkelled around Kwale Island identifying sea cucumbers, and visited a sea cucumber processor and trader in Mtoni.
4	Decision support tool and governance	**Session 5:** *Decision-making in sea cucumber fisheries management* This session focused on mentoring participants using the roadmap (page 32 in Purcell, 2010; pages 22–23 in FAO, 2010) to make decisions on management measure and actions appropriate to their fishery and its identified status (as identified in Session 4). At the end of the session, each participant had tabulated appropriate measures and actions for their fishery. **Session 6:** *Governance in sea cucumber fisheries* To expand the management focus of the workshop, this session consisted of a stakeholder identification exercise. Participants listed and ranked the importance of various actors that participated in policy and rule making and in monitoring and enforcement of their fishery.
5	Contextualizing the workshop for implementation in the Indian Ocean	**Session 7:** *Fisheries cases and enforcement* In this session, groups were grouped around four case study fisheries from the region (Oman, Kenya, Sri Lanka and Comoros). The participants from neighbouring countries worked together with the participant from the case study country to identify the main challenges and potential management measures and actions. **Session 8:** *Contextualizing the workshop for implementation in the Indian Ocean* This session focused on summarizing discussions from the workshop and identifying key priority research areas for the future.

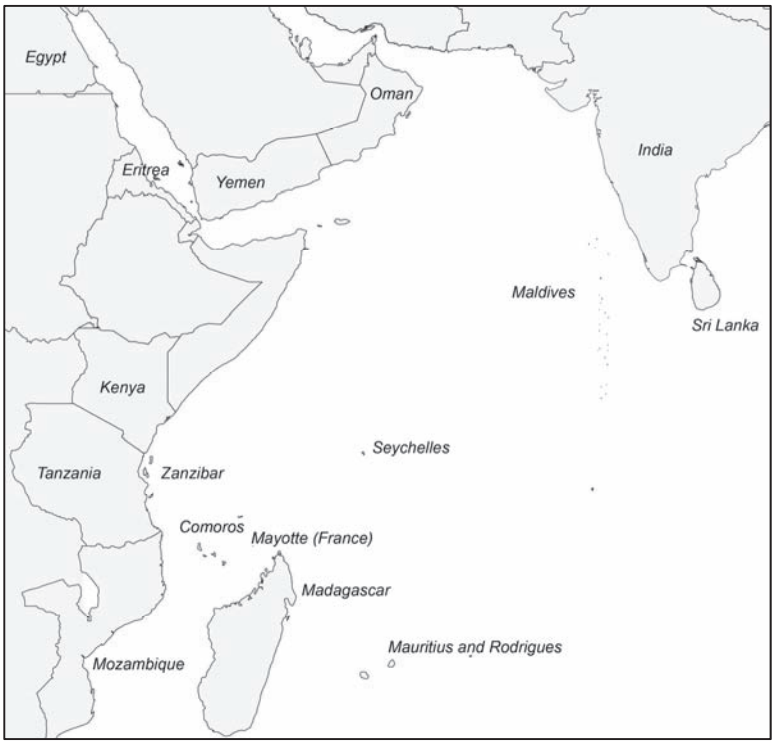


Figure 2. Map over FAO Area 51 (Indian Ocean) with invited and participating countries spelled out in text. Note that officers from Mozambique, Eritrea and Rodrigues were invited and submitted pre-workshop fishery forms, but were not able to participate at the workshop due to administrative complications.

Facilitators

12. The facilitators were required to be knowledgeable on sea cucumber fisheries and have experience in fisheries management. The workshop facilitators were members of the workshop steering committee preparing the delivery of the workshop. In addition, the facilitators jointly chaired and coordinated the workshop and delivered seminar presentations within their fields of expertise. During the workshop, an important component of the facilitator's role was to communicate and lead discussions relevant to the workshop format. The workshop facilitators are listed in Table 2.

Table 2. Facilitators and their role in the workshop

Name	Position	Workshop role
Alessandro Lovatelli	Aquaculture Officer, FAO	Organizer
Julius Francis	Executive Secretary, WIOMSA	Organizer
Hampus Eriksson	Post-doctoral Research Fellow, Stockholm University, Sweden	Workshop coordinator, facilitator and steering committee member
Steven Purcell	Senior Research Fellow, Southern Cross University, Australia	Workshop facilitator and steering committee member
Chantal Conand	Emeritus Professor, La Réunion University, France	Workshop facilitator and steering committee member
Nyawira Muthiga	Director, Kenya Marine Program, Wildlife Conservation Society	Workshop facilitator and steering committee member

PRE-WORKSHOP FISHERY FORMS

Purpose

13. The pre-workshop fishery forms were sent to the participants in early September 2012. The participants were required to return the form by the end of the month. The fishery form aimed at collecting information regarding the sea cucumber fishery operation and management aspects from all participating countries. The fishery form was structured in seven sections (A–G) with explicit aims (Table 3). The full data-form is attached in Annex 4.

Results

14. A summary of relevant results from the data-form is presented here by topical section.

Section A - Fishery operation

15. The represented countries were locations for a range of different fishing activities that targeted sea cucumbers (Table 4). Some fisheries were operated exclusively by men that commonly utilized underwater breathing devices (e.g. Seychelles and Maldives), while other countries had a range of resource users (i.e. men, women and children) collecting sea cucumbers using simple gleaning methods. This diversity of activities was important to note because it illustrates that different countries in the Indian Ocean are facing different management challenges in their sea cucumber fisheries.

Table 3. Summary of the pre-workshop data-form and the aims of the different section within it

Section	Topic	Aim
A	Fishery operation	To capture information regarding how the fishery operates (e.g. Who is fishing? How are they fishing? Where are they fishing?)
B	Human resource capacity and monitoring	To collect information on the capacity of agencies responsible for management in assessing and monitoring the sea cucumber fishery in their country
C	Management approach and governance	To identify strategies and the level of participation of agencies and communities in governance
D	Current fishery regulations	To illustrate how the participant countries are currently regulating sea cucumber fisheries
E	Enforcement and inspection	To identify the capacity to enforce regulations and export protocols
F	Stakeholder involvement and education	To explore the level of management focus on strategies that allow fishers to participate in management
G	Aquaculture	To explore preparedness and ambitions in relation to sea cucumber aquaculture

Table 4. Tabulated summary of methods and resource users in Indian Ocean countries' sea cucumber fishing operations. Note that the Comoros and Mayotte are not included as the fishery is closed there. Mainland Tanzania responded with the methods and resource users that are used illegally since the fishery was closed. CA diving means "compressed air diving" (scuba or hookah).

Country/ territory	Methods				Resource users		
	Gleaning	Skin diving	CA diving	Trawling	Men	Women	Children
Egypt	-	✓	✓	✓	✓	-	-
India	-	✓	-	✓	✓	-	-
Eritrea	-	✓	-	-	✓	✓	-
Kenya	✓	✓	-	-	✓	✓	-
Madagascar	✓	-	✓	-	✓	✓	✓
Maldives	-	✓	✓	-	✓	-	-
Mauritius	✓	✓	✓	-	✓	✓	-
Rodrigues	✓	-	-	-	✓	✓	-
Mozambique	✓	✓	✓	-	✓	✓	✓
Oman	✓	✓	-	-	✓	✓	✓
Seychelles	-	-	✓	-	✓	-	-
Sri Lanka	-	✓	✓	-	✓	-	-
United Republic of Tanzania	✓	✓	✓	-	✓	-	-
Zanzibar	✓	✓	✓	-	✓	✓	✓
Yemen	✓	✓	✓	-	✓	✓	✓

16. In relation to the fishery operation, questions were asked about the number of species that were targeted in each country's fishery. The reported species numbers varied greatly (Figure 3A) and for some countries appears underestimated compared to existing reports (e.g. Conand, 2008; Eriksson *et al*., 2010). The participants were also asked to state which of the broad categorized habitats were targeted in their country: i) soft bottom with seagrass; ii) coral reefs; iii) sand flats; and iv) deep areas. Most countries' fisheries were operating within at least three different habitats (Figure 3B). The location of each of the represented country determined the habitat that was available for fishing, and this in turn influenced the number of species that could be sourced from within the fishery. This diversity in available habitats and potential diversity of species is important to keep in mind when approaching management measures, such as a list of permissible species and spatial structuring of the fishery through open/closed zones.

Section B - Human resource capacity and monitoring

17. Two central questions of this section related to whether the appropriate agencies in the represented countries had the capacity to conduct extensive underwater populations surveys of sea cucumbers every three years in terms of i) human resources and skills, and ii) the required funding. It was notable in the responses from the participants that while half of the countries lacked human resources and skills to undertake this activity almost all countries appear to lack the funds required for these types of assessments (Figure 4). However, some countries may have research institutions with some capability to conduct surveys, which were not considered in the data form.

Section C - Management approach and governance

18. Out of the participating countries, only six had a national sea cucumber fisheries management plan (Eritrea, India, Madagascar, Mauritius [incl. Rodrigues], Seychelles and Sri Lanka). In conjunction

with this, a similar situation was reported for management objectives and the use of reference points in management. The participants also reported a low incidence of informal institutions such as village rules and by-laws; these institutions were reported only by two of the countries.

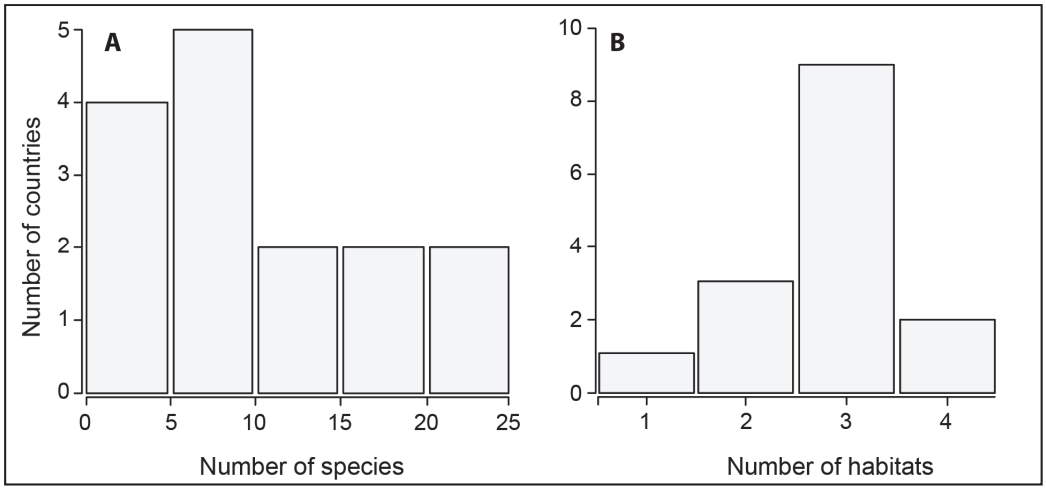


Figure 3. **A)** Number of species in intervals of five that are targeted by the countries in the Indian Ocean that were represented at the workshop. **B)** Number of habitats (soft bottom with seagrass, coral reefs, sand flats, deep areas) that are targeted by the fisheries in the Indian Ocean that were represented at the workshop. Data for Tanzania (mainland) and Mayotte were not used as these fisheries are closed. Data for the Comoros were used, as this information was available despite the fishery being closed.

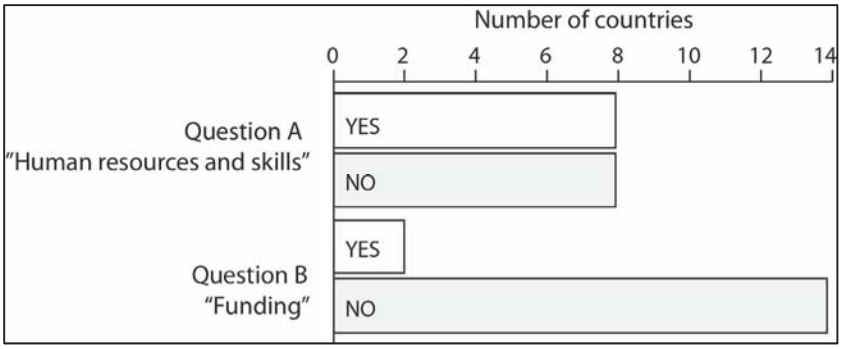


Figure 4. Question **A)** Number of participant countries that answered "Yes" or "No" to the question "if they have the human resources and skills to conduct extensive underwater population surveys of sea cucumbers every third year". Question **B)** Number of participants that answered "Yes" or "No" to the question "if they had the funds to conduct the above".

Section D - Current fishery regulations

19. Size limit as a management measure was noted in seven of the countries (Table 5). Madagascar and Mozambique reported that the size limit was the same across all species. Three countries reported that they have rules or a policy to prevent the fishery from including new and previously unfished species. In contrast, banning of scuba gear was a common strategy among the fisheries represented. The fisheries in Seychelles and Sri Lanka appeared to focus on input controls through licensing all users.

Section E - Enforcement and inspection

20. Most countries recorded that they have a patrol boat fleet of less than five boats (Figure 5A). These appeared to be boats used in general fisheries patrol matters and not specifically for sea cucumber fisheries. India reported >1 000 boats, but this number is not included in the figure summarizing the

number of boats available for monitoring and enforcement. Although a majority of countries reported that they conduct regular or occasional bêche-de-mer export inspections, there was an absence of training on species identification (Figures 5B and 5C). Exports appeared to rarely be recorded at a species level, but if future interventions expect to implement restriction and monitoring with a greater resolution, then training of species identification will be necessary.

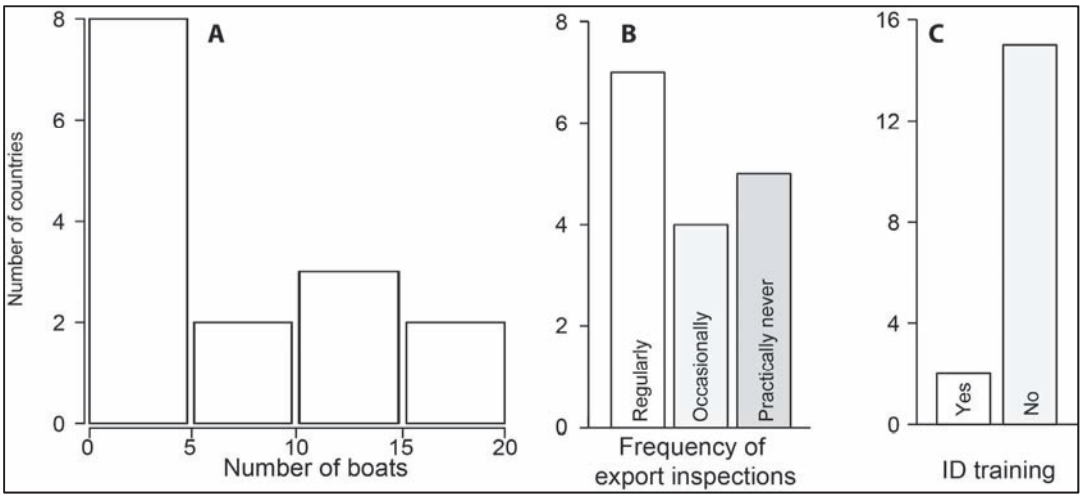


Figure 5. **A)** Number of patrol boats for monitoring and enforcement in represented Indian Ocean fisheries. **B)** Number of represented Indian Ocean countries that inspect their bêche-de-mer exports regularly, occasionally or practically never. **C)** Number of countries that reported whether customs officers had, or had not, undertaken some training in species identification.

Table 5. Summary of reported management measures in the participating countries from the Indian Ocean. Note that the Comoros and Mayotte are not included because those fisheries were closed. Tanzania (mainland) is included in the table as these regulations are for other fisheries in general but also applicable to the sea cucumber fishery, which continues illegally.

Country/territories	Size limits	Limit on new species	Ban on scuba	Fishing license	Processor licence	Export license
Egypt	-	-	✓	-	-	✓
India	-	-	-	-	✓	✓
Eritrea	✓	✓	✓	✓	✓	✓
Kenya	-	-	✓	-	✓	-
Madagascar	✓	✓	✓	✓	✓	✓
Maldives	✓	-	✓	-	-	✓
Mauritius	✓	-	✓	✓	✓	✓
Rodrigues	✓	✓	✓	✓	✓	✓
Mozambique	✓	-	✓	✓	-	-
Oman	-	-	-	-	-	-
Seychelles	-	-	-	✓	✓	✓
Sri Lanka	-	-	-	✓	✓	✓
United Republic of Tanzania	-	-	✓	✓	-	-
Zanzibar	✓	-	-	✓*	✓	✓
Yemen	-	-	-	✓	✓	-

* No licences for gleaning “foot fishers”.

Section F - Stakeholder involvement

21. To gauge the level of interaction between formal authorities and resource users, participants were asked to estimate the percentage of the fishing community with which they had contact in the past year. This included interaction through fishing committee meetings, monitoring activities, etc. While some fisheries responded with a fairly high percentage, most fishery agencies reported a limited interaction with fishing communities (Figure 6). When interpreting those results, it is important to keep in mind the diversity of fisheries and institutional contexts represented by the different countries at the workshop. In fisheries such as the one in Seychelles, which is operated by a fairly small and easily-defined group of people, it is easier to target communication than in countries such as Madagascar where thousands of people over a large geographic area are involved in the fishery.

Section G - Aquaculture

22. Eleven of the represented countries had received proposals for sea cucumber aquaculture. These proposals were predominantly presented by the academic and private sectors. The requests included species of high commercial value such as *Holothuria scabra* that generated the most interest, as well as species of low commercial value such as *Holothuria atra* (Figure 7).

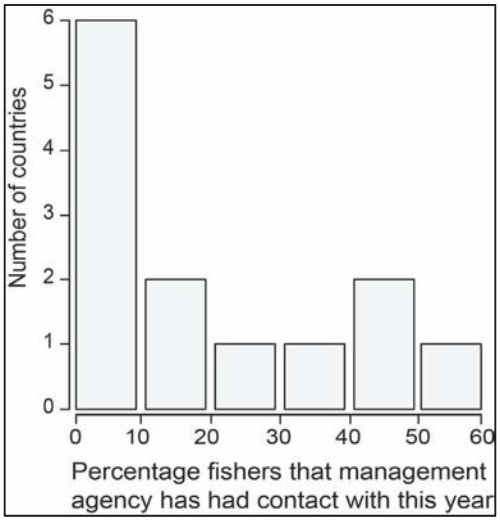


Figure 6. The level of interaction between management agencies and fishers based on the percentage of fishers interacting with management agencies in the past year.

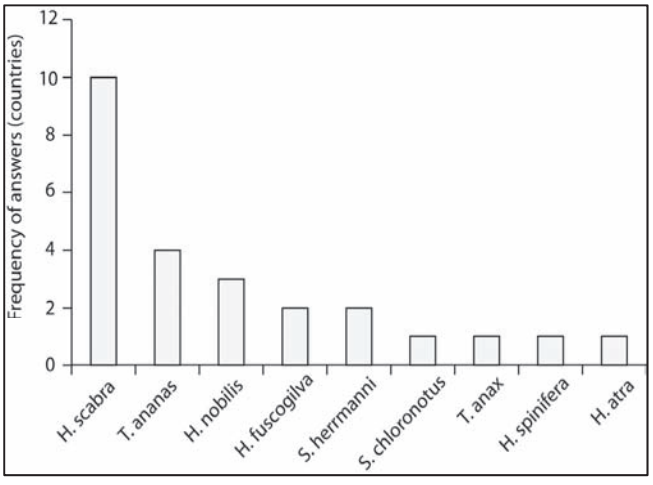


Figure 7. Species considered for aquaculture in the region.

WORKSHOP SESSIONS

Theory sessions

Session 1 - Global and regional overviews

Key points of the session:

- Sea cucumber fisheries have expanded considerably around the world in the past decades and occur in more than 70 countries involving 3 million people.
- The fisheries range from multispecies small-scale fisheries in tropical waters to mono-specific industrialized fisheries in temperate waters.
- Most fisheries in the tropical Indo-Pacific are fully exploited or overexploited.
- More than 30 species are harvested in the Indian Ocean and fisheries are diverse (i.e. in operation and management).
- Sea cucumber populations in many fisheries in the Indian Ocean are showing trends of considerable decline.
- There are long and complex trade chains in many Indian Ocean fisheries.

23. This introductory session started out by providing a global perspective on sea cucumber fisheries. A. Lovatelli made a presentation on the global status of sea cucumber fisheries, and S. Purcell described the findings in the recent global analysis of management measures and drivers of overfishing (Purcell *et al*., 2013). The presentations then narrowed the geographical scope to the Indian Ocean with a regional synthesis presentation by C. Conand (Conand, 2008) and a the Western Indian Ocean perspective by N. Muthiga on the outcomes of the recently concluded MASMA funded regional sea cucumber project (e.g. Conand and Muthiga, 2007).

Global overview seminars

24. The presentation by A. Lovatelli detailed a global overview on the endeavour of raising knowledge in sea cucumber fisheries and management starting from the workshop on Advances in Sea Cucumber Aquaculture and Management (ASCAM) in 2003 to the recent paper by Purcell *et al*. (2013). The presentation highlighted the global fishery expansion and that to meet market needs the production of bêche-de-mer now encompasses 70 countries in all the world's oceans. This expansion has also included a broadening of the target species. The high number of species is mainly exploited in multispecies small-scale fisheries, common in shallow tropical habitats of low-income countries, some which are operating illegally. The resource is easy accessed and collected by hand or diving, processed in artisanal enterprises and exported through long and complex trade chains. A few more recent fisheries are monospecies industrialized fisheries in high-income temperate countries. The management measures vary greatly between countries and are generally weaker in low-income countries. The wild resources are declining, but the demand is still growing, therefore, the interest in aquaculture is growing. Aquaculture should be perceived as a separate activity from fisheries management.

25. The next seminar, by S. Purcell, first mentioned the collaboration of scientists from the different world regions who collected data from national and international sources on 77 sea cucumber fisheries. These data indicated that there are at least three million sea cucumber fishers in the world and that many stocks are depleted or overexploited, mostly in the tropical Indo-Pacific. The following characteristics were compared among sea cucumber fisheries globally: scale of fishing, number of species collected, yields per fisher (which is related to participation rate), number of regulatory measures, key management measures. The low HDI (human development index) countries had more overexploited sea cucumber fisheries (with a worse situation than in other fisheries). Key changes are therefore needed in management of sea cucumber fisheries. The study recommended increased attention on enforcement capacity focuses on a set number of practical regulatory measures and increased support to fishers in

low-income countries with livelihood options to help them deal with restricted catches. In addition, international agreements (e.g. Convention on International Trade in Endangered Species of Wild Fauna and Flora - CITES) and instruments (e.g. IUCN Red Listing) may help safeguard loss of biodiversity.

Indian Ocean regional overview seminars

26. The following seminar by C. Conand focused on the history and status of sea cucumber fisheries in the Indian Ocean and presented an update from the regional synthesis by Conand (2008), Conand and Muthiga (2007) and Purcell *et al*. (2013). The countries in the subregions of the Indian Ocean are encompassed within in the Western Indian Ocean (WIO, FAO Area 51) and the Eastern Indian Ocean (EIO, FAO Area 57). The history of exports has been reconstructed back to the nineteenth century from several documents and a synthesis providing useful trends. The recent capture data (transformed into the processed product) presented for the period 2004 to 2010 show the important contribution of Madagascar, Maldives and Seychelles in the WIO, and Sri Lanka and Indonesia for EIO. Concerning the status of exploitation, most countries experienced overexploitation, and only a few were fully exploited or moderately exploited. There is no local consumption of holothurians in the countries of the WIO and production was for export to Asian consumers. The intermediate markets (e.g. Yemen and Dubai) are not well known, neither are the reciprocal exchanges between China, Hong Kong SAR and Singapore. The illegal trade, important in the Indian Ocean, needs more regional attention. More than 30 species of holothurians are traditionally exploited but quite a few small species with low value are now fished, owing to the decrease in the stocks of high valued species. Studies on the socio-economic aspects of the sea cucumber fishery in Madagascar, Seychelles and Zanzibar (the United Republic of Tanzania) have emphasized the importance of these aspects on the fishery. In the region, the regulations of the fisheries are very diverse, complex, involving different government bodies and lacking communication. Bans on fishing have been implemented in several countries, generally as a consequence of overexploitation, in a few cases as a precautionary approach.

27. The Regional WIOMSA/MASMA Sea Cucumber Project “Sea cucumbers, a poorly understood but important coastal resource: a regional analysis to improve management” presented in the seminar given by N. Muthiga, was conducted (2006–2009) in five countries of the WIO, Kenya, Madagascar, La Réunion (France), Seychelles and Tanzania, as a multidisciplinary project. The main objectives were to study the ecology and biology of the exploited species, and the socio-economic and management aspects of the national fisheries. Following a start-up workshop, a review on the current knowledge was published by WIOMSA (Conand and Muthiga, 2007). Comprehensive inventories of the sea cucumbers extended the biodiversity knowledge, while surveys on the occurrence and abundance of the species and ecology provided relative information on stocks. The studied marine protected areas (MPAs) had higher diversities and densities than the non-protected areas indicating the efficacy of MPAs in protecting sea cucumbers. Studies on the morphometry and reproductive biology of eight important species provided original data on sexual cycle and size at maturity, useful for management, but growth and recruitment evaluations are still needed. The fisher communities’ characteristics and management regulations were compared for Kenya, Madagascar, Seychelles and Zanzibar (the United Republic of Tanzania). The trade chain was very long in Madagascar compared with other countries, involving several local and national stages before the export. A final report by N. Muthiga and C. Conand with the main results and recommendations is in preparation. Many publications in international journals, congress proceedings, student reports and theses have been published and are available (a list of publications can be found on www.wiomsa.org) for further national or regional use.

Session 2 - Managing, assessing and monitoring sea cucumber fisheries

Key points of the session:

- It is important to set management objectives and reference points.
- Refer to the ecosystem approach to management and adaptive management.
- Surrogate information ("indicators") by which to decide how healthy stocks are in the fishery.
- How to work through the roadmap to decide regulatory measures and management actions.
- Use, limitations and implementation of various regulatory measures that can be imposed on fishers.
- Use, limitations and implementation of management actions to be undertaken by the fishery manager.

28. This information-rich session gave participants a summary of the management principles, regulatory measures and management actions that can be found in the FAO manuals on an ecosystem approach to managing sea cucumber fisheries (FAO, 2010; Purcell, 2010). Facilitators gave technical seminars to explain how the management principles and measures can be applied to sea cucumber fisheries. The seminars set a foundation for the participants to use the information in subsequent sessions in which they had to prioritize objectives, define the status of stocks, and choose regulatory measures and management actions for their fishery.

