

## A framework for addressing socioeconomic and management aspects of sea cucumber resources in the western Indian Ocean

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### Summary

This paper reveals how the socioeconomic and management objectives of a three-year sea cucumber project in the western Indian Ocean (WIO) (cf. Conand et al. 2006) will be addressed. A conceptual model of sea cucumber resource dynamics is presented. This model encompasses multiple levels and considers the main structures of the sea cucumber fishery such as fishing and collection grounds, resource users and other stakeholders involved in the fishery (e.g. fishers, middlemen and importers), the links between stakeholders, villages and countries, and the associated management initiatives at different levels. This framework is promising when analyzing the sea cucumber fishery from a holistic perspective, considering both social and ecological interactions. The results of the study will provide knowledge and management advice for the sustainability of the sea cucumber fishery in the WIO; however, the framework is not restricted to the WIO, and may be adapted to other fisheries.

### Introduction

Sea cucumbers have always been an important resource in the coastal areas of the western Indian Ocean (WIO). Historical reports illustrate the commercial importance of sea cucumbers through narratives of complex routes of export from the WIO to China and probably other destinations in Asia (Gilbert 2004). Beche-de-mer or bicho-do-mar (sea slug) is the name used for sea cucumbers in the Pacific Islands, and refers to the name used by the original merchants of the triangular trade. Goods from Europe were exchanged for sea cucumbers, which were traded again in China for tea and spices (Conand 1989, 1990, 2001). Probably the expression of the merchants “We are looking for beche-de-mer” was common and gave birth to the common name for holothurians used currently. At present, sea cucumbers still constitute an important resource in the region, although the understanding of their biology, ecology, socioeconomic importance, and associated management initiatives is poor (Conand et al. 2006).

The WIO region — which extends along the east African coast from Somalia to South Africa and includes the island states of Mauritius, Comoros, Seychelles, Reunion and Madagascar — has numerous rural populations that are mainly

dependent on marine resources for subsistence and commerce. Although sea cucumbers are not consumed by the local communities, they are still one of the most highly priced fisheries products (Department of Fisheries and Marine Resources Zanzibar, Tanzania, pers.comm.). The resource is widespread along the complex, 12,000-km-long coastline of the WIO. The number of species is high — about 106 — with at least 20 species being commercially valuable (Clark and Rowe 1971; Conand 1999).

This paper presents the generalities of a newly developed framework to analyze the socioeconomic and management aspects of sea cucumbers in the WIO. It is linked to the article by Conand et al. (2006), in which a general description of a larger three-year project analyzing sea cucumber resources in the WIO is presented. Here, we focus on the particular objectives dealing with the project’s socioeconomic and management issues, referred to as objectives 4 and 5 in the article by Conand et al. (2006).

### Understanding sea cucumbers as a resource: Premises and approaches

The main premise of the sea cucumber project in the WIO is that “successful management cannot be

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achieved without key ecological and socioeconomic information” (Conand et al. 2006). In general, three levels of analysis and understanding are needed for the achievement of successful management that will maintain productive ecosystems.

- 1) Knowledge about the ecology of the system, including structures (e.g. species, ecosystems, etc.) and their dynamics (e.g. processes, succession, resilience, disturbance regimes, etc.);
- 2) Knowledge about management systems currently in effect and the efficiency of feedback systems in monitoring; and
- 3) Consideration of the governance structures framing resource use in which local users and civil society are considered (Berkes and Folke 1998).

Point 1 will be addressed by the three-year project (Conand et al. 2006), but points two and three are directly related to the economic, social and management issues, and an overview of how to handle these issues will also be presented.