Principles and objectives of management

29. The first seminar by A. Lovatelli presented management principles, objectives, reference points, and the ecosystem approach to managing fisheries. Management principles were summarized from the *Precautionary Approach to Capture Fisheries and Species Introductions* (FAO, 1996), the *Code of Conduct for Responsible Fisheries* (FAO, 1995) and the *Ecosystem Approach to Fisheries* (FAO, 2003). The key point explained about the precautionary approach is that an absence of data and information on the fishery should not be an excuse for managers to delay the implementation of management. Indeed, most sea cucumber fisheries are data poor and managers must go ahead and implement best-practice management while they go about the task of gathering more information to assess stocks, fishing and the effectiveness of management measures.

30. Setting objectives is a vital early step by managers because these establish a logical basis by which regulatory measures and management actions are chosen. Reference points give the management plan pre-defined limits by which management effectiveness can be gauged during, and at the end of, a management cycle (Purcell, 2010). Decision-support rules should be linked to the reference points to set pre-agreed actions that should occur in the event that limit reference points or target reference points are surpassed. In the plenary session, the advantages of decision-support rules was emphasized: they describe to fishers and other stakeholders what adaptations to management will occur in the case of poor performance of management measures, and they establish actions that can be agreed ahead of time by decision-makers (e.g. ministers, community leaders) so that adaptive management is not undermined later by a lack of political will to make hard decisions in light of unsustainable use of the resources.

31. Finally, the seminar highlighted that the ecosystem approach to fisheries (EAF) is not just about protecting ecosystems. Rather, it is a holistic approach to management in which a range of important economic, sociological and biological aspects are taken into consideration by the fishery manager (FAO, 2003). An especially important aspect of an EAF is the involvement of various stakeholders in the different steps of developing and implementing management.

Assessing the state of stocks

32. In order to set appropriate regulatory measures, managers must have a reasonable idea of the status of sea cucumber stocks in their fishery. For example, are stocks fully exploited and could

withstand further exploitation at the current rate, or are they over exploited? Clearly, the measures needed to manage stocks in an unfavourable state (e.g. over exploited or depleted) will need to be more conservative than those for stocks less affected by fishing. A seminar by S. Purcell about indicators for fishery stocks explained six indicators that are listed in the ACIAR Manager's Toolbox booklet (Friedman *et al*., 2008). The indicators use fishery-dependent surveys, fishery-independent surveys, and interviews with fishers or analysis of logbooks or export data to gauge the relative health of sea cucumber populations in the fishery. The seminar pointed out that multiple indicators should be used and many of them are easier to obtain information on than extensive underwater visual census of stocks.

Understanding biological attributes important for management

33. A seminar by S. Purcell gave an overview of different biological and ecological attributes of sea cucumbers and how those attributes need to be considered for various regulatory measures and the management of sea cucumber stocks as a whole. One key message was that there is a lack of information on basic biological parameters, including growth rates, longevity and recruitment rates. That makes it difficult, or impossible, to reliably use some regulatory measures, such as rotational closures and catch quotas. A further important message was that some sea cucumber species appear to be relatively long-lived, slow-growing and have irregular rates of recruitment, which all mean that stocks need to be managed quite conservatively to avoid eventual depletion of populations. The role of sea cucumbers in reef ecosystems was also discussed.

Regulatory measures

34. The so-called "toolbox" of a fishery manager contains a range of potential management measures that could be used in certain situations. Like a tradesperson with a box of tools, the manager needs to select the right management tools for the job and not all tools will be needed. The choice of which tools to use for certain fishery situations is guided by the "roadmap" developed by FAO for sea cucumber fisheries, which gives fishery managers a starting suggestion of which regulatory measures and management actions to use depending on: i) the fishery type; (ii) the stock status; and (iii) the technical capacity and human resources of the fishery agency. This process is also explained in "Practical sessions" section below.

35. In two further seminars, S. Purcell explained various regulatory measures that could potentially be used in a sea cucumber fishery, which are defined and described in Purcell (2010). Regulatory measures are regulations, or rules, imposed on fishers. An important point was that each regulatory measure has different advantages and constraints. The first set of regulatory measures discussed were temporal and spatial closures, and the second set were other regulatory measures in the managers toolbox including size limits, gear limitations, catch quotas, logbooks and reporting. In short, the regulatory measures that were discussed are the following:

- Seasonal and short-term closures;
- "closure-pulse fishing-closure" strategy;
- bans/moratoria;
- marine reserves/no-take zones;
- rotational harvest closures;
- territorial use rights in fisheries (TURFs);
- size limits;
- gear limitations, e.g. bans on use of nets or compressed air for diving;
- catch quotas (or total allowable catches - TACs), which could be global quotas for the whole fishery or individual transferable quotas;
- capacity controls, such as licensing and limited entry rules, and vessel and fleet limitation;
- logbooks and reporting requirements.

Actions by the fishery manager

36. Two seminars by H. Eriksson explained the range of actions that fishery managers could undertake in the implementation of regulatory measures and the monitoring of compliance by fishers. The first seminar started with discussion of the adaptive management process and the importance of feedback from fishers. Resilience of the socio-ecological system of the fishery will depend, in part, on how well the fishery managers can engage with stakeholders and the social context in which the sea cucumbers are exploited. In the diagnosis phase of the management process (discussed in an earlier seminar by A. Lovatelli), managers must undertake a review to understand the stocks, in terms of species, their biology, abundances and distribution within the fishery.

37. Once existing information (e.g. from national reports and scientific articles and manuals) has been reviewed, the manager should also consider some investment in fishery-independent surveys, fishery-dependent surveys and/or socio-economic surveys. Fishery-independent surveys are ones that do not rely on catches by fishers, and commonly comprise underwater visual censuses of the abundances and sizes of sea cucumbers in fishing grounds. Those can be compared with abundances and sizes of the same species in no-take reserves. Fishery-dependent surveys could include data collected on the sea cucumbers landed by fishers or data on weights of sea cucumbers exported from the country. Socio-economic surveys should rely on questionnaire-based interviews with fishers and processors.

38. The second seminar by H. Eriksson gave an overview of the other actions that managers could undertake. Management advisory committees (MACs) can be supported by the managing agency to ensure that they have representation from different stakeholder groups and are supported financially to occur on a regular basis. Mangers must be active in pushing management plans forward within the legislative system so that the regulations are set into law and have effect within the fishery international agreements, such as CITES, or regional agreements among neighbouring countries. Such agreements may help to regulate illegal trade or limit the trade of vulnerable species. Enforcement means ensuring the compliance of management measures and regulations, and enabling the application of penalties for rule breaking. Enforcement needs to occur at different levels (e.g. fishers, processor, exporters), and the fishery manager should take actions to help enforcement officers to have skills to conduct inspections of fresh animals collected by fishers and dried product at processing stations or points of export.

39. The seminar also underscored the importance of communication and education activities to inform fishery participants about sea cucumber biology, status of fishery and current/up-coming regulations. The fishery manager could invest in the production of fishery leaflets, radio announcements, newsletters and recurring meetings with stakeholders.

40. Lastly, restocking was discussed as a potential option by fishery managers to recover depleted stocks. The crucial point was that restocking should be considered as a very last resort when other management measures have failed to recover viable sea cucumber populations. In the first instance, other management measures should be employed to curb exploitation rates to levels that will sustain healthy breeding populations of each species. Restocking is a very expensive measure and can distract fishery managers from other, more important, activities such as active communication with fishers and enforcing regulations.

Session 3 - Indian Ocean sea cucumber fisheries presentations

41. In this session eight participants, representing different subregions of the Indian Ocean, presented seminars on the status and management of the sea cucumber fisheries in their country. Presentations were made by H. Hasan (Egypt), P.S. Asha (India), E. Mueni (Kenya), H. Raboanarijoana (Madagascar), E. Socrate (Seychelles), M. Saad (Yemen), A. Kumara (Sri Lanka), N. Jiddawi and H. Omar (the United Republic of Tanzania). For the purpose of ensuring that information on the sea cucumber fishery activities and management from participating countries was documented, all workshop participants were also invited to submit a brief “country summary” report. The scope of these reports was to attempt to document the fishery situation in each participant’s country. The reports are presented in alphabetical order, by country, in Annex 5.

Practical sessions

Session 4 - Assessment of sea cucumber fisheries using the ACIAR toolbox

Key points of the session:

- Participants identified the fishery status in their countries applying the indicators from the ACIAR manual in workgroups.
- Ten of the 14 fisheries were considered overexploited or depleted.
- The only countries with an underexploited status were Mayotte and the Comoros
  (NB: the Comoros is illegally fished and this is possibly an overestimate of the situation).
- Only in one country (Seychelles) with a currently operating fishery were the benefits perceived to be contributing at an appropriate level to the fishing communities.

42. Participants were divided into four workgroups. The workgroup focus was to assess the status of their fishery using the six indicators in the ACIAR manual (Friedman *et al*., 2008). The workgroups included one facilitator that assisted the participants, and facilitated discussions between participants, when working through each fishery indicator. This structure assisted participants in their scoring of the indicators. Responses of "yes" were noted as ticks in the appropriate cells in the table, responses of "no" were noted as crosses, and a question mark was noted if the answer was uncertain. Once all the indicators had been addressed, each participant then summarized the ticks and crosses to make a decision on the current status of the fishery. As a guide to support the decision, participants were presented with the following approximate guidelines:

U (*Underexploited*)	–	Ticks on all indicators; stocks are not very affected by past fishing.
M (*Moderately exploited*)	–	One or two crosses; but stocks appear healthy.
F (*Fully exploited*)	–	One to three crosses or question marks; but fishing appears to be sustainable.
O (*Overexploited*)	–	Few ticks; fishing appears unsustainable but some breeding populations still exist.
D (*Depleted*)	–	Few or no ticks; fishing is unsustainable with stocks below 10 percent of unfished abundance.

43. Participants could add a minus (-) to indicate that the nominated decision is slightly worse than the given definition; e.g. O- is between Overexploited and Depleted. The collated results from the workgroups are presented in Table 6.

44. Facilitators emphasized throughout the exercise that the indicators provide a decision-support tool for the participants and that the indicators must be interpreted in each fishery in context with other information. In the process of defining the status of their fisheries, the participants exposed themselves to the challenges associated with understanding the nuances of their fishery, many of which are data-poor. This included, for example, lack of recent appraisals of stocks limiting the ability to gauge indicators 1 and 3, and insufficient monitoring of catch, which limited the participants' ability to confidently gauge indicators 4 and 5. From the summaries of fishery status, there appeared to be a tendency for managers to overestimate the status of their fishery (e.g. the Comoros and Zanzibar, the United Republic of Tanzania). Perhaps this was related to missing baselines to build perceptions of potential abundances and productivity.

45. Another point of misinterpretation revealed from the exercise and plenary session was the definition of fully exploited. Taken from definitions by FAO (2005), which have been subsequently paraphrased in other documents (e.g. Sumaila *et al*., 2007; Purcell *et al*., 2013), fully exploited means that exploitation, i.e. fishing, has been at a maximum level that stocks can withstand without depleting

breeding populations to unsustainable levels. The question here is whether fishing has reduced the sea cucumber populations such that they would eventually decline to unviable abundance levels if the past or current rates of exploitation were left unchanged. In other words, if fishers keep fishing as much as they are now, will stocks of some species be likely to be extinguished? If this is the case (i.e. stocks have been reduced at rates unsustainable in the long term), then the stock status should be set at overexploited or depleted.

Field day

46. A day for field activities was organised to get hands-on experience on sea cucumbers and products in Zanzibar (the United Republic of Tanzania). The field excursion was arranged by N. Jiddawi from the Institute of Marine Science in Zanzibar. The first activity was a presentation by C. Conand of the commercial species of the Indian Ocean region, including the presentation of an original laminated sheet prepared for the workshop. The species identification sheet contains the 36 most important species and is attached in Annex 6.

47. The second activity was a walk at low tide in the intertidal zone near Fumba village in Menai Bay on the southwest corner of Zanzibar. The exercise was led by two female community members who used to fish in the area. The habitat was a mixture of seagrass beds, sand-muddy patches and rubble. Three species were recorded on this site; sandfish *Holothuria scabra* at medium to small sizes (a few specimens) that women collected at low tide, lollyfish *H. atra* and white threadsfish *H. leucospilota*.

Table 6. Summary of each fishery's indicators and nominated fishery status decision from workgroups in Session 4. Ticks (✓) are "yes", crosses (X) are "no", question marks are unsure. U = Underexploited, M = Moderately exploited, O = Overexploited, F = Fully exploited, D = Depleted. NA means that information is not available because the fishery is closed.

Indicator	**Comoros**	**Egypt**	**India**	**Kenya**	**Madagascar**	**Maldives**	**Mauritius**	**Mayotte**	**Oman**	**Seychelles**	**Sri Lanka**	**United Rep. of Tanzania**	**Zanzibar**	**Yemen**
1. Are there still areas where adult sea cucumbers remain protected near the main fishing grounds?	✓	✓	✓	X*	X	X	X	✓	X	✓	?	X	?	X
2. Are small-scale, traditional fishing methods mostly used to harvest sea cucumbers?	NA	X	X	✓	✓	X	NA	NA	✓	X	X	NA	✓	✓
3. Are the abundances of sea cucumbers in the fishery stable?	✓	X	X	X	X	X	X	✓	X	✓	X	X	X	X
4. Are high-value and medium-value species still abundant and well represented in catches?	✓	✓-	✓	✓-	X	?	X	✓	?	✓	✓	X	X	✓-
5. Are large-sized sea cucumbers still caught? Is mostly "A" grade bêche-de-mer produced?	✓	X	✓	X	X	?	X	✓	?	✓	X	X	✓	X
6. Do the benefits from the fishery flow mainly to fishing communities?	✓	X-	X	X-	X	X	NA	NA	X	✓	X	NA	X	X
Decision	U	O-	O	O-	D	D	D	U-M	O	F	O	D	F	O

* Sea cucumbers are protected in several MPAs where fishing of sea cucumbers also occurs in the adjacent areas.

48. The third activity was a snorkel trip to Kwale Island. The group was brought out to the island on two boats and a group of ten participants went to snorkel on the west side of the island. The group searched for sea cucumbers among patches of live corals, sandy floor and seagrass areas (predominantly *Thalassodendron*) at approximately three metres depth. The following species were found in decreasing order of abundances: large *Pearsonothuria graeffei* was quite abundant, two small (less than 20 cm) *Thelenota ananas*, two *Actinopyga echinites*, two *H. atra*, one *Bohadschia subrubra*, one *Stichopus herrmanni* medium-sized and one *H. edulis* (16 cm).

49. The fourth activity was a visit to a processing facility in Mtoni just north of Stone Town on Unguja Island. The processing facilities showed the classical processing procedures. The participants observed live catch, salted boiled product, smoking racks, drying in oven, and sun drying on bare concrete. Observed species in seawater, ready for the first boiling were: several *Stichopus herrmanni*, *Holothuria spinifera*, *H. lessoni*. There was a large variety of species, drying in the sun, graded by species; most were from medium to low value. The high-valued teatfish (black teatfish *H. nobilis*, white teatfish *H. fuscogilva* and *H.* sp. "pentard") and several large specimens of *Thelenota ananas* only represented a small percentage of the large quantities of drying product. A large batch of *Thelenota anax* of large size was still drying, as were many *Bohadschia* spp. (some *B. atra*, *B. vitiensis* and other species). Stichopodids represented also a fair amount of product, with *S. herrmanni* and another characteristic species that had large papillae presenting a spiny appearance and which could be *S. naso* or a yet undescribed species. The *Actinopyga* spp. were fairly abundant with mostly *A. echinites* and *A. mauritiana*, which are both traded under the local name "Mbura" in Zanzibar. Finally, several small species including *H. atra* were mixed together. Several bags, containing dry product, already sorted by species, were ready for shipping in the large drying room.

Session 5 - Decision-making in sea cucumber fisheries management

Key points of the session:

- Participants proposed management measures and actions following FAO roadmap manuals and based on the identified status of their fishery (from the previous session).
- Size limits, gear restrictions and licences and logbooks for exporters were the most commonly chosen regulatory measures.
- Participants from countries with fisheries where many categories of people and activities are represented found it difficult to navigate through input controls such as licensing systems.
- Periodic closures (seasonal or otherwise) with associated appraisals of impact and decisions are limited by capacity of responsible agencies.
- Management advisory committees (MACs) should reflect the fishery by including participants relevant to the fishing activities (e.g. councils, fishers, industry) and institutional context (several agencies).
- Accountability for conduct and decision-making should reflect the engagement of stakeholders in the fishery (e.g. assigned to participants intimately involved with the fishery), but complex governance arrangements make accountability difficult to define and assign.
- Restocking is considered in a number of locations but care must be taken so that it does not take attention and resources away from the underlying challenge of sustainable fisheries management.

50. Chantal Conand presented a seminar on "Choosing regulatory measures and management actions to use, based on a decision support tool from the Galapagos workshop and exceptions". The presentation addressed three main questions: what type of fishery is being managed? What is the status of the stocks? And what is the management capacity?

51. Following the identification of the status of each fishery, the participants were divided into workgroups and assisted in following the FAO roadmap to determine the regulatory measures and actions needed for their fishery. Similarly to the ACIAR manual, it was stressed that the roadmap serves

as a suggested starting point for which regulatory measures and management actions may be the most appropriate depending on: i) the fishery type; ii) the stock status; and iii) the technical capacity and human resources of the fishery agency. The proposed regulatory measures and management actions are summarized in Tables 7 and 8.

52. In the course of working through the FAO roadmap, the participants encountered barriers and challenges to implementation that were discussed in plenary. The issue of fishery diversity was debated (note the diversity of activities and resource users among the participating countries from the pre-workshop forms in Section A, Fishery operation) and the question on how to manage fisheries with many people, who may be men, women, children, and occasional fishers. This discussion centred on the importance of understanding the demography of the fishers and the difficulty in licensing fishers when they are many and several groups of people. In addition, the gender/age of fishers may cause different fishing methods and harvest at different fishing grounds, requiring different management measures. From experience in the Pacific, women can be included in processing, generating additional income for fishing families.

53. The management process on which periodic closures should be operating was discussed. The reasoning behind the closures is partly to allow for stocks to recover from fishing effort, but importantly to allow for management systems to gauge the fishing impact and decide upon relevant effort for re-opening the fishery. In cases where there are seasonal closures (annual), it may be beyond the capacity of agencies to conduct fishery-independent surveys to gauge impact. This should be interpreted in the context of the results from the pre-workshop forms (Section B, Human resource capacity and monitoring), where most participating countries stated that they lack the funds to conduct in-water assessments of stocks. This is a barrier for implementation of management that is perceived by the participants as beneficial to these fisheries. In those situations, however, logbook analysis can potentially complement in-water assessments for short closures/ operations. In fisheries with large and diverse groups of fisheries, perhaps logbooks at the processor or export level is a feasible option. The main benefit of seasonal closures is that managers can limit the time/effort in the fishery over the year. One suggestion is to open fisheries in times when fishers may be in particular need for additional income (Eid-al-Fitr, school fees, other religious or cultural holidays).

54. The implementation of MACs was discussed because questions arose on their scope (e.g. should they be specific for species?) and their composition (e.g. who should participate?). Fishers often collect several species (other than sea cucumbers), so in the discussion it appeared that it would be relevant and beneficial to have cross-fishery information sharing and integrative decision-making with other fisheries. This was, for example, raised by Seychelles, where sea cucumber fishers also collect shellfish. This is also the case in Zanzibar, where sea cucumbers are part of a multispecies catch (gastropods, lobster, and a range of fish targeted with spear guns) from intertidal areas to deep habitats (Eriksson, de la Torre-Castro and Olsson, 2012). In Madagascar, it was presented that species-specific MACs exist, and that for sea cucumber fisheries, an advisory group exists that includes representation from the government, fishers and the market (China).

55. The discussion also touched upon elements of assigning accountability. Assigning accountability to high levels can be misdirected, as directors may be “detached” from the activity (not actively participating in the fishery or its management). A central question is: “What is the engagement of the different stakeholders in the management process?” Accountability should be directed to relevant levels in that process. Several levels in governance can also make it difficult to define, assign and formalize accountability. It is important to maintain accountability to “lower levels” in the governance system. Those accountable should be given the appropriate resources to fulfil the task. In Zanzibar, an example was presented where accountability has been assigned to communities managing no-take zones of an invertebrate fishery (arkshells, *Anadara* spp.).

Table 7. Summary of each fishery's proposed regulatory measures from workgroups in session 5. Ticks (✓) are "yes", and question marks are desirable but unsure due to limited capacity. SS is small-scale; Ind. is industrial. U = Underexploited, M = Moderately exploited, O = Overexploited, F = Fully exploited, D = Depleted.

Country/ territory	Fishery type	Stock status	Size limits	Gear restriction	Limit number of fishers	Limit boat size	Catch quotas	Licences and logbooks for exporters	Licences and logbooks for fishers	Seasonal or short-term closures	Bans and moratoria	No-take reserves	Rotational harvest closures	Area and user access rights	Set a small list of permissible species	Closure-pulse fishing-closure strategy
Comoros	SS	U	✓	✓	-	-	✓	✓	-	-	-	✓	-	-	✓	-
Egypt	SS/Ind.	D	✓	-	-	-	✓	-	-	-	✓	-	-	-	✓	✓
India	SS	O	-	-	-	-	✓	✓	✓	-	-	-	✓	✓	-	-
Kenya	SS	O	?	✓	-	-	-	✓	✓	✓	-	✓	-	✓	-	-
Madagascar	SS	O	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓	✓	-
Madagascar	Ind.	M	✓	✓	-	-	✓	✓	-	-	✓	-	-	-	-	-
Maldives	SS	D	-	✓	-	-	-	✓	✓	-	-	-	-	-	?	-
Mauritius	SS	D	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-	-	?	-
Mayotte	SS	U/M	✓	✓	-	-	-	✓	✓	-	-	✓	-	✓	✓	-
Oman	SS	O	-	✓	✓	-	-	✓	✓	✓	-	-	-	✓	-	-
Seychelles	Ind.	F	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	✓	-	-
Sri Lanka	Ind.	O	✓	✓	✓	-	✓	✓	✓	-	-	✓	-	✓	✓	✓
United Republic of Tanzania	SS	D	✓	✓	-	✓	-	✓	✓	-	-	✓	-	-	✓	-
Zanzibar	SS	F	✓	✓	-	-	-	✓	✓	-	-	✓	-	-	-	-
Yemen	SS/Ind.	D	✓	✓	-	-	-	✓	✓	-	-	✓	-	-	-	-

Table 8. Summary of each fishery's proposed management actions from workgroups in session 5. Ticks (✓) are "yes", and question marks are desirable but unsure due to limited capacity. SS is small-scale; Ind. is industrial. U = Underexploited, M = Moderately exploited, O = Overexploited, F = Fully exploited, D = Depleted.

Country/ territory	Fishery type	Stock status	Overview of the harvested species	Fishery-independent stock surveys	Fishery-dependent stock surveys	Socio-economic surveys	Price monitoring	Support local-scale management	Establish management advisory committees	Legislation of management regulations	Assign accountability	Enforcement	Education and communication with stakeholders	Improve quality of processing through training	Restocking	Supply-chain restrictions and\or auctioning
Comoros	SS	U	✓	✓	✓	✓	-	-	-	-	✓	✓	✓	-	-	-
Egypt	SS/Ind.	D	-	✓	✓	✓	✓	-	✓	✓	✓	-	✓	✓	✓	-
India	SS	O	-	✓	✓	✓	✓	?	✓	-	-	✓	✓	✓	✓	-
Kenya	SS	O	-	?	✓	✓	-	✓	-	✓	-	✓	✓	✓	-	-
Madagascar	SS	O	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	-	-
Madagascar	Ind.	M	✓	-	-	-	✓	-	✓	✓	✓	✓	✓	✓	-	-
Maldives	SS	D	✓	✓	✓	✓	-	-	?	✓	-	?	✓	✓	-	-
Mauritius	SS	D	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓	-	-
Mayotte	SS	U/M	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓	-	-	-
Oman	SS	O	✓	✓	✓	✓	-	-	?	✓	?	✓	✓	✓	?	-
Seychelles	Ind.	F	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-	-
Sri Lanka	Ind.	O	-	?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	?
United Republic of Tanzania	SS	D	-	✓	-	✓	-	-	-	✓	-	✓	✓	-	-	-
Zanzibar	SS	F	✓	✓	✓	✓	-	?	✓	?	✓	✓	?	?	-	-
Yemen	SS/Ind.	D	-	✓	-	✓	-	-	✓	✓	✓	?	✓	✓	-	-

56. Finally the discussion focused on restocking programmes. In India, it was presented that there is a collaborative programme (by the government) that can do restocking. Critical factors are funds, technological expertise, support, and good ecological understanding of target species. For example, choosing sites and species for restocking is difficult and a thorough ecological understanding is critical. This knowledge is not widely present within countries and this is a barrier because ecological predisposition must be considered. This missing knowledge was emphasized in the context of the findings from the pre-workshop forms where species that are low value and not ecologically predisposed (e.g. present in deep or complex coral reef habitats which is difficult to farm and recoup animals in) are considered. Facilitators emphasized in the discussion that managers should not "put all their eggs in one basket", abandoning management strategies to rely on restocking. There have to be clear objectives in restocking programmes. If the fishery has been depleted, then the causes of the stock depletions should be addressed before considering restocking – otherwise the use of the investments will be limited. There are no examples from around the world that restocking no-take zones with juveniles has had any positive effect on fishable stocks of sea cucumbers.

Session 6 - Governance of sea cucumber fisheries, enforcement and inspections

Key points of the session:

- The institutional system was emphasized as important in governing fisheries management.
- A diversity of institutional systems was evident in the Indian Ocean.
- Important to bridge organizational gaps through broad participation in influencing forums (e.g. MACs or decision-making meetings).
- A management intervention is only effective when compliance is high, therefore effective and consistent enforcement and inspections are needed.
- An enforcement and inspection programme not only requires the resources (people, equipment and funds), but also a protocol for inspection and database.
- Involving local stakeholders in enforcement has some advantages and constraints.

57. This session focused on highlighting and exploring the governance context of sea cucumber fisheries management. A seminar by H. Eriksson presented a summary of research on governance and natural resource management. This summary identified that it is important to reflect on the participation in the formation of rules and enforcement. Following the seminar, the participants did a stakeholder identification and participation exercise. In the exercise each participant identified the organizations or agencies (e.g. government authorities, non-governmental organization [NGOs], fisher associations, and the market sector) that influence firstly, policy and rules, and secondly, monitoring and enforcement, in their country's fishery. This exercise aimed to add perspective on the circumstances that management is implemented in and how the different countries that were represented at the workshop operate under very diverse institutional systems. For example, it became evident in the exercise that Egypt and Seychelles had three government bodies that influenced policy and rules (Table 9). In Seychelles, the association of members of the sea cucumber fishery was also identified as able to influence policy and rules. In contrast to these two cases, countries like Kenya and the United Republic of Tanzania appeared to have a more complex institutional system with many government bodies and representation of NGOs or fisher organizations (e.g. village fishing committees or beach management units [BMUs]) that in some capacity shape policy and rules for this fishery. In the discussion following the exercise, the complexity and diversity of these systems was highlighted. For example, government agencies are sometimes under the same department or ministry, which can facilitate dialogue and cooperation, but in instances where this is not the case efforts are required to bridge organizational gaps. There also appeared to be differences between the organizations that influence policy and rules and those that influence monitoring and enforcement. This difference appears intuitive, as rule-makers and enforcers are not necessarily the same, but again highlights a substantial challenge to bridge organizational gaps in the institutional system. It was discussed that including all identified organizations in MACs or even decision-making bodies can

facilitate dialogue and cooperation in matching the organisations that influence policy and rules to those influencing monitoring and enforcement.

58. From the broad overview of governance and this stakeholder participation exercise, the session then narrowed down to one governance aspect that the countries identified as a challenge, that of enforcement and inspections. Ms N. Muthiga gave an introductory presentation on the definition of enforcement, the aspects that need to be taken into consideration when designing an enforcement and inspection programme, and the capacity (people skills and equipment) needed for a basic programme. Participants then held a facilitated discussion on the challenges encountered in enforcement programmes in their countries.

Table 9. Summary of the number of organisations or agencies that influence policy and rules in each country's fishery. NB: Eritrea, Mozambique and Rodrigues did not participate at the workshop.

Country/territory	Government	NGO	Fisher associations	Market
Comoros	4	2	-	-
Egypt	3	-	-	-
India	10	-	1	3
Kenya	7	3	2	3
Madagascar	8	3	1	-
Maldives	5	-	1	1
Mauritius	5	-	-	1
Mayotte	7	1	1	2
Oman	5	-	1	1
Seychelles	3	-	1	-
Sri Lanka	6	1	1	1
United Republic of Tanzania	6	1	1	1
Zanzibar	6	4	3	1
Yemen	3	2	-	-

59. The working definition that was presented for enforcement was the following:

> Enforcement is an intervention to ensure that users comply with management regulations and enable penalties to be ascribed to offenders. Enforcement may entail physically checking catches, gear used on boats, or the areas being fished, and imposing fines or other sanctions if the catch or fishing gears are not in accord with the regulations (Purcell, 2010).

60. The importance of taking into consideration the context of the fishery and the environment within which it operates was emphasized. For example, it is crucial to have an understanding of the biological, ecological and socio-economic characteristics of the fisheries. Information on the geographical boundaries of the resource, whether dealing with a single or species/multispecies fishery, the characteristic of the users/fishers including the number, level of dependence and socio-economic conditions, the institutional arrangements whether sectoral or multisectoral and jurisdictional issues and finally the external environment including trade, transboundary conflicts and political issues are all key aspects that need to be considered when designing an enforcement and inspection programme.

61. Because a management intervention is only effective when compliance is high, there are some key capacity elements that are needed for surveillance to enhance compliance. These include resources for enforcement (such as cameras, Global Positioning System [GPS], measuring and weighing equipment, identification cards for all species of fresh and dried products), skills and capacity for enforcement (identification, conflict resolution, legal knowledge, sea safety skills), monitoring and

evaluation skills (evidence collection, data recording and reporting skills) and consistency in applying enforcement (funds to conduct regular inspections), and stakeholder engagement (communication strategy, advisory committee, etc.). The importance of keeping reliable and accessible records in an enforcement database was emphasized. This need not be a very complex database and could consist of the following minimum information: the dates and time, the details of confiscations (species, sizes, weights), information of the offenders including the offender's name, boat name, people on board, the type of gear used, the fishing area, relevant photographs. It was also recommended that the enforcement unit should produce regular reports on inspection results quarterly/annually and review the reports and adapt management actions. In addition, an inspection protocol that could be followed during each enforcement and surveillance exercise was recommended. Ultimately, the enforcement and inspections strategy that would include all the elements detailed above should be included in the management plan of the fishery.

62. Finally, the benefits of involving local stakeholders in patrolling and surveillance were presented. Such a strategy has many advantages, including promoting a shared sense of responsibility for compliance, which reduces costs and infringement of regulations. It also has the broader advantage of encouraging a sense of local ownership of management activities, which could lead to an improved overall management of fisheries as many sea cucumber fishers also collect other groups. However, participants were cautioned to be realistic and aware of the challenges of stakeholder involvement; for example, the potential for violence during enforcement activities, and the need for appropriately selected and trained local participants in enforcement activities. Issues could also arise if locally recruited rangers ignore illegal activities perpetrated by their own communities, and if equipment is misused. Overall, a consistent and reliable enforcement programme however simple that puts eyes on the ground and that collects reliable information to feed back to management would be more effective than sporadic enforcement activities.

Session 7 - Fisheries case studies and management plans

Key points of the session:

- The Comoros, Kenya, Oman and Sri Lanka were selected as case studies.
- Group discussions focused on addressing case study country's management challenges and exploring idiosyncrasies between other countries.
- Participants identified and ranked management objectives for their fisheries.
- The highest ranked objective among the participants was to "Maintain/restore sea cucumber populations for future generations".

63. Four fisheries were selected for case studies: the Comoros, Kenya, Oman and Sri Lanka. These were selected because they differed to some extent in geographic location and current management. The case studies aimed for group interaction, addressing potential regulatory measures and the currently experienced management constraints. During the exercise, the participant representing the case study country was assisted by 3–4 other participants from nearby countries or with similar management situation and challenges.

64. The participant representing the case study country presented the key issues that were identified and discussed by the case study groups in a plenary. A brief summary of the cases is presented below.

65. The following discussion points were suggested for the groups to focus and comment on:

Management actions

- Key constraints and impediments to improving sustainability
- How to achieve acceptable enforcement

- Can advisory committees or local level management be supported?
- Research or information needs
- Define the communication strategy with stakeholders
- Issues with post-harvesting and trade – how to improve the situation
- Governance issues

Regulatory measures

- Specifics about regulatory measures
- Which species to put on a "permissible species list" and how many to allow to be harvested
- If quotas, how to set these and what levels are appropriate
- How could fishers be licensed? What conditions? Licence fees?
- Regulate number of buyers? Licensing requirements for buyers?
- Are more no-take marine reserves needed and what are the impediments?
- Are short-term closures a good strategy? For how long? When?

Case study - the Comoros

66. Despite the fishery being illegal, there still exists IUU fishing and the first step of processing (first boil) in the Comoros. The product is shipped by boat to Zanzibar apparently with the knowledge of the customs department. This is coupled with a lack of awareness of the ban on sea cucumber among the regulatory authorities. Therefore, the discussion focused on actions to inform stakeholders of the ban and basic knowledge for a sustainable fishery. This includes training and raising the level of awareness among management authorities. It was identified that there is a will and human capacity to address this but funding is scarce to support management actions. There are no regular underwater censuses being conducted in the Comoros and there is a shortage of information about the country's sea cucumbers. In parallel, there is no monitoring of exports, so the information available on the trade is also limited.

67. There is a plan to reopen the fishery in 2013 with a new management plan. The plan includes new strategies to develop dialogue and interaction with fishers. This has already begun on Moheli Island. The strategy will include meetings in villages and dissemination of information materials, such as posters. To address post-harvesting and trade issues, there is now a need to support villages to complete the whole processing. In conjunction with this, a suggested strategy is also to implement exporter logbooks to monitor trade. In addition, these are the suggested management regulations suggested for the reopening of the fishery:

- permissible list of 6 species (black and white teatfish, *T. ananas*, *H. scabra*, *T. anax*, *H.* sp. type "pentard");
- quota of 2 tonnes of dried products per month;
- Size limit of 17 cm (fresh);
- licence for fishers -> No;
- number of buyers -> 1 company;
- No-take zone -> 8 marine reserves;
- seasonal closures -> no;
- resource assessment: logbook filled by "ecoguards" (officers employed by the marine park authority) at a central landing site;
- scuba allowed only to certified divers (but there are no fisher divers in the Comoros, which raises the question if they will come from Madagascar).

Case study - Kenya

68. The diversity and complexity of the fishery was noted as a constraint to management. For example, it was emphasized that there are many people in the fishery and that it targets many species. A key constraint is that sea cucumbers are landed at multiple locations and this makes it difficult to maintain monitoring and enforcement. There also appears to be a great deal of transborder trade, which makes the fishery even more difficult to monitor. Limited understanding of the ecology and status of most species also limits management.

69. Funding for enforcement is required, along with further development of co-management arrangements and more rigorous and specific regulations for the sea cucumber fishery. Co-management arrangements through the BMU process are already in place, and there is a plan to support local-level management in Kenya. Capacity building is important in this context and can perhaps be achieved through strategies to support MSc and PhD students that research the topics associated with the sustainability of this fishery. Increased interactions in governance are required to make the link between all the different actors involved in sea cucumbers, e.g. government institutions, NGOs, traders.

70. To improve the profit potential among village members, a series of workshops to train in processing would be desirable. Within the same ambition to improve processing, an effort to inform about species value could assist fishers to receive a fair value for their catch.

71. A short list of permissible species would perhaps be desirable as this would make it easier for officers to identify species and could steer fishing towards species that appear more ecologically able to cope with fishing. This is probably not possible, however, because the species could be fished and sold in Tanzania or in the island of Zanzibar. Strategies that influence the fishery in this region could possible benefit from being standardized across the region. Quotas will be difficult to develop as there are few ecological data to base quantities on and limited capacity to enforce in the multiple landing sites. Licensing would possibly be a feasible way to engage with the buyers/exporters both as a focal point for regulations (given the spatial spread of the fishery) and to monitor catch volumes. Regulations at the fisher level are probably best included in ongoing village fishing arrangements and marine management areas.

Case study - Oman

72. In Oman, the key constraints to achieving a sustainable fishery were summarized as:

- open access;
- accessibility;
- low expertise;
- decision-makers do not prioritize the fishery;
- difficulty in obtaining fisheries-dependant data.

73. At the moment, there is no fishery regulation in Oman. Therefore, the first step is to implement sufficient regulations and then the second step is to gather the resources to apply these regulations (people, funds, equipment, skills). Step one can perhaps be achieved through use of a benchmarking approach and by utilizing the knowledge from this workshop. Advisory committees and the support of local level management are feasible but will require a lot of effort, including training, facilitation and mobilization.

74. In 2007 a fishery-independent survey was carried out. However, resurvey and fishery-dependent data are needed (stock assessment, catch data, processed products, number of people fishing, catch per unit effort [CPUE], types of gear, stakeholder analysis, etc.) to better inform management. A wide-ranging survey to meet these information needs is necessary and, within such a

project, a communication strategy can be developed to facilitate dialogue with fishers. There is a basic governance structure, represented in the ministries of agriculture and fisheries, and municipal government. A review of this structure and the participation of fisher groups will also be important.

75. Quotas are difficult to enforce, as there are many fishers and complex spatial patterns for fishing and landing that will be a barrier to monitoring. Licences may be feasible to implement for fishers, collectors (intermediaries) and exporter. The licence will have the location, resource and gear.

Case study - Sri Lanka

76. In Sri Lanka, the key constraints and impediments to improving sustainability were summarized as follows:

- lack of abundance data;
- information available is spatially limited;
- limitations in funding;
- licensing of fishers, processors and exporters (but no limits on the number of licences);
- illegal shipments into and out of the country unknown;
- no permissible lists or size limits are currently implemented;
- exporters used not to buy animals below a certain length, but this is changing now.

77. This situation highlighted a need to pursue more research and information to support improvements in management, especially socio-economic surveys and appraisals of the stock status.

78. The many landing sites that need to be monitored limit enforcement, and officers (fishery and customs) cannot identify the different species in the fishery. Perhaps an approach to continue to include the navy in the management plans and enforcement may be a feasible way forward. The inclusion of the navy is important for surveillance of illegal fisheries. There are about 2 000 families participating in the sea cucumber fishery and there is a plan for local level co-management arrangements, but it is in the early stages of development. There are regular community-level meetings (every three months), the fishery inspectors monitor the landing sites on a daily basis, and fisher associations have been formed at the regional level – so there is some advancement in government-to-fisher dialogue. Governance is complex and difficult because there are many ethnic/religious groups that have different views of the rules and regulations. There have been conflicts between the central government and the provincial council.

79. There is scope to improve processing but only 1 percent of the fishers are estimated to do their own processing, so at the moment there is limited scope to improve add-on value to fishers. There appears to be a trend of shifting towards collection of low-value species, and therefore a list of permissible species is a good option to reduce stock depletions. It is impossible to develop relevant quotas with the current level of knowledge about the status of stocks. The perceived next steps are to implement short fishing seasons to focus control over a shorter period, to limit the number of fishers, and the implementation of a general licence with specific guidelines on the collection of sea cucumbers. The licence would be renewed for those that can show that they have complied with the set conditions.

Ranking management objectives

80. The session plenary also focused on the development of management plans and their objectives. This was perceived as particularly relevant as only six out of 17 countries had reported in their pre-workshop forms that they had a management plan for their fishery. The first step in the development of a management plan is a clear idea of the management objectives.

81. The participants suggested and agreed on a list of ten relevant management objectives in a group exercise. Each participant then individually ranked, in their personal view, the objectives in order of priority for their fishery, ranging from the most important objective (1) to the least important objective (10). Lower mean ranks are therefore the objectives most commonly considered by participants as being more important for their fishery. The management objectives and each country ranking are shown in Table 10.

Table 10. Summary of the prioritization of management objectives exercise. Most to least important objectives were ranked by each participant from 1 to 10, respectively.

Fishery management objective	Comoros	Egypt	India	Kenya	Madagascar	Maldives	Mauritius	Mayotte	Oman	Seychelles	Sri Lanka	United Republic of Tanzania	Zanzibar (UR of Tanzania)	Yemen	Mean
1. Maintain/restore abundances of sea cucumbers for future generations	1	4	6	1	1	1	1	2	1	4	2	1	5	6	2.6
2. Maximizing the economic return from the fishery	4	6	1	2	10	7	3	10	4	3	4	8	2	4	4.9
3. Maintain ecosystem health in the fishing grounds	6	3	4	3	7	4	4	1	7	6	5	2	3	2	4.1
4. Promote conservation and biodiversity of sea cucumber populations	2	7	5	6	5	3	7	3	8	7	6	3	1	10	5.2
5. Make sure fishing benefit communities	3	5	2	7	6	6	10	6	5	1	3	7	4	3	4.9
6. Safeguard a continuous and sustainable rate of exploitation	8	1	8	10	2	2	8	7	9	2	1	4	6	1	4.9
7. Ensure community participation and ownership of resource and decision-making	7	9	10	4	3	5	5	4	6	5	7	6	7	5	5.9
8. Ensure large animals are available in fishing grounds	5	8	3	9	8	10	6	8	10	10	8	9	9	7	7.9
9. Ensure that exports comply with regulations	9	10	7	8	9	9	9	9	2	8	9	10	8	8	8.2
10. Restrict illegal fishing (IUU)	10	2	9	5	4	8	2	5	3	9	10	5	10	9	6.5

Session 8 - Contextualizing the workshop for implementation in the Indian Ocean

Key points of the session:

- Three prioritized topics of research and actions were identified to facilitate better management in the region:
  1. Regional/subregional coordination for management.
  2. Addressing knowledge gaps for understanding sea cucumber population status and ecology.
  3. Meeting the needs for training.

82. The plenary discussion in this session focused on the constraints to improved management and the research needed to break these constraints. This discussion has been summarized in three broad prioritized topics below.

1. Regional/subregional coordination for management

83. During the course of the workshop the participants noted cross-border activities that limited their ability to manage stocks within their own country. This was for example the case in the Red Sea subregion where mobile fishers travelled into other countries waters to harvest sea cucumbers. Similarly, the proximity to Zanzibar was a limit to Kenya and Tanzania to uphold management regulations that were not in place in Zanzibar, as fishers can sell their catch there. In the fishery case study of Kenya in Session 7, the regulation to limit the number of harvestable species was perceived as unworkable unless all neighbouring countries also implemented the same list of species – otherwise fishers would travel to sell other species to those countries. These cross-border situations prompted a discussion on the relevance and potential paths towards subregional cooperation between the states in the Red Sea and in the Western Indian Ocean for management, including surveys and stakeholder identification. No clear way forward could be identified, but there was a recognized need for research on the enabling conditions towards these types of cooperative management and governance partnerships (e.g. Eriksson, de la Torre-Castro and Olsson, 2012). It was emphasized that the support by global and regional organizations such as FAO or WIOMSA is important for bringing relevant actors to the table for dialogue and that it is important to raise the level of awareness and participation in governance. The Arabian Gulf and Red Sea currently do not have the same level of coordination as the countries represented in the WIO, and this is a barrier towards improvements there. The Southwest Indian Ocean Fisheries Commission (SWIOFC) could be a feasible organization to raise the issue of sea cucumber fisheries. Being representatives of their countries, the participants could act as agents to influence the discussions and decisions of their members in the SWIOFC and regional fisheries meetings.

2. Addressing knowledge gaps for understanding sea cucumber population status and ecology

84. The participants indicated that there is a need for support for habitat mapping and appraisals of sea cucumber stocks. This was raised in the context of the scarcity of basic biological data for many harvested species, preventing informed decision-making. The participants emphasized in particular that understanding the life-history, connectivity and habitat utilization of commercial sea cucumber species needs to be improved to assist in definitions of ecological scales and ability to implement an ecosystem approach to management. This information is also important to gauge the effectiveness of no-take zones/reserves.

85. Barriers towards making reliable appraisals were the lack of funds (as mentioned in the pre-workshop forms) and, in some contexts, the political will to spend money on this fishery. Another more pragmatic barrier to collecting information on stocks is that in-water sampling in this part of the world is strongly affected by monsoonal weather patterns, which influence the accessibility of some fishing grounds. For example, in Mauritius, there are scattered islands within the territory that have

been difficult to survey due to inaccessibility for researchers (but are potential target locales for fishers). The issue of lack of species identification skills also surfaced and there was a consensus that there is a need for training at the regional level on species identification of both live animals and products (see section below on training needs). In addition, a larger genetic study is required to improve understanding of taxonomy and connectivity.

86. In the context of missing information, participants discussed that countries in the region would benefit from having a database for information (grey and scientific literature), a platform that can also constitute a forum for sharing of experience and maintaining networks of people involved with managing the fishery in the region. This may be facilitated through an actively managed web page. WIOMSA can provide administrative support for such activities (e.g. web page). Further efforts on regional workshops and technical meetings are also relevant to pursue as that has the scope to further support local improvements in management. Building on the MASMA-funded regional project, other regional activities can be designed to, for example, facilitate standardized protocols for more reliable and comparable data collection methods on abundances and catches, as well as collection of trade and socio-economic data throughout the regions.

87. It was emphasised that value-chain analysis would help managers better understand how the profits of the fishery are benefiting local fishers. In most locations, it appears to be unknown how much value is added to the product as it goes through the chain of intermediaries and traders through to China. This type of information could support activities that promote fishers' ability to better capture profits and the poverty alleviation strategies of the countries. At least eight countries voiced their support for such research. Research should ideally include market studies following products (also including regional transborder shipments) from the fishing grounds to recipient markets and consumers.

3. Meeting the needs for training

88. Participants identified multiple training needs during the plenary discussion. Species identification training activities that target relevant management levels were requested. These types of identification programmes should include live animals and basic identification procedures (including extraction of ossicles). At least ten participants identified that training for export officers in identifying bêche-de-mer would be valuable for improving monitoring and the ability to enforce species restrictions. The FAO sea cucumber species identification guide (Purcell, Samyn and Conand, 2012) will assist managers and export officers in identification, but practical training was also suggested to enhance skills and facilitate implementation of monitoring programmes.

89. The discussion also focused on value-chains of the fishery product and how these can be monitored and improved to allow for greater profits to be captured at the fisher and national level. Training workshops in processing for fishers and processors were requested. A processing workshop was held in 1985 in Dar es Salaam on fish handling and bêche-de-mer processing, but since then no such practical activity addressing processing improvements has been conducted. As the market has developed since the training, and there appear to be relatively large benefits in profits by employing simple processing measures for product improvement, such training for product improvements could be an invaluable tool to increasing incomes.

90. Requests for a standard survey methods protocol so that densities are comparable in the region were also raised, along with suggested activities on how to implement marine no-take zones. Examples of data collection forms for sea cucumber abundance and fishery data surveys can be found in the report by Purcell, Gossin and Agudo (2009). The discussion also included the importance of enhancing research capacity by increasing and supporting more MSc and PhD students to become involved in the research of sea cucumber ecology and fisheries management.

91. Despite the workshop focusing on fisheries management, participants also noted that there are training needs on various aquaculture aspects of sea cucumbers. These include low-tech aquaculture

(e.g. capture-base aquaculture), multitrophic co-culture strategies and use or implementation of hatcheries. The discussion also included aspects of improved knowledge of ecology and life-history of suitable species and development of strategies for community-based mariculture. Sea cucumber aquaculture activities are operating in Maldives and Madagascar that could provide valuable learning experiences for other countries in the Indian Ocean.

CONCLUSIONS AND RECOMMENDATIONS

92. The ability of sea cucumber fisheries managers in the Indian Ocean to implement strengthened management is limited by barriers such as lack of data to define the situation, limited capacity and complexity in resource use. These issues were at the core of the workshop. The analysis of the participants' responses to the workshop satisfaction form (see next Section below) suggests that the workshop format was suitable for facilitating the incorporation of the ACIAR and FAO manuals in decision-making in the Indian Ocean fisheries. The six indicators of fishery health in the ACIAR manual assisted the participants in defining a status of their fishery. In the process of reviewing the indicators, the participants were not only exposed to ways of interpreting indicators, but also the importance of taking into consideration context, as they observed how other participants reasoned around the indicators' applicability in their fishery. The participants mentioned in plenary discussions that after reviewing the indicators they gained a new understanding about their fishery; for example, that monitoring the number and value of species in fishers' catches can reveal a great deal about the fishery and its status. This self-supported ability for critical interpretation of the indicators was a substantial skill gained from the workgroups. Similarly to the ACIAR manual, the FAO "roadmap" for management regulations and actions exposed participants to new tools and the reasoning behind why to choose different management measures. The session on governance had not been included in the previous SCEAM workshop and was a welcome addition to the workshop, as was the exercise to identify actors that participate in management of sea cucumber fisheries. The session served to influence the perception of the dynamics and complexities of management not only for this fishery, but also in the context of developing marine protected areas and the management of other fisheries.

93. While the facilitators provided a critical and relevant component in coordinating seminars and interactive sessions, much knowledge and confidence appear to have been gained from interactions among the participants. For example, through the workgroups and discussions, the participants exposed each other to the challenges they were facing. In that process, there was a realization of how common the challenges were across the countries, and solutions were shared and debated among themselves, without the input of the facilitators. However, an overarching conclusion on the discussions and workgroups over the week-long meeting was that there are multiple fisheries in the region that target sea cucumbers, and that this diversity illustrates that there are different management requirements and needs between the countries. With this background, the importance of actions to meet the research priorities and training needs as identified in the plenary of Session 8 were summarized (Table 11).

Table 11. Research priorities identified from the Session 8 plenary

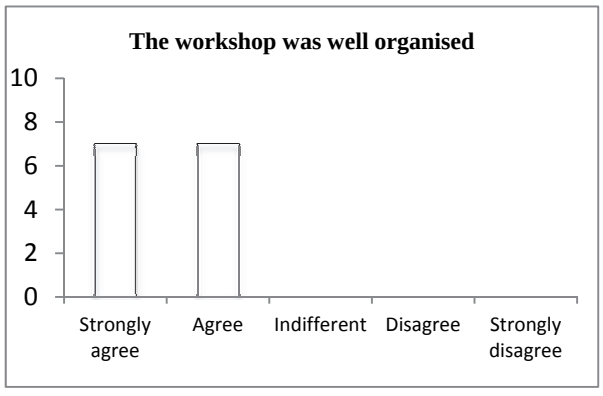
Prioritized research and training needs	Description
1. Research on regional/ subregional patterns and processes	- Quantify and evaluate transborder movements (fishers and products). - Understand the conditions that can enable cooperative management. - Facilitate governance partnerships at the subregional to regional level.
2. Development of a standardized protocol for assessments of commercial sea cucumber populations	- Collation of existing methods and the application of those in commercial sea cucumber population assessments to create comparable data-sets (data collection forms that may be used for this purpose can be found in the report by Purcell, Gossin and Agudo, 2009).

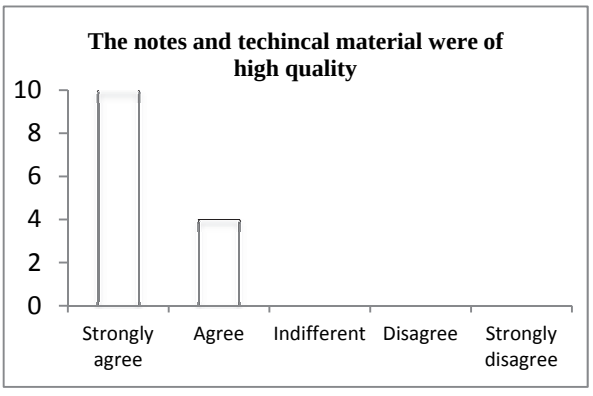
3. Research on life-history and biological metrics to support decisions in fisheries management and aquaculture	- Size at first sexual maturity and population size class distribution of commercial species. - Recruitment processes such as settlement, substrates and habitats. - Species-specific abundances across the region. - Reproduction, growth and development data for harvested species and aquaculture candidate species.
4. Training customs officers and managers in species and product identification	- Development and dissemination of a field guide with photos of live animals and export products (a detailed species identification guide developed by FAO [Purcell, Samyn and Conand, 2012] will be distributed during 2013). - Conducting species and product identification training workshops.
5. Training fishers and village members in post-harvesting improvements	- Development and dissemination of a processing guide. - Conducting workshops on product processing.

WORKSHOP SATISFACTION SURVEY

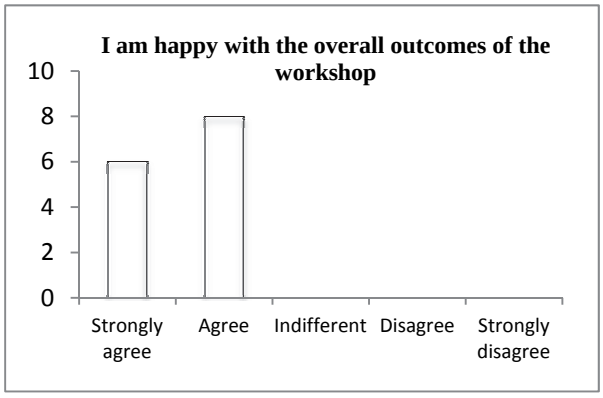
94. The participants agreed that the workshop was well organized and were pleased with the quality of the technical material (i.e. workshop binders containing PowerPoint hand-outs, relevant references, general information and a laminated sheet of the species identification card).