### **The importance of temporal and spatial scales**

Socioecological problems cannot be treated in isolation. Cross-scale interactions in both temporal and spatial terms are crucial to the understanding of resource use dynamics (e.g. Holling 1973, 1992; Levin 2000; Berkes and Folke 1998; Young 2002). Scale should be considered in order to understand the complexity of interrelated economic, ecological and social systems (Holling 2001). Management and institutional arrangements are more likely to succeed if they work at the correct scale, in accordance with the ecological scale (e.g. spatial, temporal and functional; Lee 1993) and ecological processes (e.g. Christensen et al. 1996). There are, however, common mismatches between institutions and scales, both temporally and spatially, which produces management failures. Mismatches between institutions themselves have been identified as fundamental recently (de la Torre-Castro 2006; de la Torre-Castro and Lindström in prep.). The importance of scales has been illustrated in the WIO region for different coastal systems. In Tanzania, for example, studies on resource use dynamics (fisheries and seaweed farming) addressing the local scale of Chwaka Bay with cross links to Zanzibar and Tanzania mainland (de la Torre-Castro 2006, 2006a), on local involvement of women in shellfish production (N.S. Jiddawi, Institute of Marine Sciences, Zanzibar Tanzania, pers. comm.), and resource dynamics and marine protected areas (MPAs) in Mafia Island (I. Bryceson, Norwegian University of Life Sciences, UMB Norway, pers. comm.). In Kenya, studies on the changes in fisheries practices in four villages on the south coast (Ochiewo 2004), baseline socioeconomic studies in northern Kenya (Cinner and McClanahan 2006),

and mangrove fisheries in Gazi Bay (Crona 2006), have also been completed. At larger scales, the WIO has been historically linked to global scales through commercial routes involving the trade of a large variety of commodities in which probably sea cucumbers played an important role. Our conceptual model for the analysis of sea cucumber resources in the WIO considers cross-scale interactions from local to global levels and is presented in subsequent sections (see also Fig. 1).

### **Socioeconomic and management specific objectives**

The specific objectives of the socioeconomic and management components are defined in Conand et al. (2006).