95. The responses from the survey are detailed below. Note that the y-axis on all figures below is the number of responses for each response category.

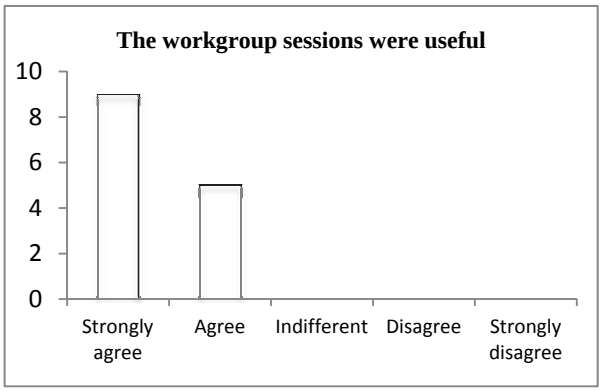


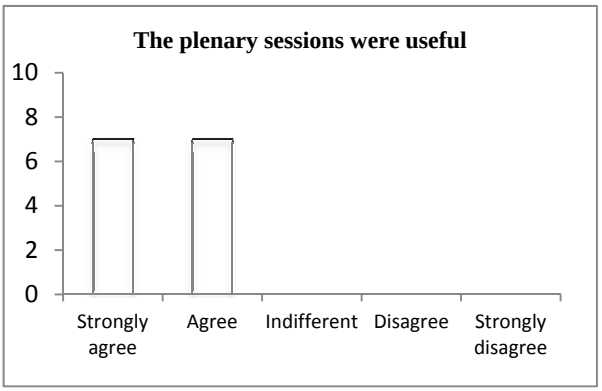


96. All of the participants were content with the outcomes of the workshop.

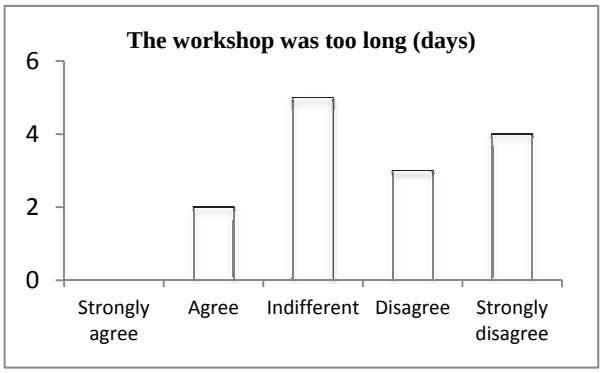


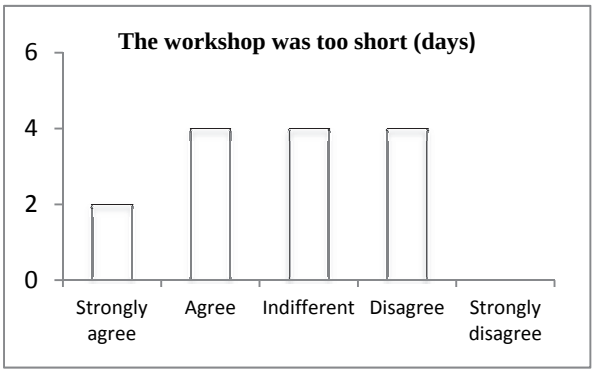
97. Participants felt that both the workgroup sessions and the plenary sessions were useful.



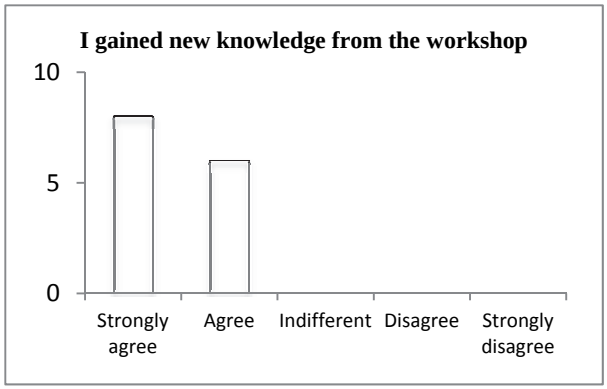


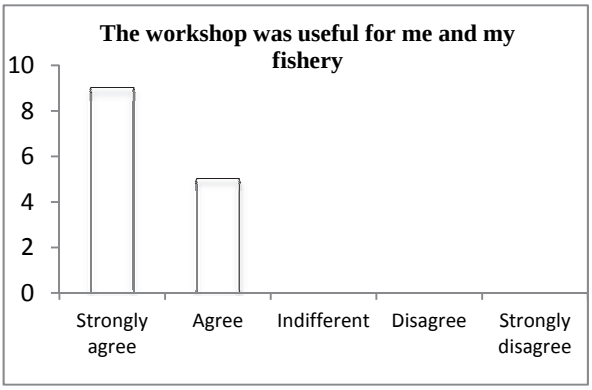
98. Most participants felt that the workshop was neither too long nor too short.



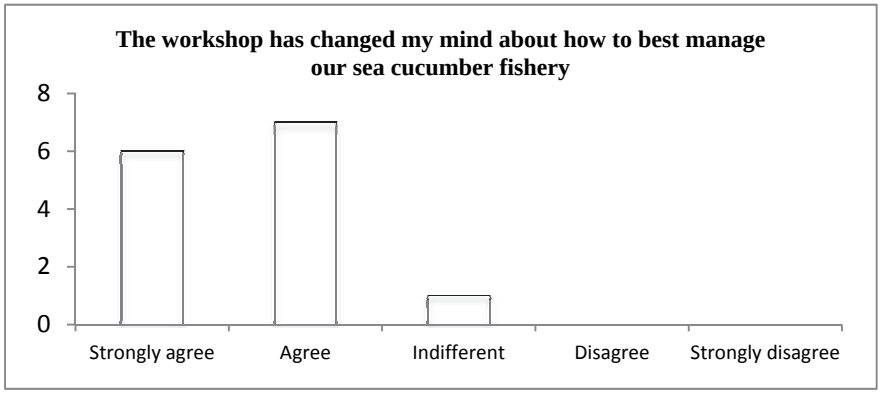


99. Most participants felt that the workshop was useful to them and that they gained new knowledge from the workshop.





100. Almost all participants responded that the workshop had changed their opinion about how to manage the sea cucumber fishery in their country.



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ANNEX 1

INVITATION AND PROSPECTUS

SEA CUCUMBER FISHERIES: AN ECOSYSTEM APPROACH TO MANAGEMENT IN THE INDIAN OCEAN (SCEAM Indian Ocean)

INVITATION

2012-06-26

Address
Address
Address

Dear Mr/Mrs/Dr Participant

We are pleased to invite you to the SCEAM Indian Ocean workshop, which will be organized by FAO (Food and Agriculture Organization of the United Nations) and WIOMSA (Western Indian Ocean Marine Science Association) in Zanzibar, Tanzania, from **12 to 16 November 2012.** We believe you can play a key role in identifying the management measures and main issues facing your country's sea cucumber fisheries.

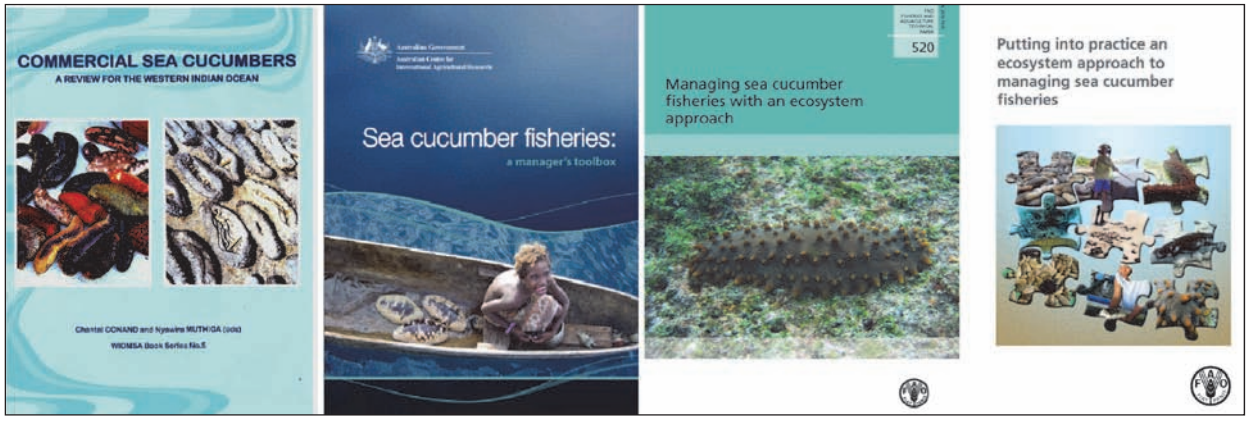
Funding through FAO and WIOMSA will cover your travel costs, accommodation and daily subsistence for the workshop. Additional information on the workshop is provided below. You are kindly invited to confirm your participation **no later than 31 July 2012** by e-mail to **the organizers** (see e-mail below signatures) and copying Dr Hampus Eriksson, member of the organizational Steering Committee (hampus@ecology.su.se).

Julius Francis (WIOMSA)
julius@wiomsa.org

Alessandro Lovatelli (FAO)
alessandro.lovatelli@fao.org

BACKGROUND

Depletion of sea cucumber resources is impacting ecosystems and coastal communities around the world. In the Indian Ocean, nearly half of the sea cucumber fisheries are overexploited and this is impacting on the household income of fishers (Conand, 2008). In response to the urgent need for improved management, a number of projects have been initiated around the world. In the Western Indian Ocean a recently completed WIOMSA-funded sea cucumber project was the first concerted effort in the region to gain a comprehensive understanding on a range of aspects relating to this resource (Conand and Muthiga, 2007). In the Pacific, the Australian Centre for International Research (ACIAR) has published a booklet, *Sea cucumber Fisheries: A Manager's Toolbox* (Friedman *et al*., 2008) following a regional workshop. At a global scale, FAO has supported the development of improved management plans for sea cucumber fisheries through a multifaceted programme. Two outputs from the programme have been a technical manual on the ecosystem approach to managing sea cucumber fisheries (Purcell, 2010) and a simpler guidebook on putting the approach into practice (FAO, 2010). The documents provide a "roadmap" for developing and implementing better management of sea cucumber fisheries.



Covers of relevant reports and manuals in order left to right: Conand and Muthiga, 2007; Friedman *et al.*, 2008; Purcell, 2010; and FAO, 2010. See reference list for full citation and link to free downloads.

While these baseline studies and pragmatic manuals are important and necessary steps forward, the task still remains to assist fisheries agencies to use them to design new and practical management plans to save or maintain sea cucumber fisheries. To meet this objective, FAO and WIOMSA have partnered to coordinate this regional workshop in the Indian Ocean. Primarily, the proposed workshop aims to bring together managers in the region to share experiences on governance and constraints in implementation, and to work towards improved arrangements for fishery management. The workshop will centre on the principles within the ACIAR and FAO guidebooks and the outputs will include proposed sets of management measures for each fishery.

WORKSHOP PURPOSE

The recent manuals by ACIAR and the FAO give technical and practical guidance to diagnosing and managing sea cucumber fisheries. Now is the time to put the principles into action. The workshop seeks to help fisheries agencies from fifteen Indian Ocean nations to apply the principles to their own situations in order to adapt or re-develop management plans for their sea cucumber fishery. Workshop facilitators will deal with some of the more technical aspects of management measures for sea cucumber fisheries and will use group discussions to identify any constraints that may apply to their application in each country. The workshop participants and facilitators will collectively work through a couple of case examples from the participant countries to gain better insight into how to tackle the management challenges that have been difficult to conquer.

The workshop aims to be a platform for sharing management strategies striving towards ecologically sustainable and socially accepted harvest levels. At the workshop, management tools and governance aspects of this high-valued resource will be discussed. The workshop will rely on experiences from both the Indian Ocean and the Pacific, and consist of theoretical and mentoring components to support sea cucumber fisheries management improvements to Indian Ocean fisheries, where they are needed. Workgroup sessions with fishery managers will seek to determine appropriate management actions for fisheries of each participating country.

The workshop objectives are to:

1. Collate and analyse current fisheries contexts, management practices and constraints from Indian Ocean sea cucumber fisheries.
2. Train Indian Ocean managers about technical aspects of the biology and management of sea cucumber fisheries through an ecosystems approach.
3. Assist managers in interpreting and putting in to practice the advice provided in the ACIAR and FAO manuals.
4. Discuss governance contexts and the relevance of tailored national fishery management plans.

INPUTS AND PARTICIPATION

Prior to the workshop, participants should familiarise themselves with the three manuals on sea cucumber fisheries management produced by ACIAR and FAO. The WIOMSA review of sea cucumber fisheries in the Western Indian Ocean and the Regional Review by Conand (2008) also provide important background information. Please find full citation and link to free download in the reference list below.

Each participant will be issued a pre-workshop fishery form that they should complete and submit before **21 September**. The form will need responses about fishery context, current management arrangements and regulations. The responses of the forms will be collated and the information will be used in different aspects of the workshop and in post-workshop reporting. **Please set aside time to fill out the required fishery-data form during early September** so that the facilitators will have time to summarize the information for the workshop.

Participants are expected to contribute to discussions and a few will be invited to give a brief presentation about the sea cucumber fishery in his/her country.

FACILITATORS

Six experts will facilitate the workshop:

Alessandro Lovatelli	FAO Aquaculture Officer	Organizer
Julius Francis	WIOMSA Executive Secretary	Organizer
Chantal Conand	University of La Réunion Professor Emeritus	Marine ecologist Facilitator
Hampus Eriksson	Stockholm University Researcher	Systems ecologist Workshop coordinator/Facilitator

Nyawira Muthiga	Wildlife Conservation Society Director Kenya Marine Program	Conservation Scientist Facilitator
Steven Purcell	Southern Cross University Research Fellow	Fishery ecologist Facilitator

TOPICAL AGENDA AND LOGICAL FRAMEWORK

Day 1 Seminars by the facilitators about fishery indicators, governance challenges and management actions appropriate for different scenarios.

Day 2 Summary of fishery data-forms, illustration of the diversity and complexity of the different fisheries represented at the workshop.

Short presentations from some participants on their country's sea cucumber fisheries and management challenges.

Plenary session to list and prioritise management objectives.

Smaller workshop groups that work through fishery indicators for each country from the ACIAR Manger's Toolbox.

Day 3 Field excursion.

Day 4 Smaller workshop groups that discuss and choose more practical management tools and strategies for each countries context based on FAO manuals.

Plenary discussions of key contentious governance and management issues.

Day 5 Smaller workshop groups to discuss case studies.

Plenary discussions of management plans and legislation.

Recommendations.

The seminars aim to expose the participants to the most current information on sea cucumber biology and ecology needed to apply an ecosystem approach to management. The facilitators will cover scientifically technical concepts and explain results from recent global analyses of sea cucumber fisheries. These will include case studies in the Western Indian Ocean and the Western-Central Pacific.

Choosing management objectives relevant in the Indian Ocean, and prioritizing them for each fishery, is an important initial step. The workshop will use the ACIAR sea cucumber manager's toolbox (Friedman *et al*., 2008) to apply indicators of stock status as a support tool for participants to nominate the stock status of their fishery.

Participants will then follow the "roadmap" in the recent FAO manuals on an ecosystem approach to managing sea cucumber fisheries (Purcell, 2010; FAO, 2010) to appraise the appropriateness of current regulatory measures and management actions in their fishery and propose potential changes. In this context, property rights and formalizing existing or new institutions to support co-management arrangements will also be discussed.

OUTPUTS

1. Each participant should leave the workshop with an increased knowledge on how to improve the management of his/her fishery. They will take away hard-copy tables of current and proposed regulatory measures and management actions for their fishery, an assessment of their fishery status based on objective indicators, and a ranking of management objective priorities for their fishery.

2. A report on the outcomes of the workshop will be published. This report will be made available as a downloadable PDF from both FAO and WIOMSA Web pages. The report will include:

   - lessons from the workshop process to assist future similar workshops;
   - discussion of contentious management issues raised by the participants;
   - a summary of proposed regulatory measures and management actions that would be appropriate to each fishery of the participants' country; and
   - case studies of fishery contexts and how agencies would support different institutions.

3. A scientific publication authored by the organizers and facilitators, based on pre-workshop fishery-data forms and the workshop outputs.

TRAVEL AND ADMINISTRATION

Travel: Please contact the WIOMSA for your travel arrangements. In line with the organizations' rules and regulations, the Organizers will cover your travel costs as follows: a) transportation, by the most direct and economical regularly-scheduled route; b) a per diem for the duration of the workshop. Kindly provide Ms Lilian Omolo (lilian@wiomsa.org) with your proposed travel dates taking into consideration point a) together with a copy of your passport details. You will be expected to arrive one day prior to the commencement and leave the evening of the closure of the meeting. Should there be no available or suitable flight the following day will be acceptable.

Airport transfers in Zanzibar: Participants will arrive at Abeid Karume Airport in Zanzibar. The organizers will arrange airport transfer. The venue is approximately 10 minute by car from the airport.

Visa: While visa can be obtained on arrival in Zanzibar at a cost of USD 50, it is advisable that the participants obtain their visa in your country, if required, to avoid delays on arrival in Zanzibar. Note that all participants **REQUIRE** a **Yellow Fever Vaccine Card** for entry into the country. For more information on travel and visa regulations for Tanzania, visit the following web site: http://www.tanzania.go.tz/visa.html. The organizers will reimburse visa costs during the workshop, so long as you can provide the original receipt of the expense at the workshop.

ADDITIONAL INFORMATION

Zanzibar – an orientation: Zanzibar is an archipelago consisting of two main Islands of Unguja (commonly referred to as Zanzibar Island), Pemba and about 51 other surrounding small islets. Zanzibar is a partner state in the United Republic of Tanzania. Zanzibar is predominantly Muslim and, as visitors, we are kindly reminded to respect the culture while on the island.

Accommodation and workshop venue: All participants will stay at the Zanzibar Beach Resort. Each participant will be housed in single rooms. The resort will cater for the entire workshop week and the workshop will take place in the venue's seminar rooms.

Zanzibar Beach Resort	Tel.: +255 24 2236033/2236044/2230208
P.O. Box 2586	Fax: +255 24 2230556/ 233957
Mazizini	E-mail: znzbeachreasort@zanlink.com
Zanzibar, Tanzania	Web: www.zanzibarbeachresort.net

All extras such as room service, telephone calls, extra guests will have to be settled directly by participants when checking out.

Climate: Zanzibar weather is typically tropical with high humidity levels with light breezes in the evening. In November, temperatures can go up to 30°C during hot days and 22°C on warm nights. Please bring appropriate sun block lotions. Light showers are expected, as November is during the short rain season. Delegates are advised to bring light clothing and cover up in the evenings. There are mosquitoes in Zanzibar, so participants are advised to carry insect repellent and take precautionary anti-malaria medications, if necessary, as advised by your physician.

Dress: Smart casual attire is suitable for the workshop and social functions. For the field trip, participants are advised to bring appropriate footwear for getting into water (closed plastic/canvas shoes or diving boots to protect against sea urchins, rocks etc. – sandals/flip-flops are not advisable), swimming costumes, sun hats, beach towels, wraps (mask and snorkel optional).

Security: While Zanzibar is safe, be careful not to walk on the beach or on deserted roads in Stone Town late at night or early in the morning. Do not walk alone or carry valuables.

Currency: The currency used in Zanzibar is Tanzanian Shilling (TSZ).

Currency	TZS
1 Euro	1,978
1 USD	1,577

Banking – cash and credit cards: Major foreign currencies can be converted to Tanzania Shillings at the airport on arrival, in many banks in Stone Town and at all Forex bureaus. Automatic Teller Machines (ATMs) are also available in a few banks and major currencies can be exchanged at the hotel. Most banks and bureaus accept only US dollar bills issued after 2000.

Power supply: Electricity on Zanzibar is fairly reliable. The hotel will have backup generators. Electricity is 220–240 V AC, 50 Hz with UK standard power points (3 square pins). A multi-adapter is advisable.

Internet: Available.

Field excursion: The field excursion is yet to be decided, but please bring clothes and gear appropriate for wear on boat and in water. The field excursion is voluntary.

Language: The workshop language will be English.

REFERENCE LIST

FAO. 2010. Putting into practice an ecosystem approach to managing sea cucumber fisheries. FAO, Rome. 81 + vii p. (also available at www.fao.org/docrep/013/i1780e/i1780e00.htm).

Friedman, K., Purcell, S., Bell, J. & Hair, C. 2008. *Sea cucumber fisheries: A manager's toolbox*. ACIAR Monograph No. 135. Australian Centre for International Agricultural Research, Canberra. 32 pp. (also available at www.aciar.gov.au/publication/mn135).

Conand, C. 2008. *Population status, fisheries and trade of sea cucumbers in Africa and the Indian Ocean* In: Toral-Granda, V., Lovatelli, A. and Vasconcellos, M. (eds.) (2008) Sea cucumbers: a global review on fisheries and trade. FAO Fisheries Technical Paper No. 516. Rome, FAO. (also available at ftp://ftp.fao.org/docrep/fao/011/i0375e/i0375e05a.pdf).

Conand, C. & Muthiga, N. eds. 2007. Commercial sea cucumbers in the Western Indian Ocean. WIOMSA Book Series No 5. (also available at http://wiomsa.net/index.php?option=com_jdownloads&Itemid=53&task=finish&cid=345&catid=70).

Purcell, S.W. 2010. *Managing sea cucumber fisheries with an ecosystem approach*. Edited/compiled by Lovatelli, A., Vasconcellos, M. and Y. Yimin. FAO Fisheries and Aquaculture Technical Paper No. 520. FAO, Rome. 157 pp. (also available at www.fao.org/docrep/012/i1384e/i1384e.pdf).

ANNEX 2

WORKSHOP AGENDA

Sea Cucumber Fisheries: an Ecosystem Approach to Management in the Indian Ocean

Workshop Agenda

PRE-WORKSHOP – 10-11 November			
Participants arrive at Zanzibar Beach Resort, Mazizini, Zanzibar **Registration and receipt of workshop documentation at check-in at the hotel**			
DAY 1 – 12 Nov *Introduction to the workshop, the fishery situation in the IO Region and to sea cucumber fisheries management*			
08:00	Registration and receipt of documents for participants arriving late		
08:15	**Opening and introduction to workshop**		
08:25	Adoption of the agenda		
SESSION 1: Global and regional overviews (Chair: HE)			
08:30		Alessandro Lovatelli	Status of sea cucumber fisheries: a global overview
08:50		Steve Purcell	Global analysis of management measures and drivers of overfishing
09:10		Chantal Conand	History and status of sea cucumber fisheries in the Indian Ocean
09:30		Nyawira Muthiga	The regional MASMA project of sea cucumber fisheries
10:00 Morning tea			
SESSION 2: Managing, assessing and monitoring sea cucumber fisheries (Chair: CC)			
10:30		Alessandro Lovatelli	Management principles, objectives, reference points, and the ecosystem approach to managing fisheries
11:00		Steve Purcell	Assessing status of your fishery stocks: using fishery-dependent, fishery-independent and sociological indicators
11:30		Plenary (Rap. HE)	Discussion of the management process and using indicators
11:45		Steve Purcell	Biological and ecological constraints to classical fisheries management approaches in sea cucumber fisheries
12.15		Plenary (Rap. HE)	Discussion of these constraints
12.30 Lunch			
13:30		Steve Purcell	Regulatory measures and their use in sea cucumber fisheries: temporal and spatial closures

14:00		Plenary (Rap. NM)	Discussion on these regulatory measures
14:10		Hampus Eriksson	Information for adaptive management
14.30		Hampus Eriksson	Other actions by the fishery manager for improved compliance and adoption of management measures
15:10		Plenary (Rap. NM)	Discussion of management actions
15:30 Afternoon tea			
16:00		Steve Purcell	Regulatory measures and their use in sea cucumber fisheries: size limits, gear limitations, catch quotas, logbooks and reporting
16:40 – 17:30		Plenary (Rap. HE)	Discussion on these regulatory measures and other elements from the days presentations
18:30 Dinner provided by the organisers			
Day 2 – 13 Nov *Background presentations, status assessments and management indicators*			
SESSION 3: Indian Ocean sea cucumber fisheries presentations (Chair: NM)			
08:30		Hampus Eriksson	Summary of data/results from pre-workshop forms
09:00		Egypt, India, Kenya, Madagascar	10 minute presentations on different management systems in the Indian Ocean, their effectiveness and constraints to compliance
10:00 Morning tea			
10:30		Seychelles, Yemen, Sri Lanka, Zanzibar	10 minute presentations on different management systems in the Indian Ocean, their effectiveness and constraints to compliance
11:45		Plenary (Rap. SP)	Discussion and questions about current problems of fisheries management in the Indian Ocean
12:30 Lunch			
SESSION 4: Assessment of sea cucumber fisheries using the ACIAR toolbox (Chair: HE)			
13:30		Steve Purcell	Organisation instructions for workgroups
14:10		3–4 Workgroups	Break out workgroups to work through stock-health indicators for each country from the ACIAR Manager's toolbox.
15:00		Plenary (Rap. SP)	Collation and discussion of stock indicators from all countries.
15:30 Afternoon tea			
15:45 – 17:00		Plenary (Rap. SP)	- Discussion and listing management objectives for each fishery. 10 Minutes individual prioritisation for each fishery. - Examples and discussion of reference points.
Evening free – Organise yourselves			
Day 3 – 14 Nov *Field day*			
08:30 – 09:00		Chantal Conand	The field day starts out with a presentation on re-described sea cucumber species, hard-to-distinguish species groups and uncommon commercial species in the Indian Ocean. Presentation of the new FAO ID book.
Refer to separate schedule provided			
Day 4 – 15 Nov *Decision support tool and governance*			
SESSION 5: Decision-making in sea cucumber fisheries management (Chair: NM)			
08:30		Chantal Conand	Choosing regulatory measures and management actions to use – a decision support tool from the Galapagos workshop and exceptions.
08:50		2 Workgroups	Break-out workgroups to work through the decision support table to choose regulatory measures for each fishery
10:00 Morning tea			

10:30		2 Workgroups	*continued*… Break-out workgroups to work through the decision support table to choose management actions for (the managing institutions of) each fishery
11:30		Plenary (Rap. HE)	Collation of decisions on regulatory measures and actions
12:30 Lunch			
SESSION 6: Governance in sea cucumber fisheries (Chair: SP)			
13:30		Hampus Eriksson	Governance of sea cucumber fisheries and summary of table on governance from the data-form.
14:00		Workgroups	Break-out workgroups to fill out expanded data-table relating to governance arrangements in respective countries
15:00 Afternoon tea			
15:30		Plenary (Rap. HE)	Collate workgroup tables on governance arrangements. Open discussion on governance and decision-making
16:00		Steve Purcell	Writing and implementing your management plan
16:30 – 17:00		Plenary (Rap. HE)	Discussion on writing and implementing a management plan
Evening free – Organise yourselves			
DAY 5 – 16 Nov *Fisheries cases and contextualising the workshop*			
SESSION 7: Fisheries cases and management plans (Chair: CC)			
08:30		Steve Purcell	Organisation instructions for workgroups on fisheries cases
08:45		3-4 Workgroups	Workgroup session on fisheries cases, identifying main challenges and potential regulatory measures and actions to improve management (3–4 case examples)
10:00 Morning tea			
10:30		Plenary	Presentation of workgroup outputs by a representative from each group and discussion
11:00		Nyawira Muthiga	Enforcement and inspections
11:40		Plenary (Rap. SP)	Open discussion on enforcement and inspections
12:30 Lunch			
SESSION 8: Contextualising the workshop for implementation in the Indian Ocean (Chair: HE)			
13:30		Steve Purcell	Supporting fishers to improve the quality of sea cucumber processing – lessons from a Pacific project.
13:50		Plenary (Rap. NM)	- Aligning to an ecosystems approach to managing sea cucumber fisheries: discussion of strengthening social science inputs, communications strategies, stakeholder involvement.
15:00 Afternoon tea			
15:30		Plenary (Rap. SP)	- Identifying key priority research areas - Workshop recommendations and evaluation form.
17:00		Closing of workshop	
18:30 Dinner provided by the organisers			
POST-WORKSHOP – 17 Nov			
Participants return home			
Facilitators conduct a post-workshop meeting for synthesis and preparation of workshop report			

ANNEX 3

LIST OF PARTICIPANTS

Participants (in alphabetical order by surname)

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ANNEX 4

PRE-WORKSHOP FISHERY FORM

Name:	
Country:	

A. FISHERY OPERATION		Responses
Section A *aims to capture information regarding how the fishery operates. This type of information will be used in the analysis to explore the diversity of collection activities that target sea cucumbers. Understanding this diversity is important because different fisheries have different management requirements.*		
1	Who are collecting sea cucumbers in your country?	Men / Women / Children
2	How are fishers collecting sea cucumbers in your country?	Gleaning / Skin-diving / Scuba or Hookah diving / Other (please specify)
3	Are the fishers using boats? If so, how big is the fleet (how many boats)?	No / Yes, number of boats:
4	What is the length of the largest boat used for fishing sea cucumbers in your fishery?	Boat length (m):
5	About what approximate % of boats in the fishery (used to collect sea cucumbers) use a motor, sail or only paddle? (Please fill out the percent of each category of boat)	Boats with motors (%): Boats with sails (%): Boats using paddle only (%):
6	Are fishers also processing sea cucumbers or do other separate processors predominantly do this?	By fishers / By processors
7	What habitats are targeted?	Soft bottom with seagrass / Coral reefs / Sand flats / Deep areas
8	How many different species of sea cucumbers are collected?	
9	Has the number of species being fished increased the last 5 years?	Yes / No
10	What was the total value of the sea cucumber exported from your county for the year 2011?	Value US$:
B. HUMAN RESOURCE CAPACITY AND MONITORING		Responses
Section B *aims to collect information on how the formal agency/agencies responsible for management is capable of gaining knowledge. This information will be used to analyse agencies ability to be adaptive and govern relevant institutions.*		
1	How many people employed by your government have responsibility for planning and implementing marine reserves?	
2	How many fishery officers in your country would be able to confidently	

	and accurately identify all of the exploited sea cucumbers species (live animals in the wild)?	
3	How many trained persons are employed by the government to inspect bêche-de-mer shipments before they leave your country?	
4	Does your agency (or other service in your government) have the human resources and skills to conduct extensive underwater population surveys of sea cucumbers every 3 years?	Yes / No
5	Does your agency (or other service in your government) have the funding to conduct extensive underwater population surveys of sea cucumbers every 3 years?	Yes / No
6	At present, how easy is it to get updated information every month on the number or wet weight of sea cucumber collected by fishers in the whole country, or in separate regions?	Relatively easy / Difficult / Impossible
7	At present, how easy is it, or would it be, to license all sea cucumber fishers in your country?	Relatively easy / Difficult / Impossible
8	At present, how easy is it, or would it be, to license all processors and exporters of sea cucumbers in your country?	Relatively easy / Difficult / Impossible
9	Does the fishery management agency keep a list of all sea cucumber fishers in your country?	Yes / No
10	Does the fishery management agency keep a list of all processors and exporters in your fishery?	Yes / No
C. MANAGEMENT APPROACH AND GOVERNANCE		Response
***Section C** aims to capture strategies and the level of participation by agencies and communities in governance.*		
1	Has your fishery agency established formal management objectives for the sea cucumber fishery?	
2	Has your fishery agency set “reference points” at which management will change in the fishery?	
3	Is there a fishery management advisory committee (or similar committee) with participation from fishers and others involved in the sea cucumber fishery?	
4	Is there a national plan (and/or regulations) for the management of sea cucumbers currently in place (i.e. finalized and distributed)? If yes, in what year was that enacted?	No / Yes, year:
5	What agency is responsible for developing and adapting the fishery management plan for sea cucumbers in your country?	
6	Is there a fishery manager with a good understanding of sea cucumber fishery biology within the agency responsible for managing the fishery?	Yes / No
7	What agency is responsible for stock monitoring and fishery data collection in your country?	

8	When was the last time that a national assessment of sea cucumber stocks was undertaken in the fishery (either by fishery-dependent or fishery-independent surveys)?	Year: / Never
9	How would you best describe who has jurisdiction for enforcing the management regulations and delivering penalties in your fishery?	National authority / Provincial government / Community / Traditional leaders
10	Are there local rules and regulations not decided by government that influence how people fish sea cucumbers (i.e. informal institutions)?	Yes / No
11	Does your fishery agency support (i.e. via funding or human resources) other initiatives such as community property rights or co-management schemes?	Yes / No If yes, how are communities supported?
D. CURRENT FISHERY REGULATIONS		Response
Section D *aims to illustrate how the participant countries are regulating sea cucumber fisheries.*		
1	Is there a national plan (and/or regulations) for the management of sea cucumbers currently in place (i.e. finalized and distributed)? If yes, in what year was that enacted?	Yes, year: / No
2	Are there minimum size limits for sea cucumbers in your fishery?	Yes / No
3	If yes, are there different size limits depending on the species?	Yes / No
4	Is there a policy or regulation to limit the number of new species of sea cucumbers that fishers can harvest?	Yes / No
5	Is there an official ban of scuba or hookah in your fishery?	Yes / No
6	If yes, do fishers obey the ban?	Yes / No
7	Are there penalties for not obeying these rules?	Yes / No
8	Are fishers supposed to obtain a fishing license/permit to be able to harvest and sell sea cucumbers?	Yes / No
9	Do fishers need to supply logbooks in order to be re-issued with a fishing permit?	Yes / No
10	Do processors or exporters need licenses to operate?	Yes, Processors / Yes, Exporters / No, neither
E. ENFORCEMENT AND INSPECTION		Response
Section E *aims to capture the capacity to enforce management and export protocols.*		
1	How many boats are there in your country that are regularly used to do patrols of fishers including sea cucumber fishers?	
2	How often would fishery or compliance officers check and record the numbers and wet weight of harvested sea cucumbers at landing sites or sea?	One or more times a week / Once or twice a month / A couple of times a year / Practically never
3	Are bags of bêche-de-mer for shipments out of your country opened and inspected?	Regularly / Occasionally / Practically never

4	Have the inspection officers in your country had training in identifying dried sea cucumbers to species level?	Yes / No
F. STAKEHOLDER INVOLVEMENT AND EDUCATION		Response
Section F *aims to explore if formal agencies focus on strategies that allow fishers to participate and govern.*		
1	What percentage roughly of sea cucumber fishers would you say that you, or someone in the fishery management agency, have met with this year to discuss their fishing activities and management?	_____ %
2	Does the fishery management agency regularly (i.e. at least once a year) send out a newsletter or information leaflets to fishers?	Yes / No
3	Does the fishery management agency communicate in other ways with fishers (e.g. village meetings or committees)? (Please state how you communicate with fishers)	Yes / No If yes, how do you communicate?
G. AQUACULTURE		Responses
Section G *aims to explore preparedness and ambitions in relation to sea cucumber aquaculture.*		
1	Does the fishery management agency (or other relevant agency) have guidelines for development of new aquaculture activities (e.g. introduction of alien organisms, disease prevention and control)?	Yes / No
2	Are private investors, NGOs or academic departments proposing to initiate sea cucumber aquaculture in your country?	Yes / No If yes, are these: Private investors / NGOs / Academic
3	If so, what is the scope of the enterprise?	Small-scale private enterprise / Community involved enterprise/ Large commercial enterprise
4	If aquaculture is active have coastal habitats been claimed to accommodate good grow-out habitat?	Yes / No
5	If aquaculture is being proposed, what species are considered?	List species names:
6	If aquaculture is already active, what species are being cultured at commercial scales in your country?	List species names:

ANNEX 5

COUNTRY REPORTS FROM INDIAN OCEAN SEA CUCUMBER FISHERIES

The country/territory reports are presented in alphabetical order. Please cite the country/territory reports by the author name as a chapter in this report. For example:

> **Naeem, S.** 2013. SCEAM Indian Ocean country report, Maldives. *In* FAO *Workshop report on sea cucumber fisheries: an ecosystem approach to management in the Indian Ocean (SCEAM Indian Ocean)*, 64–66. FAO Fisheries and Aquaculture Report No. 1038. Rome, FAO. 92 pp.

Country/territory and author(s):

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INDIA	–	P.S. Asha
KENYA	–	Elisabeth Mueni
MADAGASCAR	–	Harilalao Zoelys Raboanarijoana
MALDIVES	–	Shayia Naeem
MAURITIUS	–	Ravi D.C. Mohit
MAYOTTE	–	Johanna Herfaut
MOZAMBIQUE	–	Stela Maria Cabral Fernando
OMAN	–	Abdullah Hilal Al-Balushi, Tariq Marhoun Salim Al-Mamari and Maryam Bint Mohammed Al-Shidhani
RODRIGUES	–	Marine Jean Sylvio Perrine
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SCEAM Indian Ocean country report – EGYPT

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1. Background

In Egypt sea cucumber management is poor. The beginning of sea cucumber collection in Egypt started in 1996 with one company. At these days the people did not know sea cucumbers. No one was aware about its value and there was no collection at all for sea cucumber. The company was headed by Bedouins and the dive leaders were responsible to discover the sea cucumber populations. They offered 1 000 Egyptian pounds for every location, which had a good crop of sea cucumbers. Then the collection process began. At first the populations were healthy enough, thus were not affected by the collection, as the collection was not heavy to cause population destruction. Soon after this, many people learned about this trade and more and more traders entered the market. This required a higher fishing effort to cover the increasing requirements. At this time the most fishing was carried out at the Egyptian Red Sea from Hurghada to Shalateen, Gulfs of Suez and Aqaba. The sea cucumber fisheries did not stop at this time but continued slowly until year 2002 when the fishing pressure was very high and a huge destruction occurred to the sea cucumber populations.

Towards late 2002, the Egyptian Government issued a number of fishing licenses to a number of boats and fishers, but without any management strategy or reliable fishery data. Then the government banned this fishery, but illegal, unregulated and unreported fisheries (IUU) continued. The overfishing occurred heavily under this weak surveillance. Nowadays, the Red Sea as whole is suffering from sea cucumber overfishing. The sea cucumber populations disappeared from many places, and were much reduced from others.

The sea cucumber fishery and management problems in Egypt are characterised by i) fishers have gone to low value species and catch more individuals to compensate the lower price, therefore putting more pressure on the environment; ii) many diving accidents occur due to the inexperience of untrained divers; iii) the IUU continues in spite of the ban; and iv) during the past few months, exporters of sea cucumber won the case at the court of justice to reopen the export of sea cucumber. Thus the ban will be stopped and subsequently the need of proper and solid management plan is a must.

2. Fishery operations

The Egyptian sea cucumber fishing is operated by several means, summarized as follows:

- Fishing boats especially equipped for this purpose (e.g. scuba gear) are divided into:
  - large boats which go offshore to islands and patches
  - small boats operating in nearshore areas
- Local operators are dive leaders
- Local communities (the Bedouin people) are divers

The effect of the fishing boats especially equipped for the sea cucumber fishery in eliminating the fauna is very obvious; it is followed by the effect by Bedouin populations, while the effect of collection by diving guides is less dangerous, because the dive guides are busy most of the time with the tourist groups.

The supply chain in Egypt is not long, and varies according to the fishing method as follows:

1. Fishing by boats: These boats are owned by the exporter himself, thus the sea cucumbers are going from the fishermen directly to the exporter. The fishermen here are hired by the exporter who pays wages with a small percentage on their catch.
2. Fishing by small boats, local operator and local communities: they sell their processed catch to a middle man, who then delivers the shipment to the exporter.

3. Status of fishery and stocks

About 11 sea cucumber species were included in the Egyptian fisheries *(Holothuria scabra, Holothuria fuscogilva, Holothuria nobilis, Stichopus herrmanni, Thelenota ananas, Actinopyga echinites, Actinopyga crassa, Actinopyga mauritiana, Personothuria graeffei. Holothuria edulis* and *Holothuria atra*). This list was greatly reduced to only three to four species, the most common in catch being *Holothuria atra* and to a lower extent *Holothuria fuscogilva, Actinopyga mauritiana* and *Holothuria nobilis.*

Nowadays, the Red Sea as whole is suffering from sea cucumber overfishing. The sea cucumber populations disappeared from many places, and greatly reduced from others.

4. Current management

The implemented management procedure in Egypt includes only the ban of the fishery. The main problem encountered is IUU, which going intensively, leading to a dramatic decline in the population abundance and species diversity.

Management strategies implemented in Egypt:

Presence of reliable fishery data	No

(Distribution, age and growth, fishing mortality, natural mortality, catch per unit effort, total landings, fecundity, recruitment of each species, total live weight harvested per species, total processed weight per species, total weight exported, etc.).

Size limit	No
Upgraded skills of processors through training	No
Restriction of collection method	No
Closed seasons and areas	No

5. Plans for the future

Nowadays, there is no future management plan set for sea cucumber species in Egypt. But there is an urgent need to start moving towards the management of sea cucumber population in Egypt because we are far across the Red Line and we already lost much and we can afford to lose more.

SCEAM Indian Ocean country report – INDIA

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1. Background

In India, sea cucumbers are chiefly found in the Lakshadweep Islands and Gulf of Kutch of the Arabian Sea, Andaman and Nicobar Island, Gulf of Mannar and Palk Bay in the Bay of Bengal Sea. They also occur in small numbers along the mainland coast of India. However, the fishery and trade of

holothurians existed in a narrow strip in the Gulf of Mannar and Palk Bay of the southeast coast of India. The fishery of holothurians is an age-old practice and was introduced by Chinese people more than 1 000 years ago. The Chinese people stationed on the southeast coast of India, taught the processing techniques and the industry slowly got established under their supervision. Sea cucumber landings were reported chiefly from 15 major centres at Gulf of Mannar and from 25 centres at Palk Bay. Sea cucumber fishing and trade served as an important source of income for the livelihoods of almost 200 000 fishermen in this area.

2. Fishery operations

In India, holothurians were mainly collected by skin diving using masks in shallow waters of 2–10 m depth. The divers went out in sailing boat in the morning and return in the afternoon. In each boat, four to five persons including even boys went out for diving. The divers took net bags in which live holothurians were put and brought to the shore. Each diver could collect an average of 15 specimens per day. The holothurians were caught as by-catch in the bottom trawls, which were introduced in the early 1960s in Gulf of Mannar and Palk Bay for collecting prawns as well as in a modified country trawler "Thallumadai" which was operated by sailboats in shallow waters of 5–10 m depth. They were also reported to have been landed by a specifically designed trawler with 40 mm mesh for sea cucumber collection called "Attai madi" operating at 15–20 m depth. The holothurians were fished year round. In Palk Bay, the fishing was conducted from March to October, the peak is being April and May and in the Gulf of Mannar from October to March with a peak in December and January.

The Indian sea cucumber industry included fishermen who collect sea cucumbers, the processors, who were the middlemen engaged in processing, and the exporters who grab the lion's share of the profits from the industry. The processed sea cucumbers were chiefly exported to Singapore, from where they were re-exported to Hong Kong and Chinese markets.

3. Status of fishery and stocks

In India the sea cucumber fishery mainly depended on the high-value species *Holothuria scabra.* Apart from that species, medium-value species like *H. spinifera, Actinopyga echinites, A. miliaris* and low-value species such as *Bohadschia marmorata* were also fished in considerable quantities. India generated considerable foreign exchange during 1980s and 1990s from holothurians export. The industry grew tremendously due to the attractive prices and increasing demand in the international market. During the year 1996–1997, India exported 70 tonnes of processed holothurians. However, by 2001, export volume reduced to 3.8 tonnes. The small size of the collected sea cucumbers and also poor returns per unit of effort indicated over exploitation of sea cucumber resources in Indian waters.

The Ministry of Environment and Forestry, Government of India, took the first step to conserve holothurians in 1982 by imposing a ban to limit the export of bêche-de-mer of less than 75 mm in length. However, it became impossible to regulate the catch of under sized sea cucumbers effectively.

4. Current management

At present, both fishery and trade of sea cucumbers are banned by the Government of India by including all sea cucumber species under Schedule 1 of the Wild Life Protection Act of 1972. Strict enforcement of this law was effected since 2003. Heavy fines and imprisonment were charged against those violating this law.

The major problems encountered in the enforcement of the current management plan are poaching and illegal trade of both raw and dried sea cucumbers to neighbouring countries. Despite the awareness about the ban and punishment, fishermen are involving in these illegal practices for their livelihood. The ban on fishery and trade are still in force. Representations from fishermen welfare agencies and political parties have been made to authorities, highlighting the negative impacts of ban on the livelihood of poor coastal fishing communities, urging the need for lifting the ban.

5. Plans for the future

As a stepping stone to lift the ban on sea cucumbers trade, the Government commissioned the Zoological Survey of India to undertake studies on population status assessment during 2003, 2006 and in 2011. The surveys reported no recovery in the population size.

Once the sea cucumber population attains the desired level, the ban would be lifted on a species-specific basis in a phased manner, in an attempt to resolve potential social conflicts. Implementation of effective and sustainable management methods, involving various stakeholders in the fishing sectors, from the fishermen men to the exporters, will be made. The management measures will likely include the restoration of overexploited holothurian stocks in the protected areas. That will be accompanied by training fishermen on sea cucumber aquaculture practices to meet the marketing demand and continuous stock assessment of the sea cucumber fishery resources in the wild.

SCEAM Indian Ocean country report – KENYA

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1. Background

The sea cucumber fishery in Kenya has been in existence since the early 1900s (KNA Coast 1917–1925) and is thought to coincide with the influx of Asian nationals in the 1900s. Most information on the evolution of this fishery in Kenya derives from a regional project (Muthiga *et al* 2007 in Conand & Muthiga 2007) that was funded by the Western Indian Ocean Marine Science Association (WIOMSA). Initially fishing was done in Malindi (now in Kilifi County), Mombasa and Kipini (Tana River County) through fisheries concessions. These fishing concessions were on three to five year terms and could be transferred upon death. The fishing was then dominated by Chinese fishers and traders (KNA Coast 1917–1925a) and was so lucrative that concessions and fishing grounds were fiercely protected (Muthiga *et al*., 2007). In 1959 royalties for fishing of sea cucumbers were removed as a management measure to restrict trade. However, fishing of sea cucumber continued to spread to other fishing villages in Lamu, Kwale and Mombasa Districts. In the early 1990s, scuba diving for various fisheries was introduced in Kenya and this period coincides with increased production of the sea cucumber fishery that peaked in 1992. The use of scuba diving for sea cucumber was prohibited at a departmental meeting in 1998, but its use continued until 2003 when a ban on the use of scuba was gazetted. Currently, sea cucumber are landed in Vanga/Jimbo, Majoreni, Shimoni, Gazi, Lamu, Kilifi, Vipingo, Nyali, Mombasa, Tiwi, Diani, Msambweni, Kimbuyuni and Ngomeni.

2. Fishery operations

Sea cucumbers in Kenya are either fished in shallow lagoons and seagrass areas, or in deeper waters off the reef edge. The fishery is artisanal using simple collection methods; such as hand-collection (gleaning) during low tides and skin diving, which is the most commonly used method. Sea cucumbers are also caught as bycatch in the shrimp trawl fishery, by spear gun and ringnet fishers. Access to fishing grounds is on foot (i.e. walk, swim, wade), or by traditional boats often dugout canoes in the south coast and sail boats (Mashua) in Lamu. The fishing boats carry 3–4 fishers/trip (or divers) and fishing time is depended of the tides mainly 3–4 hours per trip. Collectors fishing in deeper waters use snorkel and mask or scuba equipment that is supplied by dealers for other fisheries such as lobsters.

It is difficult to estimate the exact numbers of fishers involved in the fishery because catches from gleaners and other fishers are not always recorded by the fisheries department and the recent marine fisheries frame survey (2012) did not collect data at a such a fine resolution, however, sea cucumber

harvesting is concentrated in a few villages mainly in the south and north of the Kenyan coast as detailed above. The fishery occurs year round although it is seasonal in some locations such as Malindi and some fishers are migratory hence do not land at designated landing sites. The supply chain in the sea cucumber fishery includes; collectors, dealers and exporters. The 'Collectors'/fishers fish and process the product and mainly reside close to the landing beaches, the 'Dealers' purchase the dried product, and sell to exporters who reside in urban centres like Mombasa. The product is packed and exported to Hong Kong SAR and China, which is the main bêche-de-mer market. Reports have also indicated that sea cucumbers harvested in Kenya also make their way to mainland Tanzania and Zanzibar becoming part of that country's exports to Hong Kong and China.

3. Status of fishery and stocks

More than seventeen species of sea cucumbers are harvested in Kenya although forty four species have been reported on the Kenyan coast (Muthiga *et al*., 2007). It is difficult to accurately estimate the production of sea cucumbers in Kenya due to weaknesses in catch and export monitoring. Catch reconstruction from various sources of historical data by Muthiga *et al*, (2007) showed that the catches were generally low in the early 1950s (3 and 12 tonnes/yr) increased to ~80 metric tonnes/yr with the highest ever catches reported in 1992 (~225 metric tons/yr). Since then the sea cucumber catches have averaged ~20 tonnes/yr. No comprehensive stock assessments have been carried out of sea cucumbers in Kenya however abundance and distribution surveys have indicated the presence of sea cucumbers in a variety of habitats along the Kenyan coast including, sea grass beds, shallow water reef habitats including reef lagoons and reef flats and in soft bottom channels and reef edges to a depth of 20m (Muthiga and Ndirangu, 2000; Samyn, 2003). Estimated fishing effort at the main landing beaches ranged from 12 to 30 pieces/man /day (2–6 kg/man/day) at Gazi and 20 and 24 pieces/man/day (4–4.8 kg/man/day) at Shimoni in 2000 (Muthiga and Ndirangu (2000) and 12 to 25 at Vanga and Shimoni in 2005 (Beadle, 2005). The most recent estimates by Ochiewo *et al*. (2010) showed a significant decline in catches at Gazi (6 pieces/man/day) and a smaller decline at Shimoni (17 pieces/man/day).

4. Current management

Sea cucumbers are mainly managed under the Fisheries Act Cap 378 of 1989 (revised in 1991) and are fully protected in MPAs by the Kenya Wildlife Service (KWS) under the Wildlife Conservation and management Act Cap 376 (1989 amendment). The general legislation prescribes overall fisheries development and management measures including prohibition of areas, species and gear. Sea cucumbers are specifically referred to in the subsidiary regulation that refers to "bêche-de-mer" and prescribes the payment of fishing and export licenses. Both collectors and exporters are supposed to be licensed by the fisheries department annually and an export fee of 5 percent of *ad valorem* of the market price is also charged. Catch statistics are submitted in kilograms of dry weight to the district fisheries officers for compilation into the national statistics (Muthiga *et al*., 2007).

The main management challenges that the sea cucumber fishery faces in Kenya include; over-exploitation, lack of stock and ecological data; inadequate collection and management of catch statistics; and inadequate licensing and enforcement despite an adequate management framework. Although the management Authority encourages fishers not to collect small individuals, there are no regulations on size limits and the gleaners continue to land extremely small sizes of sea cucumber. In 2001 there was a temporary directive to stop issuance of fishing licences by the Fisheries department and in 2003 the use of spear gun and Scuba diving equipment for fishing of sea cucumber was banned under the Legal Notice No. 214, Part 2 (c), Cap. 378 in 2003.

5. Plans for the future

There are recommendations from studies and stakeholders in the fishing industry to improve the management of the fishery including setting size limits, seasonal closures for specific species and even a total ban on harvesting sea cucumbers (Beadle, 2005; Muthiga *et al*., 2007). Even with the current regulations there are challenges in monitoring and enforcement and hence compliance is low for example harvesting with scuba continues to be used despite the ban. Because the fishery is an open access resource and is mainly conducted by poor artisanal fishers as most other fisheries in Kenya,

control of effort and over exploitation is a management challenge. This challenge however, is being addressed through the Beach Management Unit (BMU) regulation (2007). This regulation supports a co-management process allowing local communities some authority over fishing activities within their fishing grounds. BMUs for example can regulate and enforce limits on effort and gears. There are currently over 70 registered BMUs along the coast and most have embraced the co-management concept although their capacity in fisheries management needs strengthening. In addition, some communities have established fisheries closures commonly known as Tengefu with the support the East African Wildlife Society and Wildlife Conservation Society. The other key activity that the management authority is working on is the improvement of the collection of catch statistics. Currently, catches are reported as dry weight and if catch records are taken at the landing site it is possible to record wet weight by species. There are also plans to include a weekly catch reporting system for sea cucumber as has been introduced for other artisanal targeted fisheries like the octopus.. There are also plans to step up the enforcement through building the capacity of the BMUs to increase, voluntary compliance, surveillance in the areas under their jurisdiction and reporting of infringement of fisheries regulations. Finally, following the recommendations from the regional project (Conand and Muthiga, 2007), there are plans to develop a sea cucumber management plan, which will be highly consultative with stakeholders in the fishery. Long-term plans include farming of sea cucumbers given the interest in mariculture of sea cucumbers and the possibility of heavy investments by the Kenya government in aquaculture.