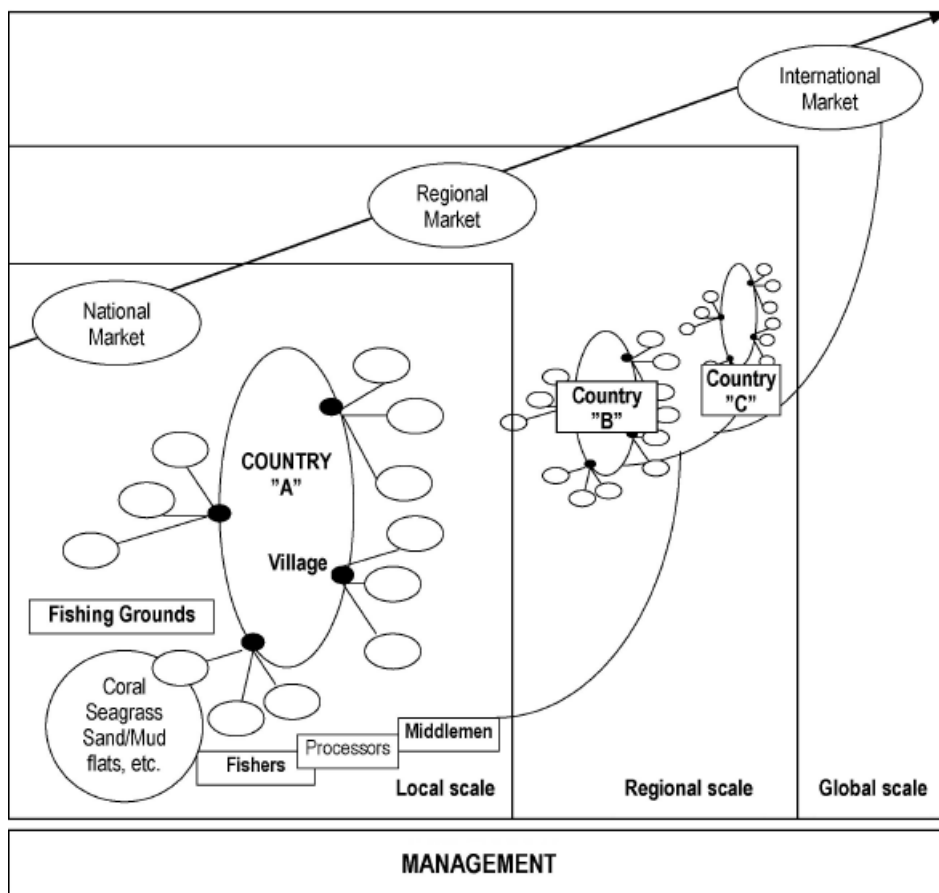
#### ***Socioeconomic objective***

“To determine the national marine resource use patterns, the social and economic characteristics of the fisher communities and the contribution of sea cucumbers to the national economies and local livelihoods of the coastal areas.”

#### ***Management objective***

“To analyze the management systems present in the area. To gain knowledge and synthesize information about the general management efforts and strategies including monitoring, licensing, control, statistical catch collection, general policies, establishment of MPAs, resource perception, etc. The target organizations will be governmental agencies that are concerned with management of fisheries and marine protected areas, in order to understand the existing fisheries management regimes and establish the existing constraints, opportunities and/or challenges faced by these regimes.”

The objectives of the socioeconomic component of the sea cucumber project can be expressed in two main research lines: 1) livelihood and local importance of the sea cucumber fishery (objective 4), and 2) formal management associated with the different levels and agents of the sea cucumber fishery (objective 5). Some of the most important aspects considered in the investigation will be to address the livelihood component, including the socioeconomic characteristics of the local coastal communities dealing with the sea cucumber fishery. The focus will be on the sea cucumber collectors and middlemen. Questions such as: Who are the sea cucumber fishers? What is the contribution of this fishery to local communities and particular households? What is the role of the sea cucumber fishery in livelihood diversification and benefits? What is the division of labour? What are the subsistence and commercial components of the fishery? What are the most important fishing



**Figure 1.** Conceptual model for the socioeconomic analysis of sea cucumber resources in the western Indian Ocean.

grounds and what are the most valuable species? Moreover, what is the relationship between sea cucumber fishers and middlemen? What is the adaptive capacity of sea cucumber fishers? And how resilient is the resource?

The project will also address formal management (i.e. management structures and initiatives in government agencies), and the following aspects will be covered: type of licensing system, monitoring systems, basic statistical information (weight and value), consideration of the differences in species, methods of statistical capture, the existence of a specific policy for sea cucumber fisheries, communication with local communities involved in sea cucumber fishery, perception of the problems of the sea cucumber fishery, and the level of commitment of fisheries managers.

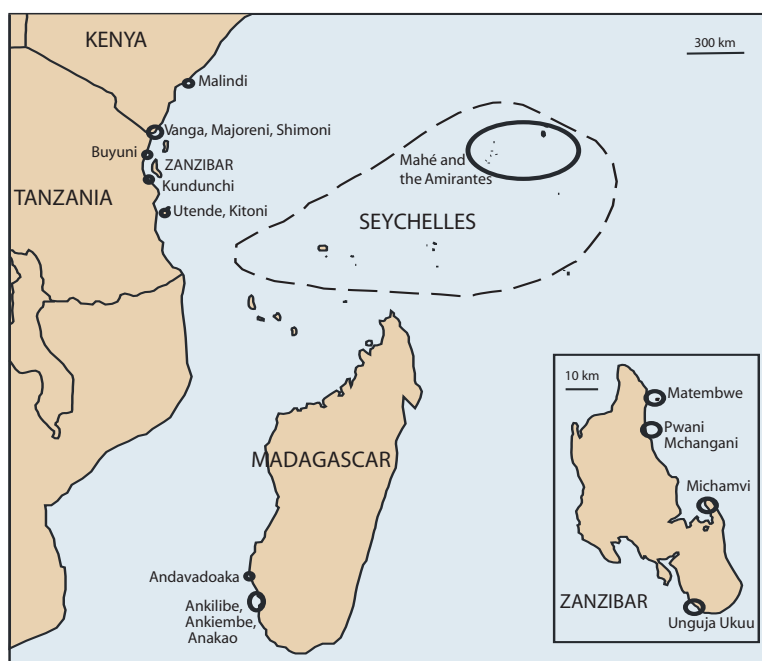
### Grasping the big picture: Conceptual model for the analysis of sea cucumber resources in the WIO