6. Conclusion

The sea cucumber fishery in Kenya is showing strong indications of overfishing hence this valuable resource is at risk if no effort is taken to regulate the fishery. Despite the review during the sea cucumber regional project, there is still a need to carry out more detailed stock assessments and biological studies to understand the stocks. In addition, more detailed socio-economic information is needed to better understand the impacts of this fishery on livelihoods. Some of these information gaps can be achieved through current projects such as the Kenya Coastal Development Project (KCDP) and other collaborative initiatives in the region. The transboundary issues especially fishing and trade across borders are critical issues that even as the Ministry of Fisheries Development develop management plans and management measures, will need to be addressed.

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SCEAM Indian Ocean country report – MADAGASCAR

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1. Background

The beginning of sea cucumber exploitation in Madagascar started at 1920. The number of species collected increased from three in 1920 to eight in 1990 and twenty-five in 1996 (Table 1). Sea cucumber harvesting is a traditional and permanent activity in coastal regions of Madagascar, especially near coral reefs, and this activity has developed increasingly from the early nineties. The sea cucumber fishery is intensively carried out in the west coast. Fishers collect various resources such as shellfish, urchins, octopus and sea cucumber on the reef flat during the low tide (Rasolofonirina and Conand, 1998). The collection of sea cucumbers provides a considerable source of income for people in coastal communities. Currently more than 30 species are exploited. Common harvested species are: *Holothuria scabra*, *H. fuscogilva*, *H. nobilis*, *Stichopus horrens*, *Actinopyga miliaris* and *Thelenota ananas*. According to the studies of exploited species in the south west of Madagascar *Holothuria notabilis* is presently the dominant species in the catch and *Stichopus horrens* is the third most common species after *Holothuria scabra*. According to the studies underway by IHSM and Aqua-lab in Toliara, among the exploited species in the south west of Madagascar, *Holothuria notabilis* is presently the dominant species in the catch and *Stichopus horrens* is the third most common species after *Holothuria scabra*.

Photo 1. Catch of *Holothuria scabra* kept in shallow water before processing in southwest coastal village Tampolove (Programme DeFi Zanga).

Table 1. Different species exploited in Toliara' s regions (IHSM, 1996). Sources: Petit, 1930; Rasoarinoro, 1990; Mara *et al*., 1997; Rasolofonirina *et al*., 2004.

Scientific names	Local names	Authors
Actinopyga echinites	Trokena	Jaeger, 1833
Actinopyga lecanora	Zangambato Zangamboriky Dosodoso	Jaeger, 1833
Actinopyga mauritiania	Fotsitsetsake	Quoy and Gimard, 1833
Actinopyga miliaris	Trokenambato	Quoy and Gimard, 1833
Actinopyga sp.	--	--

Bohadschia argus	Falalijake Madarasy Papiro	Jaeger, 1833
Bohadschia marmorata	Bemengovitse	Jaeger, 1833
Bohadschia tenuissima	Falalijake	Semper, 1867
Bohadschia vitiensis	Falalijake Mangerifoty Piripoty	Semper, 1867
Holothuria scabra	Zanga fotsy	Jaeger, 1833
Holothuria lessoni	Zanga mena , Bemavo, Zanga vola	Jaeger, 1833
Holothuria atra	Stylo noir	Jaeger, 1833
Holothuria insolita	Dorilisy	Cherbonnier, 1988
Holothuria excellens	Delave , Lapora	Ludwig, 1875
Holothuria fuscogilva	Benono mainty	Cherbonnier, 1988
Holothuria nobilis	Benono fotsy	Selenka, 1867
Holothuria edulis	Stylo rouge	Lessons, 1830
Holothuria leucospilota	Zanga kida	Brandt, 1835
Holothuria cinerascens	Zanga fleur	Brandt, 1835
Holothuria rigida	Zanga mofo	Selenka, 1867
Holothuria arenicola	Kankana	Semper, 1868
Holothuria impatiens	Stylo	Forskal, 1775
Pearsonothuria graeffei	Zanga somotse	Semper, 1868
Family STICHOPODIDAE	--	
Thelenota ananas	Zanga borosy	Jaeger, 1833
Thelenota anax	--	Clark
Stichopus chloronotus	Zanga sono	Brandt, 1835
Stichopus horrens	Crampon, Jomelipapa, Tsomotsomoko	Selenka, 1867
Stichopus herrmanni	Trakitera	Semper, 1868
Stichopus naso	--	Semper, 1868

Since 1990 signs of over exploitation of the sea cucumber resources are observed, the most important are:

- the declining quality of the product
- the decrease in product size and consequently the prize
- the use of illegal equipment for harvesting (diving tank)
- intense competition between collectors (Conand *et al*., 1998)
- the exploitation of fishing areas outside of Malagasy water
- the collection of juveniles (Conand, 1999)

Because the overexploitation of the sea cucumbers resources, various actions have been undertaken since 1990 by scientists, the industry (ONET – Organisation des Exportateurs de Trepangs) and government institutions to monitor the fishing catches and marketing in many coastal villages of the country.

Research and aquaculture on *Holothuria scabra* are currently underway by the Institute of Fisheries and Marine Sciences (IHSM) and Aqua-lab in Madagascar. Biological studies concerning mainly feeding, growth and mortality are also undertaken of other species.

Gleaning is an activity undertaken by women and children under 10 years old, because of the proximity of the collecting areas to the villages , and their accessibility from the shore, eliminating the need for boats and therefore for men to drive them. The fringing reefs near the shore and shallow lagoon environments offer good collecting areas for many species. Predominantly men glean or fish with nets as a primary activity, but many men also rely on spear fishing or hook-and-line fishing as their primary activity, with gleaning or raising livestock (cattle or goals) as a secondary activity. Gleaning at night is also important. Only a few gleaners limit their activity to sea cucumber collection and most gleaners also collect fish and a variety of invertebrate species including molluscs, bivalves, echinoids and crustaceans for subsistence, or limited local sale. Generally, men target finfish while women tend to focus on collecting invertebrates, including sea cucumbers.

The gutting of sea cucumbers prior to boiling and drying varies with species. *Holothuria nobilis* and *A. miliaris* individuals are cut along the whole length of the body, while *H. scabra* and *S. herrmanni* are only cut in the centre. In the case of *H. nobilis*, this is to ensure that individuals dry quickly to prevent spoiling. *Stichopus herrmanni* individuals are gutted immediately after capture as otherwise they will deform and spoil.

After gutting, the sea cucumbers are processed and dried. The processing begins with boiling in seawater until the sea cucumbers take on a rubber-like consistency. The boiled individuals are then buried under 10-20 cm of sand for 24 hours before being scraped with a knife to remove the skin. They are then boiled again in fresh water with salt added. The final stage involves leaving the skinned, twice boiled sea cucumbers to dry in the sun on wooden planks until completely ready for sale. Gleaners have stated that sea cucumbers are harder to prepare between November and January, this being attributed to the reproductive season in January. From February-March, sea cucumbers become less fragile and easier to process again.

Photo 2. Delivery of collected sea cucumbers at the village in the south west coast (Source: Madagascar Holothurie SA).

Photo 3. Poor handling of live animals lead to spoiled catch (Source: Programme DeFi Zanga)

After being purchased from the gleaners, the sea cucumbers are sold to collectors or *Society authorized for sea cucumber export.* The price paid by collectors varies and depend on species and quality: *H. scabra* can fetch up to USD 15,00/Kg (dry weight) (Rasolofonirina, 2005)

The collectors then transport the sea cucumbers to the capital Antananarivo, where they are sold to exporters that ship to the Asian markets. No figures were obtained regarding the prices paid to the

collectors by exporters, as they were unwilling to reveal the information. However, it was discovered that due to their low quality, dry *A. miliaris* are usually only bought by exporters every two or three months to supplement the total weight and complete shipments for export.

Photo 4. Sea cucumbers ready to be exported (Source: Madagascar Holothurie SA)

2. Status of fishery and stocks

Three important regions were identified for sea cucumber exploitation*:*

- in the north: Région Diana
- in the west: Région de Boeny
- in the south west: Région Atsimo Andrefana

Collectors have to respect the use of transport logbooks established by MPRH, which indicate the origin, the nature, the quantity and destination of products (Table 2). 64 formal collectors are recorded to be active. Catch data and exported data are based on the results of logbooks data processing in the Fishery Statistic Service (Table 3).

Table 2. Catch data reported of sea cucumber in fishery logbooks 2005 to 2011 (Unit: Tonne)**.** Source: Ministry of Fishery and Halieutic Resources (MPRH). For exported trepang, no distinction between species is recorded, only the total quantity.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Sea cucumber (mt)	850	850	820	850	470	470	302	415	891

Table 3. Exported data of dried sea cucumber (trepang). Source: Ministry of Fishery and Halieutic Resources (MPRH) (Service Statistique, Authorité Sanitaire Halieutique).

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Sea cucumber (mt)	204.5	299.9	223.3	243.6	293.5	309.3	301.9	412.5	447.6
Value (USD)	660 256	181 258	134 668	174 768	179 698	234 649	189 068	232 261	458 608

3. Current management

Overfishing, missing legislation and complex administration are the current problems of sea cucumber resources management. This situation is for example indicated by:

- Decline in traditional fishing and the increase in the harvest of small sized individuals (Conand, 1999).
- Illegal exploitation by Malagasy ships in neighbouring countries.
- Employment of hundreds illegal scuba divers to harvest sea cucumbers and intense competition between collectors or operators.

The Madagascar sea cucumber fisheries are managed and regulated under several Fisheries regulations including:

* Arrêté N°525 of the 5th February 1975 that regulates the minimum legal size of capture to 11cm and processed trepan to 08 cm body length.
* Arrêté N°4796/96 of 16th August 1990 on the sea cucumber fishery and processing.
* Ordinance N°93-022 of May 1993 that prohibited the use of scuba for the collection of sea cucumbers.

However, legislations in force are not applied or appropriated for all species. For example, the minimum harvest size is not available for all species because the different size at sexual maturity neither does the legislation take into consideration the managements requirements of the various players in fishery. In addition, while the use of scuba is forbidden, enforcement is weak and harvesting using scuba is still commonly carried out in Madagascar.

Photo 4. Important confiscation of diving equipment used to collect sea cucumbers at Ampapamena in the d'Ambaja District, Région Diana, by the Center of Surveillance team in May 2011 (La Tribune de Diego-Suarez 2011).

Apart from weak enforcement of regulations, there are also the problem of inadequate data collection and handling. This is partly due to the collectors' under-reporting catch to avoid paying the corresponding taxes. The exact quantity of trepang that the country export is unknown making informed management difficult. Implementation of sustainable management processes will only take place through collaboration between all the stakeholders in the fishing sector, from the fisherman to the exporters.

In response to the threats facing sea cucumber populations in Toliara region, a sea cucumber hatchery and mariculture project started in Toliara in 1999 (Jangoux *et al*., 2000) . The objective was to breed and grow-out juveniles of commercially important species for restocking fished areas and reducing fishing pressure on wild populations. A hatchery was built in the site of IHSM (Institut Halieutique des Sciences Marines) in Toliara and the first production in 2003 produced around thousand juveniles of *Holothuria scabra*. In 2004, a sea cucumber farm for grow-out was created in order to satisfy the market demands. The size and the weight required are up to 20 cm and 300 g respectively, with an optimal density of 20 individuals by square meter. The farm is located at Belaza (20 km from Toliara). When the financial support ended in March 2008, a tripartite partnership agreement between Belgian's University, IHSM and MH SA (Madagascar Holothurie SA), led to the creation of Madagascar Holothurie SA, which aims for a development of holothurians aquaculture in Madagascar. In 2012,

Indian Ocean Trepang (IOT) was created for the same objectives but to scale up to an industrial size enterprise.

4. Plans for the future

Sea cucumber fishery and mariculture plays an important role in the economy of coastal villages and the country as whole. Exported sea cucumbers value has been increasing since 2007 from179 698 USD to 458 608 USD in 2011.The development of mariculture lead by the private sector, with NGOs and Associations is a large contributing factor for the high sea cucumber production.

The management authority has opted for:

- a sustainable management and environment preservation for sea cucumber.
- adaptation of legal regime for sea cucumber running.
- improvement of quality of products intended for exportation.
- new fishing zone identification.
- aquaculture development for sea cucumber with different partners (NGO, societies, research institutes).

These cannot be achieved without developing the partnership with all stakeholders and financial partner. Therefore, while more in-depth work is required to evaluate the status and exploitation levels of sea cucumber stocks it is clear that some form of education and interim management at the village level is required to ensure the long-term future of this important source of income.

Future work includes:

1. Review the legislation in force;
2. Management scheme of sea cucumber study: identification of favourable zone for sea cucumber aquaculture development in the Northwest coast, Middle and South-West coast;
3. Environmental education in collaboration with Non Governmental Organisation (Blue Ventures), Association (Velondriake), Private Society (IOT), in order to make aware the population adults and children with impact on environment damage;
4. Creation of no-take zone, introduction of protected nurseries to isolate them from predators during their first months;
5. Hatchery and sea cucumber aquaculture development at villages in collaboration with project, association, non-governmental organisation.

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SCEAM Indian Ocean country report – MALDIVES

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1. Background

The fishery for sea cucumbers (Huifilandaa in Dhivehi language) in the Maldives began in 1985, with a single trial shipment of about 30kg of prickly redfish (*Thelenota ananas*) to Singapore. Only this species was collected and processed until late 1986, where the collection and export of a second species, the white teatfish (*Holothuria fuscogilva*) began. The fishery began in the northern atolls starting from Raa Atoll (in 1985), and extending it to Haa Alif Atoll (1988) with the number of boats involved increasing from two to five over that period. The fishery was also started in the southern atolls, Gaafu Dhaalu, Gaafu Alifu and Laamu Atolls, where the operation was carried out by providing soft loans to fishers to enter into the fishery and a guarantee by the exporter that the processed product would be harvested at the market prices. At this point only two exporters were involved in the business, the first operating in the north and the other in the south. The fishery then extended to many other atolls across the country within two years.

As the fishery progressed, and the number of foreign buyers increased, the number of species harvested also increased. Nine species are now commercially harvested from Maldivian waters - *Holothuria nobilis* (black teatfish), *H. fuscogilva* (*H. fuscogilva*), *H. fuscopunctata* (elephant's trunkfish), *H. atra* (lollyfish), *Actinopyga* sp. (blackfish/killofish) *A mauritiana* (surf redfish), *Thelenota ananas* (prickly redfish), *T. anax* (amberfish/turtleshell), *Stichopus chloronotus* (greenfish) and *Bohadschia marmorata.*

2. Fishery Operations

Sea cucumbers are generally caught by tuna fishermen on a year-round basis. When the fishery was started, sea cucumbers were hand-picked from the intertidal zone during low tide, however, the abundance of sea cucumbers soon decreased and harvests had to rely on snorkelling and the use of other gear to enable harvests from deeper waters. A fishing hook fixed to a block of lead and attached to a fishing line, similar to the technique used in Solomon Islands, was used to catch sea cucumbers from just a few metres underwater. Spears were also used to collect sea cucumbers up to three metres depth.

Scuba diving for sea cucumbers started to develop and spread rapidly in response to a depletion of the high value species in shallow waters – and reached a point where they were harvested almost exclusively using scuba gear. Divers collected the bulk of the catch within a depth range of 5–30 m, and the catch comprised mostly of the white teatfish (97%) and prickly redfish (3%).

Processing of sea cucumbers is done in the fishermen's own islands or on other, preferably uninhabited islands close to where the collection was taking place. Processing involves boiling followed by smoke-drying and then finally sun-drying. Women actively engage in processing activities when the processing is done on the fishermen's islands. The processed bêche-de-mer are either taken to Malé (the capital city) directly to the exporters or to agents of some of the major exporters based in the islands. Maldivian bêche-de-mer is exported mainly to Singapore and Hong Kong SAR.

3. Status of fishery and stocks

The fishery started in the Maldives with a selective harvest of the most expensive species (white teatfish and the prickly redfish). After the fishery started in 1985, significant increases in production were observed between 1987-1988 followed by a decrease (table 1). The prickly redfish harvests (comprising up to 97 percent of the total catch in the initial years) reached a maximum in 1988, and declined to 3 percent by 1990. The fishery targeted more (lower value) species after 1988, and this was reflected by significant reductions in the export earnings despite the increase in quantities exported. The high value species are still being selectively harvested, and the low catches point to very low levels of abundance of these species in the Maldivian waters.

Table 1. Sea cucumber export figures for the Maldives

Year	Quantity(mt)	Revenue (USD)
2012	207.09	499 359
2011	321.61	864 870
2010	209.09	592 550
2009	52.78	301 365
2008	84.01	615 548
2007	112.95	853 820
2006	87.87	991 221
2005	116.53	1 803 349
2004	182.06	2 421 919
2003	239.33	3 365 608
2002	190.29	2 948 251
2001	225.85	2 677 919
2000	205.24	2 225 026

Year	Quantity (mt)	Revenue (USD)
1999	53.84	407 432
1998	85.01	345 595
1997	318.03	727 249
1996	145.33	645 754
1995	7.97	706 612
1994	66.00	432 787
1993	71.57	595 321
1992	118.81	795 519
1991	404.51	20 022
1990	745.93	3 307 230
1989	410.29	2 240 892
1988	553.11	4 496 327
1987	33.81	337 921
1986	2.56	25 540
1985	0.03	28

The export earnings from dried sea cucumbers reported are inclusive of those from aquaculture production. This account for the increase in export revenues from dried sea cucumbers since in the early 2000s. Aquaculture targets the production of a high-value, non-native species, *Holothuria scabra*.

Very little is known about the holothurian stocks in Maldivian waters, with no formal studies having been made. Crude studies show that *H. atra, S. chloronotus* and *Actinopyga* sp. were most abundant, while *T. ananas, H. nobilis* and *A. mauritiana* were the least abundant in the Maldivian waters.

4. Current management

Since the fishery began in early 1985, the catch of the high valued species was observed to have drastically decreased over a very short period of time. A review on the sea cucumber fisheries of the Maldives that was done by Joseph (1992) revealed that the stocks of the high-valued sea cucumber species in the Maldivian waters were heavily overexploited and in threat of depletion. The author put forward several recommendations to be implemented in order to ensure sustainable exploitation of the resource. The two most important measures recommended were a closure for the fishery and export of *T. ananas* for a period of 4-5 years in order to allow the stock to replenish; and a ban on scuba diving for the collection of sea cucumbers, to take pressure off the spawning stocks of the valuable species *T. ananas* and *H. nobilis*.

Other recommendations that were put forward in the report included imposing of minimum size limits for *H. atra*; discouraging the night fishing practices for the harvest of nocturnal species such as *B. marmorata*; establishing a data collection and a monitoring mechanism; introduction of regulations giving extensive rights to sedentary resources such as bêche-de-mer within an atoll to the fishermen of that atoll; training and demonstration to the fisherfolk on proper processing to achieve maximum economic return from the processed products; and establishment of sea ranching programmes for sea cucumbers with active involvement of fishermen.

Despite these recommendations the only measure that was taken toward sustaining the Maldivian sea cucumber resource was the implementation of a ban on the use of scuba diving for the harvest of sea cucumbers.

5. Plans for the future

It is clear that the high-valued sea cucumber stocks are heavily over-fished if not already depleted, and drastic measures are necessary to be implemented for the resource to recover. A total ban on the harvest and export of sea cucumbers for a few years, so that the depleted populations are allowed to recover, is perhaps the most important of all the possible management measures.

In order to facilitate proper management and monitoring, there is a need to train people on the identification of the commercially harvested species. The only available information is from export figures, which report sea cucumber shipments as 'dried sea cucumbers' and does not categorise the shipment by species.

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SCEAM Indian Ocean country report – MAURITIUS

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1. Background

The collection and processing of sea cucumbers started in late 2005 when two locally based fishing companies were granted permits to collect and export sea cucumbers for a period of six months ending in July 2006 on a trial basis. Subsequently, a third company was authorised to collect sea cucumbers for a period of six months. Other companies then submitted applications for authorisation to collect sea cucumbers in the maritime zones of Mauritius for export.

The main sea cucumber species collected were *Actinopyga echinites, A. mauritiana, Bohadschia marmorata, Stichopus chloronotus, S. herrmanni, Holothuria scabra* and *H. nobilis*. A total of 415 tonnes of sea cucumbers were collected and 80 tonnes in the processed form were exported to Far East countries in 2006.

In the absence of adequate data from this fishery and the fear of over-exploitation, a survey was carried out in February 2007 to estimate the stock of the sea cucumbers in the lagoon of Mauritius. Based on the findings of this study, it was recommended that a precautionary approach be adopted to ensure the sustainable exploitation of the sea cucumbers while at the same time conserving the marine ecosystem. Thus, a Total Allowable Catch (TAC) of 550 tonnes, which was equivalent to 90 tonnes dried sea cucumbers, was proposed. In March 2007, this TAC was equally allocated among five locally-based fishing companies to collect sea cucumbers for a period of six months. Thus, a quota for the export of 18 tonnes dried sea cucumbers was given to each company. Additionally, the authorisations were subject to a set of conditions which included a closed period from 1st January to 31st March, a size limit of 15cm and closed areas. As at April 2008, a total of 481 tonnes of sea cucumbers were removed from the lagoon and 36 tonnes of processed sea cucumbers were exported mainly to Hong Kong by the five companies.

Based on the findings of another survey carried out in April 2008 on the stock of sea cucumbers in the lagoon down to a depth of 3m and adopting a precautionary approach to ensure the sustainable exploitation of the resource, a TAC of 212 tonnes which was equivalent to 35 tonnes of dried sea cucumbers was proposed. In August 2008, this TAC was shared among ten companies to collect and export sea cucumbers. As at July 2009, a total of 114 tonnes of sea cucumbers were collected and comprised mainly of *Holothuria atra.*

A suspension in the collection of sea cucumbers for a period of two years from 1st October 2009 was then enforced with the purpose to allow the replenishment of the stock. Based on the conclusions of subsequent surveys, provisions were made for the extension of the moratorium period of prohibition to fish sea cucumbers for another four years as from 1st March 2012.

2. Fishery Operations

A 2-year moratorium period of prohibition to fish sea cucumbers was put in place as from 1st October 2009 and it was extended for another four-year period as from 1st March 2012. Thus, the sea cucumber fishery has not been operating since October 2009.

During the days of operation, collection of sea cucumbers was carried out solely through hand-picking by both men and women in the waters of Mauritius. Authorisations were granted to locally-based fishing companies subject to a set of terms and conditions, which included, *inter-alia*:

- No fishing shall be allowed during the closed season from 1st January to 31st March.
- The collection of sea cucumbers shall be through hand-picking only.
- The minimum length for all species in the catch should not be below 15 cm, when freshly caught.
- The sea cucumbers shall be processed in an approved place.
- An environmental clearance for the processing place/plant from the Ministry of Environment shall be required prior to the start of any fishing operations.

Details on the supply-chain of sea cucumbers are not available. However, the main export markets for the processed/dried sea cucumbers were the Far East countries.

3. Status of fishery and stocks

In Mauritius, limited research has been undertaken on sea cucumbers. In a study undertaken to assess the stocks in September 1998, a total of 1 129 specimens comprising nine species, *viz. Actinopyga echinites, Bohadschia marmorata, Holothuria atra, H. leucospilota, H. pervicax, H. scabra, Stichopus chloronotus, S. variegates* and *Thenelota ananas* were observed from the two selected survey sites. The abundances of holothurians were estimated at 40 individuals/1 000 m^2 and 73 individuals/1 000 m^2 at the respective survey sites.

In similar surveys carried out in March 2006 at the same locations, four species were encountered, viz. *Actinopyga echinites, Bohadschia marmorata, Holothuria atra,* and *H. leucospilota.* The abundances of sea cucumbers were estimated at 16 individuals/1 000 m^2 and 34 individuals/1 000 m^2 at the respective survey sites. Based on those surveys, the total biomass in the lagoon of Mauritius was calculated and the Maximum Sustainable Yield (MSY) was estimated at 556 tonnes (wet weight), roughly equivalent to 92 tonnes of dried sea cucumbers.

In February 2007, another survey was carried out at fourteen selected sites around Mauritius to estimate the stock of sea cucumbers in the lagoon, its distribution and abundance and to recommend management strategies for its sustainable exploitation. The overall density in the lagoon around the island was calculated at 37 000 individuals/km^2 and the standing biomass was estimated at 1 846 tonnes (wet weight). The bulk of this was found to be those of low value species such as *Holothuria atra*. The MSY was estimated at 550 tonnes (wet weight), which is equivalent to 90 tonnes of dried sea cucumbers.

In April 2008, yet another survey was undertaken at eight sites around the island to review the status of the stock of sea cucumbers in the lagoon down to 3m depth. A total of 1 563 specimens comprising seven species, viz. *Holothuria atra, H leucospilota, H. scabra, H. pervicax, Stichopus chloronatus, Bohadschia marmorata* and *Thenelota anax* were observed at the survey sites. The overall density in the lagoon was estimated at 30 000 individuals/km^2 and the standing biomass was estimated at 1 418 tonnes (wet weight). The bulk of this was found to be those of low value species such as *Holothuria atra*. The MSY was calculated at 425 tonnes (wet weight). Given that the sea cucumber fishery in Mauritius was already in the exploitation phase and that some species were being over-exploited in the shallow strata, a TAC of 212 tonnes (wet weight) was recommended, which is equivalent to 35 tonnes of dried sea cucumbers at a recovery rate of about 16 percent.

In September 2010, a follow-up survey was carried out at eight selected sites around Mauritius. A total of 770 specimens comprising of 5 species were observed: *Holothuria atra* (92.5%), *H. leucospilota* (4.9%), *Stichopus chloronotus* (0.6%), *Bohadschia marmorata* (1.7%) and *Thenelota anax* (0.3%).

4. Current management

Since 2006, several operators were authorised to collect sea cucumbers in the waters of Mauritius. On 9th September 2008, the Fisheries and Marine Resources (Fishing of Sea Cucumbers) Regulations were promulgated. It provided for the control of the collection of sea cucumbers in the maritime zones of Mauritius so as to ensure the sustainable exploitation of the resource. As per the regulations, which came into operation as from 15th September 2008, the Permanent Secretary of the Ministry of Fisheries could authorise the fishing of sea cucumbers under terms and conditions as he thought fit and no person

could fish any undersized (less than 15 cm in length) sea cucumbers and no person could fish any sea cucumbers from 1st January to 31st March in a year.

However, in September 2009, the Fisheries and Marine Resources (Fishing of Sea Cucumbers) Regulations 2008 were revoked and new regulations were made to suspend the fishing for a period of 2 years to allow the stock of sea cucumbers to replenish. Thus the Fisheries and Marine Resources (Fishing of Sea Cucumbers) Regulations 2009 was promulgated on 28th September 2009 and it stipulates, amongst others, that "…… *Notwithstanding the other provisions of these regulations, no person shall fish any* sea cucumbers *from 1st October 2009 to 30th September 2011*."

Based on the conclusions of the surveys undertaken in 2010, the Fisheries and Marine Resources (Fishing of Sea Cucumbers) Regulations 2009 was amended in February 2012 to provide for the extension of the moratorium period of prohibition to fish sea cucumbers for another 4 years. The Fisheries and Marine Resources (Fishing of Sea Cucumbers) (Amendment) Regulations 2012 was thus promulgated on 23 February 2012 and came into operation on 1st March 2012. It stipulates, amongst others, that "…… *Notwithstanding these regulations, no person shall fish any sea cucumbers from 1st March 2012 to 29th February 2016*."

5. Plans for the future

With a view to ensuring the long-term exploitation of sea cucumber fishery in Mauritius, follow-up surveys would be undertaken before the end of the moratorium period ending in February 2016 to determine the status of the stock of sea cucumbers in the waters of Mauritius. Future management measures would be based on the outcomes of these surveys.

SCEAM Indian Ocean country report – MAYOTTE (FRANCE)

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1. Background

An exploitation of sea cucumbers has been reported in the early 1900s. But the further development of the fishery during the mid 1900s is unclear. A real exploitation has started at the end of the 1990s, probably implemented by Malagasy immigrants and due to the rarefaction of Madagascar stocks. The precise date of the starting is difficult to say. The first export certificate was found in 2002 (Pouget and Wickel, 2003). A collector came in villages asking fishermen for sea cucumbers. The collection was first made at low tide on the intertidal zone. As free diving fishing was forbidden in the lagoon of Mayotte, fishermen with small boats collected most of the catches outside the lagoon. No scuba diving fishers have been noticed during this period. The processing was done in a "shibushi" village (original from Madagascar) in the south of the island.

2. Fishery Operations

The main targeted species was *Holothuria nobilis*. However, according to Pouget (2004) a total of 5300 kg of dried product was exported during year 2002. This is roughly the equivalent of 53 000 kg live weight. Assuming that the last five years of operation averaged at this export rate a total of 26 500 kg of product, equivalent of ~265 000 kg live weight, was exported from 2000–2004 (Eriksson, 2010).

3. Status of fishery and stocks

There is no data of the stock before the exploitation started. It is impossible to compare the actual stock with the virgin stock. A total of 19 species with a commercial value were recorded. The distribution of stock is heterogeneous or scarce for some species while others are commonly found. The good coverage and density of the black teatfish (*Holothuria nobilis*) and the prickly redfish (*Thelenota ananas*) found in this survey is a good indicator of a healthy commercial stock as these species are high-value (Eriksson, 2010). After eight years of closure the stocks show a good recovery.

4. Current management

Based on the example of the fishery depletion in Madagascar, and recognising the lack of control by Service de Pêche (SEP), the sea cucumber fishery in Mayotte was closed in 2004 when collecting, processing or selling sea cucumbers became illegal (Arrêté préfectoral n°21/SG/DAF/2004 du 15 avril 2004 portant interdiction de l'exploitation des holothuries sur le territoire de la collectivité départementale de Mayotte) (Eriksson, 2010). The fishing has been banned such as the processing. The control was stronger at land and put a high constraint on the sector that quickly disappeared.

5. Plans for the future

The re-opening of the fisheries is not in discussion at the present time. The exclusive economic zone of Mayotte is now a Natural Marine Park. The effort on fishing management will mostly concern lagoon and coral reef habitat. But Comoros will sell fishing license to a Chinese company in 2013 on Moheli island. It seems important to take care on the fishermen practice in Mayotte to avoid illegal fishing. Unreported exportation might appear with the migration flows between the islands, regarding the financial manna it can represent for the immigrants population.

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SCEAM Indian Ocean country report – MOZAMBIQUE

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1. Background

Sea cucumbers are known in Mozambique as Magajojo and they are distributed throughout the coast. Sea cucumber fishing is not a new activity – it has been in existence since the 1950s. In 1983, the country earned ~600 000USD of exports. According to a report by Abdula (1998), the catch was 500 tonnes in 1983, 700 tonnes in 1993 and had declined to 6 tonnes in 1995 and 54 tonnes in 1996. Between 2000 and 2004 when the last reports are available, production was <10 tonnes/year (Conand and Muthiga, 2007). Unfortunately, it is difficult to know to what extent the variability in the catch is

due to irregular reporting in the provinces and to over-exploitation, but given that there has been such a dramatic drop in the catch, overexploitation is probably a reasonable explanation.

The fishery intensified in the 1990s resulting in its virtual collapse mainly in the southern area of the country (Maputo and Inhambane). Despite not having had a directed fishery, the Chinese have always been the main buyers. Currently the fishery takes place in the northern part of the country (Cabo Delgado and Nampula Province), where the fishermen have reported a decrease in catches forcing them to move to deeper zones. The main commercial species harvested in Mozambique are: *Holothuria scabra*, *Holothuria nobilis*, *Holothuria fuscogilva*, *Actinopyga echinites*, *Holothuria atra* and *Actinopyga mauritiana*. There are other species occurring in Mozambique waters such as *Actinopyga lecanora*, *Stichopus chloronotus*, *Stichopus herrmanni* for which catch levels are not known, and a few more that remain unidentified.

2. Fishery operations

The sea cucumber fishery is mainly a small scale fishery, practiced by men using diving and collection by hand in shallow areas and to depths of 10–20 m. In a few regions of the country children collect *Holothuria scabra* over the seagrass beds. The market is driven by demand, with fishing occurring only when there is a buyer. The fishermen do not do any kind of processing but sell the wet product to Chinese traders who then process and procure an export license from the National Fisheries Administration.

3. Status of fishery and stocks

It is difficult to describe the trends and their influence on the status of the resource, since the monitoring of this fishery is not done in Mozambique, neither in terms of catches, nor even in terms of species. There are only a few specific studies on certain species in some areas of the country. Reports indicate that in general the stocks are decreasing over time, and in some areas such as Maputo and Inhambane the fishery has collapsed.

4. Current management

There is a regulatory tool, the General Regulation of marine fisheries, that directs the management of the sea cucumber resource, but it does not provide information on the species. The regulation of marine fisheries states, in some of the articles that it is prohibited to:

- harvest larvae or juveniles of any species, unless it is for aquaculture;
- hunt underwater using scuba gear; and
- collect for all species of sea cucumbers individuals of less than 20 cm or 250 g.

The local community (especially the CCP's which are local fisheries councils) have the main responsibility of supervising fishery activities in Mozambique.

5. Plans for the future

There is a need and desire by the Ministry of Fisheries to collect information (monitoring) of the catches through artisanal fishermen and from processing and export companies of sea cucumbers. Currently, there is a review of an effective model of data collection.

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SCEAM Indian Ocean country report – OMAN

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1. Background

Oman has a coastline of 3 165 km characterized by a rich marine biodiversity and productive ecosystems with valuable stocks. Sea cucumbers (Holothuroidea) are one of those valuable resources. The utilization of sea cucumbers in Oman dates back to the 1960s when the local fishermen in Wilay at Mahout started to collect the sea cucumbers to exchange them with foodstuffs from the ships coming from East Africa. The sea cucumber fishery at that time was not very important economically, and was not considered as a major livelihood activity. Sea cucumber fishery halted during 1970s and 1980s, there are no records of collecting or trading during that time. However, during 1990s the importance of sea cucumbers started to gradually increase due to the interest shown by traders from neighbouring countries, and reached its peak during 2004. The Omani sea cucumber fishery engages mainly artisanal fishermen, on a small scale, and no commercial companies have been involved in this fishery.

2. Fishery operations

The Omani sea cucumber fishery is exploited by artisanal fishermen along the nation's coastline. The most valuable and commercially fished species is *Holothuria scabra*, which is commonly known as *feik al-bahar*. Artisanal fishermen collect sandfish by wading in shallow areas at low tides and by snorkelling from small fibreglass in depth not more 10 m. This species is currently overexploited in Oman, and fishermen have shifted their fishing activities to a lower-value species as a substitute; the Lollyfish (*Holothuria atra*), locally called *abuar-Reyf*, and *Holothuria leucospilota*, locally called *abuar-Reyfnaqly*. Fishermen undertake the following steps to process the sea cucumbers for sale:

1) Get rid of the guts
2) Preliminary cooking
3) Storing under beach sands
4) Cleaning (to remove calcareous deposits on the body)
5) Second cooking
6) Drying

Generally, there is no local consumption or domestic market for sea cucumber in Oman. The entire production is exported (in the dried form) to the United Arab Emirates, Hong Kong SAR, Singapore and China PR. Export of sea cucumber products is done mainly by the local traders, who collect the raw products from local artisanal fishermen. Local traders transfer the product then to the neighbouring markets mainly United Arab Emirates, which in their turn export it to foreign countries. In 2006, about 14.5 tonnes of dried *H. scabra* was exported from Oman to the United Arab Emirates.

3. Status of fishery and stocks

In 2004, during the peak of sea cucumber fishery activity in Oman, there were around 400 persons involved in this fishery, half of them were women. The stocks collapsed dramatically after 2004. In 2005, 100 sea cucumber units were collected per fishermen per fishing trip, while in 2007, the average daily harvest was only 20 sea cucumber units per fishermen per fishing trip. This change in catch per unit effort demonstrates the drastic decline of the stocks. Overall, the stocks of *Holothuria scabra* have been particularly overexploited, due to the extensive fishing practiced by fishermen on this species. As a result, the fishermen started to target other lower-value species such as *Holothuria atra.*

4. Current management

Because extensive fishing of sea cucumbers in Oman is relatively recent, there are no biological and ecological information on Omani sea cucumber populations. Also, population dynamics for sea cucumber is not well known. Due to the lack of the basic information and as a result of the recent development of the fishery, there are no conventional or state-directed management strategies in place. It is an open access fishery.

The situation of *Holothuria scabra* is evidently of high concern and urgent measures should be prescribed to stop its further depletion and engage the fishery in a process of recovery. Similar consequences may affect *H. atra* if appropriates measures are not undertaken. It is certainly not an easy task to ban fishing activities as a unique management measure in Oman. Limitations on exports would also need to be decided.

As an interim measure, and on the basis of a precautionary approach, a moratorium should be implemented while a comprehensive survey is being undertaken to understand the spatial distribution of these species and a preliminary assessment is achieved by the Research Institute.

A global Quota should then be determined together with other technical measures to monitor the fishery, such as seasonal fishing closures and gear restrictions.

5. Plans for the future

Besides the management measures that should be initiated as indicated above, the Ministry of Agriculture and Fisheries, in collaboration with Sultan Qaboos University, is executing a research project, with the objective to identify the aquaculture techniques for sea cucumber (sandfish), to help re-build the stock.

In addition to the above-mentioned programs, further investigations are being started to determine the basic biological parameters of sea cucumbers in Oman. Such studies will provide a good basis upon which the Ministry can develop a specific management plan for these species.

SCEAM Indian Ocean country report – RODRIGUES (MAURITIUS)

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1. Background

The sea cucumber fishery is a new fishery, which started in April 2006 on a trial basis for 15 days with one private company involved. As this fishery was never exploited before, the result of the trial was so good due to massive fishing of the species target. Consequently, the fishery was closed to conduct a survey on abundance and distribution of sea cucumber in the lagoon. Five additional licences were issued to private companies to begin the exploitation of sea cucumber in the lagoon only.

In July 2007, a survey of sea cucumbers was conducted in the lagoon and the objectives were (i) gather information on the status of the stock of sea cucumber, its distribution and abundance in the lagoon, (ii) determine the species composition and their size and (iii) come up with recommendations for the sustainable exploitation of the sea cucumber resources. The survey was carried out at 16 sites and the observation were conducted by using the Belt Transect Method along 100 metre main transect lines and on five side transects of 20 metres laid at random at different depth in the lagoon. The average density in the surveyed area in the lagoon around the island was calculated at 85 400 individual/km². The

highest density of sea cucumber was found at 423 000 individuals/km² and 300 g average live weight of an individual sea cucumber. The standing population was calculated at 17 million, which comprised of mainly *Holothuria atra* (AFRC, 2007).

2. Fishery operations

Base on the result of the survey, quota was allocated to the 6 companies processing the sea cucumber. In the beginning there was no licence issued to fish sea cucumber i.e. all persons who wanted to fish were allowed to do so and it was found that children were also collecting sea cucumber. Consequently, permit was issued to 396 fishers who have applied for the fishing of sea cucumber to have a better control on fishing and fishers who do not have permit were not allowed to fish sea cucumbers. There were about 50 boats that were involved in the fishing activities. As fishing was done during low tide, many fishers walked from the shore to the reef for fishing. Sea cucumbers were collected by gleaning, except for *Holothuria scabra* and *Bohadschia marmorata*, which were strictly prohibited. Fishers were not authorised to practice under water diving fishing.

All sea cucumber fished are sold to processers who have been granted permit to process sea cucumber subjected to term and condition for collecting and processing of sea cucumber laid by the Rodrigues Regional Assembly (RRA). After processing the sea cucumber are exported to Mauritius. Exportation of sea cucumber is carried out only when the processor has received a written approved from the RRA granted the company authorisation to export the quantity requested. The fishery was recently closed (see below under 4. Current management).

3. Status of fishery and stocks

There are 29 species of sea cucumber in Rodrigues and only six species were exploited namely *Holothuria atra*, *H. leucospilata*, *Stichopus chloronotus*, *S. herrmanni*, and *Thelenota ananas*. More fishers were interested to join the fishery, as it was easy to fish sea cucumbers.. After the closure of the fishery, no survey has been conducted to gather information on the status of actual stock of sea cucumber and its distribution and abundance in the lagoon. It has been planned to conduct a survey in the lagoon to see the standing stock and it distribution.

4. Current management

As there was massive exploitation of the fishery and many individual sea cucumbers below 300g were being fished, the fishery was closed as from January 2009 subsequent to a regulation passed in the Rodrigues Regional Assembly to prevent complete depletion of the resources. Moreover, as the price was not fixed, the many company were purchased fresh sea cucumber at low price with fishers. The fishery remains closed until good management measures have been identified.

5. Plans for the future

The sea cucumber fishery has been seen as a prominent fishery, but wild exploitation will result in overexploitation of the resources. In 2010 with the support of the former ReCoMaP project, a consultant worked on the potential of sea cucumber farming in the lagoon and three sites were identified as potential sites for aquaculture. Now we are looking in the possibility of doing aquaculture through establishing a hatchery for farming/ranching of sea cucumber.

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SCEAM Indian Ocean country report – SEYCHELLES

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1. Background

In Seychelles, sea cucumbers have been fished for more than a hundred years, with reports of bêche-de-mer exports dating back to the late 1800s. However the quantities fished were fairly low and it is only in the late nineties that the fishery has seen a rapid growth. This is due to several factors, the main one being the high demand for dried sea cucumbers (bêche-de-mer) on the international market and higher prices offered for the product. The fishery has evolved from a collector-type, whereby fishers collected sea cucumbers on foot, to a more sophisticated one where most of the harvesting is done by divers using scuba gear in deeper waters. In Seychelles, most of the sea cucumbers are processed to the dried form before being exported.

2. Fishery operations

In approving the memorandum on *The Future of the Sea Cucumber Fishery* in October 2001, Cabinet of Ministers agreed that entry into the fishery be limited to only 25 fishing licences until a rational management plan could be formulated following a proper assessment of the stock. Applicants are required to already have a valid local fishing vessel licence in order to qualify for a sea cucumber fishing licences, which vary according to the boat types. The sea cucumber fishing licence is subject to a number of conditions. A maximum of four divers are authorized to fish under a sea cucumber fishing licence.

Licensees are required to provide SFA with all their catch and effort data on a monthly basis as per the conditions of their fishing licence. The licensees are provided with sea cucumber catch and effort forms, along with a grid map of the Mahe Plateau, which guides them in reporting their fishing locations. The licensed processors are allowed to purchase sea cucumbers only from licensed fishers and the sea cucumber inspection certificate obtained from the licensed harvester have to be provided as proof of purchase when requested.

Processors are also required to provide SFA with all their processing data on a monthly basis as per conditions of their licence. Processors are issued receipt books to record the quantities of sea cucumbers purchased. Both the licensed fisherman from whom the processor purchase sea cucumbers from and the processor are required to sign a receipt for each transaction. This ensures that a processor purchase sea cucumbers from licensed fishermen and also allows SFA to verify the catch data provided by the fishermen. Processors are also issued with a 'ledger' by the SFA to summarise their purchase and export of sea cucumbers.

3. Status of fishery and stocks

The catch data shows a continuous increase in the number of sea cucumbers harvested over the years (2000–2007). From the catch figures, it is also clear that the fishermen are targeting mainly the white teatfish (*Holothuria fuscogilva*) and the pentard teatfish (*H.* sp. "pentard"), which fetch the highest prices on the market.

4. Current management

Currently the fishing licences are capped at 25 and be valid for the period of the open season (i.e. 1st October – 31st May). Licenses are renewable yearly, given that the licensees have complied with the license conditions set. SFA has been under considerable pressure to either lift the quota on licences and

move to an open access fishery or increase the number of licences. This is highly unadvisable given the vulnerability of sea cucumber stocks.

Real time monitoring is undertaken at landing sites and SFA inspectors issue receipts to fishermen upon verification of their catch which is done each time a sea cucumber fishing vessel enters into port; VMS data is being used. The duplicate of the receipt is produced to processors upon selling of sea cucumbers and this should be reflected in the export; the processors have to justify if there should be any discrepancy. In order to achieve this, designated sites for the landing of sea cucumbers have been established around the main island of Mahé; Victoria (fishing port), Bel Ombre, Providence (Zone 6) and Anse La Mouche.

It is required that SFA be informed of each fishing trip conducted by a vessel licensed to fish sea cucumber (i.e. when the vessel is leaving port and when it's coming back). All licensed sea cucumber fishing vessels need to have VMS onboard and this will be a condition of the licence. The VMS should remain on at all times except when in Port. All landings of sea cucumbers must be done within the hours of 8 a.m. to 4 p.m. on Monday to Friday, except on public holidays.

5. Plans for the future

A proper stock assessment is being planned in collaboration with the association of members of the sea cucumber industry so as to know the status of the stock. A review of the current management measures has been done in collaboration with the stakeholders and a Cabinet Memorandum has been prepared and is currently awaiting approval.

SCEAM Indian Ocean country report – SRI LANKA

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1. Background

Sri Lanka is a tropical island in the Indian Ocean, southeast of the Indian sub-continent between $5^0 55^0$ – $9^0 55^0$N latitudes and $79^0 42^0$ –$81^0 52^0$E longitudes. The coastline of Sri Lanka is about 1 340 km long and characterized by lagoons and shallow inlets. The major fishing activities are restricted to the relatively narrow continental shelf of 30 000 km^2 with an average width of 25 km (Joseph, 1999). The sea cucumber fishery was introduced to Sri Lanka by Chinese traders and bêche-de-mer appears to have been one of the major commodities taken to China for centuries (Hornell, 1917). Fishing activities were initially concentrated off the north (around Jaffna peninsula), east (Trincomalee, Pothuwil and Kalmunei) and northwest (from Kalpitiya to the Gulf of Mannar) coasts of Sri Lanka (Adithiya, 1969; Joseph and Moiyadeen, 1990). In the mid-1990s, sea cucumber fishing started along the southern coastal belt but it did not sustain for a long period due to overharvesting of the resources (Kumara *et al*., 2005).

As in many other coastal fisheries of Sri Lanka, the sea cucumber fishery is primarily artisanal but provides significant contribution to the livelihoods of coastal fishing communities off the north, east and northwest coasts (Dissanayake *et al*., 2010). Sea cucumbers were initially harvested by hand, by walking along the coastal areas during the low tide periods. Since the early 1980's, fishers moved further offshore using snorkelling and scuba diving as shallow water stocks became depleted (Kumara *et al*., 2005). The decline of high-value species and entry of new sea cucumber species to the fishery were reported, particularly in the vicinity of Kalpitiya off the northwest coast, where the number of

targeted species has increased from 8 to 16 during 1990 to 2002 (Dissanayake and Wijayarathne, 2007; Joseph and Moiyadeen, 1990).

Although the fishery has been practiced for several centuries, there is no tradition of consuming sea cucumbers in Sri Lanka. The entire production is processed as bêche-de-mer and exported to Singapore, Taiwan and China. Sea cucumber exports peaked between 1995 and 1997 at nearly 300 tonnes (dried), worth about US$ 3 million, followed by a drastic drop to almost half of this volume during the period 2000 to 2003 (Dissanayake *et al*., 2010; Kumara *et al*., 2005). According to statistics from the custom office, import of sea cucumbers commenced in 1996 but accurate information on import quantities and the source of imports have not been established (Kumara *et al*., 2005). Information on the annual exports have been poorly documented and, until recently, there were no records on catch and effort statistics. Hence, it is difficult to quantify the historical and current production trends of sea cucumbers in the coastal waters of Sri Lanka.

2. Fishery operations

The Fibreglass Reinforced Plastic (FRP) boats powered with 9, 15 or 25 HP outboard motors are the major fishing craft used in the sea cucumber fishery in Sri Lanka. Sea cucumbers are mainly harvested through diving and hand picking. Scuba diving is carried out by almost all the divers in the east and northwest and skin diving is practiced off the north coast. Normal practice is for two divers and a boat operator during a fishing trip but sometimes there are three divers onboard. On average, four scuba tanks are used by each diver during a fishing trip and fishing time (in the water) varies from 30–45 minutes per tank. Both day and night fishing activities are practiced in the north and northwest but night diving has predominated along the east coast as day collection is not profitable due to low catch rates. The fishing boats leave around 07:00–08:00 hrs and return around 15:00–16:00 hrs when day diving activities are carried out while they leave around 18:00 h and come back next day early morning around 02:00 hrs for the night fishing. There is no specific time for skin diving practices and normally it starts from 10:00–18:00 hrs off the north coast.

There are considerable variations in fishing depths according to the fishing mode. Day diving is carried out down to a depth of 20–25 m while the night diving is restricted to 10–12 m. However, the effective fishing time ranged from 2–2.5 hours per boat per day in both day and night diving activities. Around 650 boats are engaged in sea cucumber fishing activities off the north and northwest coasts while there are 200 boats off the east coast. Local migration of fishers takes place especially from the northwest to east and north during the respective fishing season. In each area, around 2 000–2 500 fishing families are directly or indirectly dependent on the sea cucumber fishery for their livelihoods. Almost all the fishers are either Muslims or Catholics and they did not go for fishing on Friday and Sunday, respectively, due to their religious activities, so fishing occurs mostly six days per week. Further, the active number of fishing days varies with climatic conditions as it requires clear and calm seas for successful fishing.

Most of the fishing vessels and diving equipment are owned by entrepreneurs who rent them out to the fishers at a fee. At the same time, fuel for the boats is also supplied by entrepreneurs and they are the first level of buyers. All the sea cucumbers are landed in fresh form and sold on a per-piece basis at landing sites. The market price of sea cucumbers varies from species to species and there are fluctuations from time to time. Even within the same species, the price is quite variable depending on the individual size, with larger individuals fetching higher prices than the smaller individuals.

Twenty two small-scale entrepreneurs are involved in the sea cucumber fishery off the north and northwest coasts and there are seven major processing plants. As the buyers sell their catches directly to the processing plants, local processing by fishers is rare in these areas. There are 11 buyers in the east and they carry out domestic processing as there are not any large-scale processing plants in this region. Processing steps are similar in both areas and the major processing steps involve evisceration, boiling, salting, cleaning and sun drying though there were some modifications from species to species.

At the end of each fishing operation, entrepreneurs deduct the cost for lending boats and usage of fuel and diving equipment out of the total revenue. Depending on the fishing time there are differences in the net income per operation. Night fishing always generates higher profit than the day fishing.

3. Status of fishery and stocks

As the sea cucumber fishery has developed without baseline biological data or routine monitoring, the resource status was unknown and un-quantified for a long period. Despite the observations by fishers of local depletion of sea cucumbers, particularly the high-value species, no systematic studies had been conducted in Sri Lanka to assess the status of sea cucumber populations or to evaluate the sustainability of the fishery until quite recently. To assess the status of sea cucumber stocks in the two geographical regions, northwest and east coasts of Sri Lanka, Underwater Visual Censuses (UVC) and fishery independent surveys were carried out during 2008 and 2009 by the National Aquatic Resources Research and Development Agency (NARA) (Dissanayake and Stefansson, 2010, 2012).

A total of 28 sea cucumber species belonging to nine genera (*Actinopyga, Bohadschia, Holothuria, Pearsonothuria, Stichopus, Thelenota, Acaudina, Pseudocolochirus* and *Colochirus*) were identified. Although there were 22 commercial sea cucumber species only 12 species were dominant in the commercial catches. In both regions, the commercial fishery predominantly relies on brown sandfish (*Holothuria spinifera*) and amberfish (*Thelenota anax*). Brown sandfish has the highest contribution (73%) to the total landings off the northwest coast while this is provided by from amberfish (93%) off the east coast (Dissanayake and Stefansson, 2012).

According to Dissanayake and Stefansson (2010), low value species were predominant in the east and northwest areas 79 ± 125 ind.ha^{-1} and 244 ± 488 ind.ha^{-1}, respectively, and species of medium value were relatively abundant (10 ± 34 ind.ha^{-1} in the east and 105 ± 175 ind.ha^{-1} in the northwest) when compared with high-value species (< 2 ind.ha^{-1}). The abundance of low-value species was heavily weighted by the presence of large numbers of *Holothuria edulis* which was the most dominant species in both areas *Holothuria atra* was the second highest species with an average density of 90 ± 252 ind.ha^{-1} in the northwest and 24 ± 54 ind.ha^{-1} in the east (Figure 1). The density of teatfish (*Holothuria fuscogilva* and *Holothuria nobilis*) was found to be less than 1 ind.ha^{-1} in both areas while it was 1 ± 16 ind.ha^{-1} for *Holothuria scabra* in the northwest coast (Dissanayake and Stefansson, 2010).

Lollyfish (*Holothuria atra*)

Pinkfish (*Holothuria edulis*)

Figure 1. Highly abundant species off the northwest and east coasts of Sri Lanka (Photos: D.C.T. Dissanayake)

The population densities of all the sea cucumber species were less than 30 ind.ha^{-1} except for *H. atra*, *H. edulis* and *H. spinifera* off the northwest coast and *H. edulis* off the east coast (Dissanayake & G. Stefansson, 2010). According to the approximate guide proposed by Purcell *et al*. (2009), population

densities below 30 ind.ha^{-1} can be considered as at "critical level" at which populations may fail to repopulate effectively.