The conceptual model for sea cucumber resource analysis is presented in Figure 1. The model shows the basic elements of sea cucumber resource use and the possible links between them. The model

can be seen as a global network: from a local scale level of productive ecosystems in nearby villages, to a global scale level in which the ecosystem goods reach international markets. The basic idea of the conceptual model is also linked to commodity chain analysis approaches (e.g. Gibbon and Ponte 2005), which in simple terms can be understood as following the whole production chain of the product — from local ecosystems to international markets. Local fishing grounds are found in different ecosystems, such as seagrass beds, coral reefs, and sand or mud flats. The main stakeholders are sea cucumber fishers, middlemen, and the companies buying the product. Regional links between producing countries may be present as well. The project will be working in different countries and sites (e.g. Kenya, Tanzania mainland, Tanzania/Zanzibar, Madagascar, and Seychelles), and this conceptual model will be used to organize and guide the regional and global analysis.

### Selected study sites

In each country, specific study sites will be selected (Fig. 2). The sampling design will consider protected and non-protected sites in each place. The



**Figure 2. Selected study sites for socioeconomic studies of sea cucumber resources in the western Indian Ocean.**

preliminary selected pilot study sites are shown below; however, it is possible that the conditions and/or production have changed and new sites will be considered in that case.

#### **Tanzania mainland and Zanzibar**

In Tanzania mainland, four sites have been identified: Kunduchi, Kitoni, Buyuni, and Utende. Kunduchi represents a heavily exploited site; Kitoni is a protected site, inside a marine park area. Buyuni in Dar es Salaam is where the collection of sea cucumbers has recently begun, and is growing in popularity. Utende is a protected site, located in a marine park, and will be considered if time and resources are available.

In Zanzibar, four sites have been identified: Pwani Mchangani, the village of Matemwe close to Mnemba Island, Michamvi and Unguja Ukuu. Pwani Mchangani has been an area of heavy exploitation, whereas Mnemba Island is a protected area. Unguja Ukuu in the south is where an active fishery is occurring, and Michamvi has been reported as a productive fishing ground. The island of Misali close to Pemba is a good candidate representing an almost non-exploited area.

#### **Kenya**

Four pilot study sites have been identified in Kenya: Vanga, Shimoni, Majoreni, and Malindi. Vanga is a

village with high exploitation levels. Shimoni is a protected site next to a marine park. At Majoreni, sea cucumbers are now fished following finfish exploitation. Malindi is closer to the marine park and will be considered if time and resources are available.

#### **Seychelles**

Sea cucumbers are widely fished in coastal and deeper waters, with fishing effort mainly in the 15–40 m depth range. Due to the large size of Seychelles' EEZ, stock surveys focused on the Mahe Plateau and the Amirantes. Sites within the boundaries of marine parks were also surveyed on the Mahe Plateau, and will thus permit a comparison between protected and non-protected areas.

#### **Madagascar**

Andavadoaka, located 150 km north of Tulear, is representative of a site involved in the establishment of an MPA. Ankiembe and Ankilibe are the two fishing villages of Tulear Bay. Ankiembe is located in Tulear District, while Ankilibe is located about 13 km south of Tulear. Both villages are settled by Vezo fishermen. Anakao is about 50 km south of Tulear. A part of the reef is a village MPA devoted to ecotourism.

In general, the sites overlap with the sites for other biological and ecological studies of the same larger project (Conand et al. 2006).

## Methods and targeted categories

Data about socioeconomics, resource users, and formal management structures will be gathered using five different methods. Three main stakeholders' categories will be targeted. The table below shows the interview sampling design and associated methods. The methods will apply to protected and non-protected areas so that differences will be identified and the role of MPAs in sea cucumber fisheries can be evaluated.