Sea cucumber fishing re-started off the north and northeast coasts of Sri Lanka in 2010 with the end of thirty years civil war conditions and there is a very lucrative sea cucumber fishery in these areas right now. As there was no large-scale assessment of sea cucumber populations in these areas, the resource status and fishery potentials on the north and northeast coasts are unknown and stock assessment of these resources are planned for the near future. The species *Holothuria scabra* , *Holothuria spinifera, Bohadschia marmorata, Stichopus naso* are predominant in the commercial catches off the north coast of Sri Lanka (Figure 2).

High-value species (*Holothuria scabra)*

Medium-value species (*Holothuria spinifera*)

Low-value species (*Bohadschia sp.)*

Low-value species (*Stichopus naso*)

Figure 2. Major commercial species off the north coast of Sri Lanka (Photos: D.C.T. Dissanayake)

4. Current management

Sri Lanka has adopted several management precautionary approaches for the management and sustainable utilization of sea cucumber resources in Sri Lanka. These include issuing diving and transportation licenses, prohibit catching and exporting of undersize species and development of an artificial breeding programme to restore wild population and produce seeds for aquaculture practices. Sandfish (*Holothuria scabra*) was successfully bred and juveniles are currently reared at the National Aquatic Resources Research and Development Agency (NARA) Regional Research Center at Kalpitiya

(Figure 3; Kumara *et al*., 2012). NARA is expecting to carry out this programme in a large scale to provide required juveniles for commercial mariculture.

Figure 3. Hatchery produced sandfish juveniles in Sri Lanka (Photos: P.A.D. Ajith Kumara)

5. Plans for the future

Now this is right time to do another a comprehensive resources survey throughout the island including north and northeast, which were not covered in the previous resource survey. Based on the survey results as well as existing information, NARA has proposed to implement the following measures for the management and sustainable utilization of sea cucumber resources in Sri Lanka:

- Implementation of TAC limit
- Implementation of minimum landing size
- Routine monitoring and reporting of commercial landings
- Spatial management through marine protected areas (MPAs)
- Implementation of closed areas
- Limiting of fishing licences

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SCEAM Indian Ocean country report – TANZANIA

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1. Background

Sea cucumber constitutes one of the important marine resources of Tanzania. Despite the long history of consumption by oriental population their biology is still poorly understood and therefore utilization and management in Tanzania is underdeveloped. In Tanzania, it was reported by retired fishers through informal interview that trawling by commercial harvesters of prawns in the 1970s was secretly fishing sea cucumber. In the Southern region of Tanzania Commercial prawn trawler in Kilwa and Bagamoyo used to land a small by catch of Sea cucumber. From those days, there has been rapid expansion of sea cucumber exploitation at some sites of Tanzania (Mgaya *et al*., 1999). Unfortunately, Tanzania has unknown and unquantified resource of sea cucumber, although the fishery provides income to local collectors and foreign currency to the nation.

The under development of the sea cucumber fishery monitoring in the country has lead to deficiency of the necessary data for management purpose. Only little information is available on catch (live weight), catch effort (number of fishermen and harvest time), fishermen generally do not use logbooks for data recording instead estimates have occasionally been made by scientists. The sea cucumber fishery in Tanzania, though not well recognized, bring foreign currency due to its high demand on the international market. Fishing is only done for export only and the level and potential contribution to the National economy as well to the livelihood of the coastal communities were promising. However, from 2006 the export of bêche-de-mer was closed due to concerns of overfishing. Some illegal fishing continues despite the fishery closure.

2. Fishery operations

In Tanzania, exploitation of sea cucumber was done locally by artisanal fishers within small commercial operations monopolized by a few exporters. Exploitation occurred year-round on reef flats close to the shore or sheltered from the prevailing winds. The main collection season were October to December and April to May, when the winds were usually light, and trips could be made to the offshore reefs. Various methods were used in collecting sea cucumbers which includes; hand picking either from the intertidal reef flats or by snorkel, diving over sand and sea grass areas, collection by free diving, using both manufactured or homemade goggles. Scuba diving that increased and became popular as shallow water areas became depleted and fishers move to deeper waters. Free diving and the use of scuba equipment by fisherman who are not taught to scuba dive correctly place the lives of collectors at risk, and drowning have been reported many times. Sea cucumbers were all exported outside the country in Asian countries where they are consumed. The export trade was monopolized by few traders who collected the dried bêche-de-mer from processors and exported.

3. Status of fishery and stocks

Tanzania believed to have twenty species of sea cucumber. Among those species, only few are valuable and therefore exploited in larger quantity compared to other. The valuable species like *Holothuria scabra, H. nobilis, H. spinifera and Holothuria sp* were highly exploited. This is because the valuable species is preferred on the international market. However the research conducted in 1998 in Mafia District indicated that the non-valuable species like *Actinopyga miliaris, Bohadschia argus, B. marmorata and Stichopus variegates* occurred in the highest quantities in the trade while the valuable species composed a very small percentage of catch (Marshall *et al*., 2001). This indicates the depletion of the valuable species compared to the non valuable species.

Open access nature of the fishery in Tanzania and unmanaged sea cucumber resource will likely lead to depletion of the stock. However, depletion of sea cucumber resources was first reported at Songosongo by Darwall (1996) as it was indicated by the harvest of juveniles. Other reported case of depletion includes Jiddawi (1997) in Zanzibar, Guard (1998) in Mtwara, Horsfall (1998) and Mgaya in Bagamoyo and Kithakeni and Ndaro (2002) at Kunduchi, Dar es salaam. Sea cucumber collectors in Bagamoyo indicated that the stocks were declining and the average size of the individuals was decreasing. In due to this, government decided to take precautionary approach and closed the fishery since 2006.

4. Current management

The precautionary approach to close collection and export of sea cucumber thought to create enough resources for regulation or to enforce restrictions on this fishery. Despite the depletion of the sea cucumber stocks as the various research revealed and the closer of the fishery, there are illegal exports that falsely claim to have the product from Mozambique and sometimes on transit to Zanzibar. This illegal fishery will possibly lead to seriously depleted stocks of the sea cucumbers over the next few years. The illegal collection is the main challenge and also that the type of gear used and demand for the bêche-de-mer has been developing unsustainably. To overcome these challenges, several possible management approaches have been strengthened including court cases for illegal fishers and exporters in order to ensure sustainable harvest is implemented in the future.

5. Plans for the future

In Tanzania Sea cucumbers have a long time history of exploitation, the work by various researchers proved that catches have fallen drastically over the last few years. Since sea cucumbers are slow-growing, populations in shallow water are easily overexploited. The average size of animals caught has become much smaller as the larger animals are taken first especially since the trade was not regulated. In order to reverse the trend, the appropriate actions to achieve successful management of sea cucumbers should be taken in phases. The appropriate actions/future plans are as follows

- In order to know the current status of the stock, Tanzania planned to conduct resource assessments by surveying all shallow areas to estimate the population (stock size) of each species traded in Tanzania and a socio-economic analysis carried out of the sea cucumber fishing community. This is because the sea cucumber fishery developed without baseline biological data and without any monitoring.
- To ensure law and policy enforcement through regulatory mechanisms and collaborative management by government, dealers and private sectors to protect the wild sea cucumber stocks.
- To establish the pilot small scale Sea cucumber farm of the most known specie in Tanzania *Holothuria scabra* for demonstration. This is expected to stimulate sea cucumber mariculture activities in the country to overcome the problem of overfishing as it was reported that large number of coastal communities have developed a strong dependency on it as alternative source of income. So the mariculture practice of sea cucumber will reduce fishing pressure in the natural environment and therefore creates rooms for the renewal of the stock.
- To initiate capacity building programmes to various stakeholders (e.g. training, study tours, participation in national and international meetings and workshops on sea cucumbers).

- Community involvement is the only mechanism that enhances sustainable management of the coastal resources. For the community to full participate in the conservation of the coastal resources, awareness should be done on the sea cucumbers and its fishery potential. Through research, it was detected that various stakeholders like collectors, processors and some middlemen had missing information on the sea cucumber fishery information (stock size, spatial distribution and biology). To achieve this, our future plan is to disseminate sea cucumber fishery information to various stakeholders.

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SCEAM Indian Ocean country report – YEMEN

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1. Background

The sea cucumber fishery started in 1960s, during the British time in Southern Yemen. In 1967, when Sothern Yemen got its independence from British Colonist, the new government requested assistance from FAO for developing sea cucumber fishery, which was declining. In 1982 and 1984, FAO provided assistance to Southern Yemen, in order to improve processing and to identify the potential of sea cucumber fishery. The government sector, through a National Coastal Fisheries Corporation (NCFC), was responsible for collecting, processing and exporting, until the country unification between North and South in 1990. Since then the sea cucumber fishery has been opened for cooperative and private sectors, to gather with the governmental sector along the whole coastline of Yemen. The “open access” situation in the fishery attracted many fishermen from coastal villages and other cities and town as well. In the North of Yemen before of the unification in 1990 small-scale fishers and small enterprises collected many species of sea cucumbers. No government fishing activities were recorded there. In South, *Holothuria scabra* was mainly targeted, with two more species of *Actinopyga*.

2. Fishery operations

It is recorded that regular and non-regular fishermen are involved in fishing activities. Beside them women and children (less than 16–18 years age) also conduct sea cucumber collecting, particularly from coastal fishing settlements and communities. Regular fishermen collect sea cucumber during low tide and by snorkelling. Recently, they used diving method with help of air compressors from the boat and sometimes they used scuba diving. Non-regular fishermen usually collect sea cucumber from the beach and during low tide. It is very rare that non-regular fishermen use scuba and hookah method for air supply to collect sea cucumbers. Regular fishermen use boats (fibre glass made) to reach fishing grounds around islands in the Yemeni Red Sea and near of coral reefs.

Processing of bêche-de-mer is made by fishermen themselves, but sometimes fishermen used to sell sea cucumber to traders, who process the catch up to drying step. Then, they sell the products to the exporting companies and enterprises for export. Sometimes processors also export.

3. Status of fishery and stocks

Currently, sea cucumber fishery and export have been stopped by a number of decrees, issued by the Minister of Fish Wealth (MFW), but illegal catches and collection of sea cucumber occur. Indeed, there

is a real threat to the Yemeni sea cucumber stock, caused by the continued unreported and illegal fishery. Decrease of species densities in the fishing grounds and abundance has been recorded. In addition, the number of people and companies involved has increased. For the moment, there is however very little information regarding to the sea cucumber catches available (locations, species, quantities, time of fishing, etc.).

4. Current management

Due to sea cucumber fishing and exporting bans and decrees issued by the MFW, there is no other management implemented towards sea cucumber collection and fishery.

5. Plans for the future

For the moment, there is a request from the traders and companies, to obtain a permit for bêche-de-mer export. This issue has been discussed with the MFW and it agreed to give a permit for one time only, in order to export what they have in their stores and get access to their data and information, including history of company, enterprises, location of fisheries, species and their quantities. Only in such condition and cooperation between the exports, the MFW, and the Marine Science & Biological Research Authority (MSBRA), a permit will be issued for one time. The MFW has granted the one-off permission under a special condition, which is a full cooperation with MBRA and provide an access to the companies catch and export data. This is an attempt to stop illegal, unregulated and unreported fishery of sea cucumber and gain dialog between management and industry. Given that there is little data available, for the time being MSBRA can only provide estimates on total allowable catch (TAC) as a management tool, under conditions of full cooperation with related individuals, companies, enterprises, dealing with sea cucumber handling and export. Moreover, MSBRA has a proposed scientific research plan and activities, for 2013, in order to carry out fieldwork activities and surveys of sea cucumber fishing grounds in the Yemeni Red Sea, Gulf of Aden, Arabian Sea and Socotra Archipelago.

SCEAM Indian Ocean country report – ZANZIBAR (UR TANZANIA)

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1. Background

Sea cucumbers (bêche-de-mer), locally known as "*majongoo bahari*", are among the most important fishery resources in Zanzibar. The fishery is mostly artisanal with few commercial exporters commonly led by local Chinese traders. The fishery of sea cucumber provides income to local collectors and also contributes to foreign exchange earnings to the Zanzibar economy. Not less than 30 species of sea cucumbers are found in Zanzibar (Jiddawi and Coleson, 1996; Erikson *et al*., 2010), out of these at least 13 are exploited for commercial purposes (Table 1).

Table 1. Some of the commercial species of sea cucumber in Zanzibar

Scientific name	Common name	Local name
Actinopyga mauritiana	Surf Redfish	Mbura-Khaki
A. miliaris	Blackfish	Kijino

Scientific name	Common name	Local name
Bohadschia argus	Leopardfish	Barango
Holothuria atra	Black Sea Cucumber	Pesa
H. edulis	Pinkfish	Damu
H. fuscogilva *	White Teatfish	Pauni-nyeupe
H. leucospilota	Black Sea Cucumber	Sumu
H. nobilis *	Black Teatfish	Pauni–nyeusi/Chui
B. subrubra	White Belly Sea Cucumber	Tambi
H. scabra	Sandfish	Jongoo mchanga
*Thelenota ananas**	Prickly Redfish	Spinyo baba
Stichopus herrmanni	Curry fish	Tairi kaki
H. sp. type pentard*	Flower teat fish	Pauni chui

* Species of high value.

According to Jiddawi and Ohman (2002) sea cucumber fishery in Unguja Island took place during the late 1960's by the influence of Chinese immigrants who provided market for the product through their own consumption and exports. So far very few studies have been done on sea cucumber fishery in Zanzibar. For those done most are in grey literature (Coleson and Jiddawi, 1996; Blaine, 2004; Griffith, 2006; Mkenda, 2011). A few recent ones are published (Eriksson *et al*., 2010; Eriksson *et al*., 2012).

The fishery is largely artisanal with a small commercial operation monopolised by few exporters. Exploitation occurs year-round mainly on reefs close to the shore with collection peaking during periods of light winds. The level of exploitation differs from shore to shore depending on fisher folk experience, number and category of fishers, fishing techniques and season (Mmbaga and Mgaya, 2004). Sea cucumbers are a valuable food source in the Far East but they are not consumed locally in Zanzibar. Collection is exclusively done for export. According to Mbaga and Mgaya (2004), sea cucumbers are overexploited in most parts of Tanzania due to the species being immobile and fetching a high price

2. Fishery operations

Sea cucumbers are found in intertidal areas, where collection is mostly done by women and children, to the deep sea where collection is mostly done by men. The sea cucumbers are collected by hand, by snorkel and scuba diving by fishermen. There are around 25 fishing vessels with outboard engines involved in sea cucumber scuba collection based mainly based in Mtoni, Mazizini and Mkokotoni.

The collectors usually sell the sea cucumbers to a middleman at the landing site who generally boils and dry the sea cucumber on the beach. Some fishermen claim they use lights at night in their collection. Usually collection is done during spring low tides. The fisher also claim the North east monsoon period is the best period for collection because the water is warmer, calmer and the visibility is higher. Also the sunny weather of *Kaskazi* allows for better drying conditions of the sea cucumber (Griffith, 2006).

The collectors constitute the largest actor group and are the ones that exploit sea cucumbers directly from the ecosystem. These fishers are involved for economic reasons with limited options for income (Raymond, 2006). The production chain structure in Zanzibar goes from the ecosystem through collectors, processors and traders before ending at the world market (Raymond, 2006). Until now there are only about 4 export companies with estimated export of 58 tons per year (Figure 1). Despite this, the

village collectors, especially the women who normally glean the intertidal area during low spring tides, are not the main ones profiting from the fishery. They sell directly to the processors who finally sell them to the exporters where it appears that most profit is made.

3. Status of fishery and stocks

The increase in export of bêche-de-mer in Tanzania was observed from 1980s (more than 200 tonnes/yr) to 1992 (617 tonnes); and thereafter exports have continued to decline (Marshall *et al*., 2001). Sea cucumber resource is currently overexploited in most of the sites in Tanzania (Jiddawi, 1997; Mmbaga and Mgaya, 2004). According to Conand (1997), Hong Kong SAR is the largest world market followed by Singapore and Taiwan PC. High market price and accessibility to fishing grounds by these markets are among the major factors, which make sea cucumbers susceptible to over-harvesting. The exports from 2003–2011 are summarized in Figure 1.

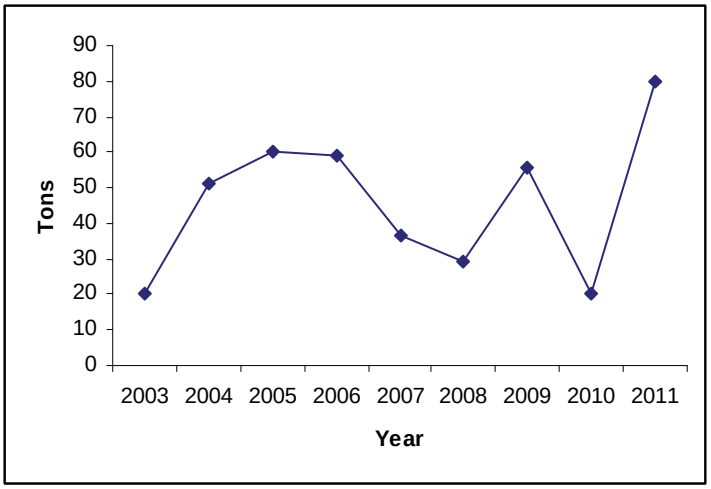

Figure 1. Export of sea cucumber in Zanzibar from 2003 to 2011

Fisheries catch statistics show that sea cucumbers are overexploited in most of the shallow coastal waters around Unguja Island (Jiddawi 1997). Despite this background knowledge, there is inadequate information on the current distribution patterns, density and species composition of these organisms. According to Zanzibar catch statistics it shows that sea cucumber catches are declining in most of the shallow coastal waters around Unguja Island and Mkenda (2011) observed that commercially important sea cucumber species in the study areas are restricted to Chumbe Reserve and were overexploited outside the reserve.

4. Current management

Currently there is little to no management for sustainable exploitation of sea cucumber in Zanzibar. Regardless of the increased fishing efforts in Tanzania in particular and WIO (Western Indian Ocean) region in general, export of bêche-de-mer started to decline since 1990s (Marshall *et al*., 2001; Conand and Muthiga, 2007). In response to this, Tanzania mainland closed the fishery in September, 2006 (Conand and Muthiga, 2007). However, the fishery is still open in Unguja Island (Zanzibar). There are plans however to establish size limits and possibly to ban sea cucumber collection soon in Zanzibar.

5. Plans for the future

There are a number of potential measures proposed to protect the resource. These include: establishment of minimum size limit for capture, introducing strict quotas, limiting numbers of fishers, closed seasons, banning scuba diving, establishing reserves and promoting stock enhancement. Given the structure of the scuba diving fishing, regional governance partnerships is important and crucial for improved understanding and management (Eriksson *et al*., 2012) Unfortunately, such efforts are still lacking.

Other possibility is establishment of mariculture of sea cucumber. Attempts have already been started in Wambaa Pemba and Kigunda in the North of Zanzibar. The species cultured so far is *Thelenota anax.* However further studies are required to check on the possibilities of stocking of sea cucumber species to help restoring the stock densities in areas where sea cucumber have been depleted to levels where by natural regeneration can no longer take place. Also other possibilities could be the establishment of no take zones. These are already present for cockles so establishing them for sea cucumber may not be a problem. Establishment of prices for the various sea cucumbers, similar to seaweed farming, would be valuable so that everyone knows the prices and everyone benefits from the fishery. Lastly having special recognized agents to buy the cucumber and checking that they comply with the existing regulations for example of size limits.

According to Eriksson *et al*. (2012) the sea cucumber fishery in Zanzibar is split into two distinct varieties: the village-based near-shore fishery and the more industrialized mobile "roving bandit-style" scuba diving fishery. Although the two fishing varieties are connected because the products transit via the same exporters, the identification of the two segments is crucial because of their different management requirements. While reformed local management may suffice for improving the situation of the near-shore segment of the fishery, the more mobile and industrialised scuba diving segment require new institutions that match the scale of the operation.

Another suggestion is possible control of fishing effort so that catches do not exceed recommended Total Allowed Catches (TAC). Management measures should then be designed to control effort on the higher value species and then do the same for the lower value species.

According to Mkenda (2011) the sea cucumber fishery needs to be closed, as populations of medium and high valued species are currently too low to support further exploitation. Fishing areas should be closed to safeguard them from declining to levels where they cannot easily be repopulated naturally and a ban should be imposed until the population densities recover to levels that can support further collection. Sea cucumber fishery in Zanzibar can be managed properly if all stakeholders play their parts rightly, starting from the collectors, processors, exporters and Managers.

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ANNEX 6

SPECIES IDENTIFICATION CARDS FOR INDIAN OCEAN SEA CUCUMBERS

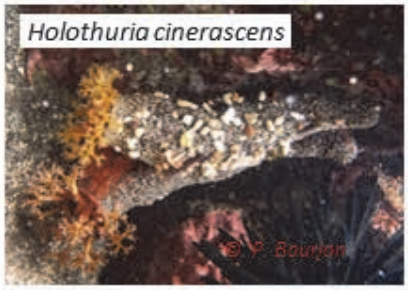

© H. Eriksson
Holothuria scabra


Holothuria fuscopunctata
© S.W. Purcell


Holothuria edulis
© S.W. Purcell


Holothuria atra
© S.W. Purcell


Holothuria flavomaculata
© S. Ribes


Holothuria cinerascens
© P. Bourjon

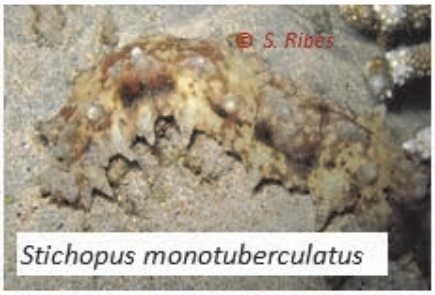

Holothuria leucospilota
© S.W. Purcell

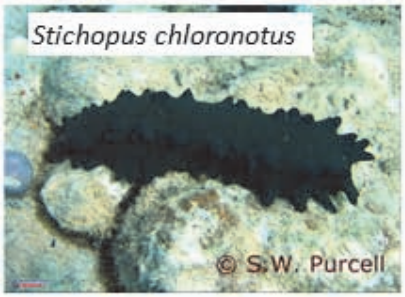

Holothuria notabilis
© IH-SM


Holothuria spinifera
© P.S. Asha


Stichopus naso
© S.W. Purcell

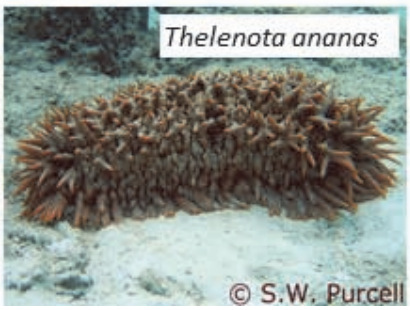

© S.W. Purcell
Stichopus horrens

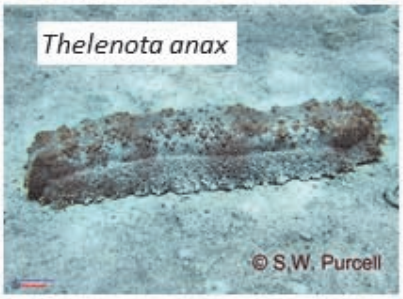

© S. Ribes
Stichopus monotuberculatus

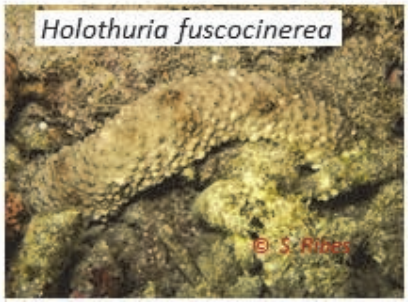

Stichopus chloronotus
© S.W. Purcell


Pearsonothuria graeffei
© S.W. Purcell


Stichopus herrmanni
© S.W. Purcell


Thelenota ananas
© S.W. Purcell


Thelenota anax
© S.W. Purcell


Holothuria fuscocinerea
© S. Ribes

ANNEX 7

WORKSHOP SATISFACTION FORM

Tick ✓ the box corresponding to your answer.

	Strongly disagree	Disagree	Indifferent	Agree	Strongly agree
My travel arrangements were well organised					
The workshop (in general) was well organised					
The notes and technical material were of high quality					
The workshop was useful to me and my fishery					
I gained new knowledge from the workshop that will be useful in sea cucumber fishery management					
The workshop has changed my mind about how best to manage our sea cucumber fishery					
Seminars given by Steve Purcell were well prepared and well presented					
Seminars given by Alessandro Lovatelli were well prepared and well presented					
Seminars given by Nyawira Muthiga were well prepared and well presented					
Seminars given by Hampus Eriksson were well prepared and well presented					
Seminars given by Chantal Conand were well prepared and well presented					
The workgroup sessions were useful					
The plenary sessions were useful					
The workshop was too long (days)					
The workshop was too short (days)					
I am happy with the accommodation and meals					
The workload was suitable and appropriate to the time available					
I am happy with the overall outcomes of the workshop					

ANNEX 8

WORKSHOP PHOTO

Group photo at the venue. *From left:* Omar Foum, Julius Francis, P.S. Asha, Steven Purcell, Elisabeth Mueni, Harilalao Raboanaijoana, Shafyia Naeem, Hampus Eriksson, Abdullah Al-Balushi, Nyawira Muthiga, Chantal Conand, Fouad Rabi, Mohammed Saad, Mohammed Hasan, Johanna Herfaut, Salum Hamed, Ajith Kumara, Alessandro Lovatelli, Narriman Jiddawi, Ravi Mohit.

The livelihood opportunity that sea cucumber fisheries provide to many coastal fishers in the Indian Ocean is threatened by widespread overfishing. The five-day SCEAM Indian Ocean workshop was held in November 2012 and brought together fishery managers from 13 countries to provide a forum for sharing knowledge and improving management plans in Indian Ocean sea cucumber fisheries. It followed the format of a similar workshop that was held in the Pacific in 2011. Workshop facilitators first presented background seminars on up-to-date research on fisheries management. The workshop then focused on interactive sessions with workgroup exercises and plenary discussions that helped participants diagnose their fisheries before deciding on appropriate objectives, regulatory measures and management actions. A field day was also included in the agenda to provide hands-on experience in species identification and product processing. The workshop outputs given in this report detail current management practices and constraints in Indian Ocean sea cucumber fisheries and the proposed strategies and research priorities of the participating fishery managers.

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