The selected methods are:

**Questionnaires:** A structured questionnaire will be administered to a selected sample of respondents to obtain quantitative data that can be statistically analysed. Respondents will be selected randomly from among the sea cucumber fishers and middlemen.

**Semi-structured interviews:** The approach proposed by Bunce et al. (2000) will be applied. Respondents will be randomly selected and will include sea cucumber fishers and middlemen. Semi-structured interviews will be conducted using interview guides/semi-structured questionnaires with open-ended questions (see also Kvale 1996). Some respondents will be interviewed in their homes while others will be interviewed at the beach where they land their fish or conduct their business. While appointments will be made for interviews to be conducted at a time that is convenient to respondents, some interviews will be conducted on the spot. Using this method, it will be possible to probe for answers, follow up on original questions, and pursue new lines of questions. It will create room for a two-way interaction and exchange of information between the interviewer and the respondent.

**Key informants interviews:** The key-informant interview technique expounded by Bunce et al. (2000) will be used to extract information from the opinion leaders. These key informants (opinion leaders) will be people who hold some respected positions in the society. The snowball method (let locals point out key informants) will be used to identify key informants in the villages. Key informants will give insight into many issues that need further clarification and will help in the validation of information collected using the other research methods.

**Focus group discussions:** The approach proposed by Bunce et al. (2000) will be used in this study. A set of open-ended questions will be used to prompt participants into free discussions focusing on the issues under the study. The focus group interviews will be arranged in advance and respondents will decide on

their preferred venue for the meetings. The focal groups will consist of 5 to 10 people. Using this method, it will be possible to probe for answers, while still following up on original research questions. This method also encourages interactions between respondents and interviewers.

**Network analysis:** Ecological networks (e.g. food webs, species dynamics, etc.) are of crucial importance. All interactions between species can be visualized as ecological networks (e.g. Montoya et al. 2006) and their importance in natural resource management has been recently illuminated (Bodin 2006; Janssen et al. 2006). The proposed conceptual model — which considers the interactions between stakeholders, ecosystems, villages, countries and the sea cucumber — can be seen as a network. This model will be used predominantly as a conceptual tool to illuminate the scales, links and nodes from the local fishing/collection grounds to importing countries of sea cucumbers. Social networks, their structural characteristics, and how they are formed are relevant for natural resource management (e.g. Tompkins and Adger 2004; Newman and Dale 2005; Bodin 2006; Bodin et al. 2006). Trust building and communication may enhance management, and networks across scales may increase ecosystem resilience (e.g. Tompkins and Adger 2004). However, networks may also be detrimental for management, for example forming much-closed groups leading to isolation and exclusion of external inputs and communication. A dynamic balance between internal (bonding) links and external (reaching) links is needed (Newman and Dale 2005). In the case of sea cucumber fisheries, the network structure is a helpful tool for identifying the number of links between elements of the fisheries (e.g. ecosystems, villages, fishers and nations), the distances and links between different places and stakeholders, and the degree of modularity or cluster formation between stakeholders associated with sea cucumber fisheries. The amount of links reaching outside single villages (bridging links) and the internal community or stakeholders' links (bonding links) are important indicators (Newman and Dale 2005). The basic idea is to work with a conceptual tool that brings all the elements and scales of sea cucumber fisheries together to better understand the dynamics. Questions such as: What is the global extension of the sea cucumber activity? How far does the activity reach? How are stakeholders grouped in the producing countries? How do elements structurally relate to each other? may be answered with the help of the model.

## Regional coordination and working plans

The socioeconomic and management components are part of the larger three-year project financed by



the Western Indian Ocean Marine Science Association (WIOMSA), which focuses on Kenya, Tanzania, Madagascar, Reunion and Seychelles. Within each country, one researcher is responsible for the socioeconomic and management components. Regional coordination is maintained through workshops, parallel data collection with harmonized methods (questionnaires and interview forms), and weekly electronic communication. Once the data are collected, the team will gather and analyze the national level information and proceed to the regional synthesis, with links to global markets, in a workshop. Planning, data collection, analysis and writing will take approximately two years.

## Conclusion

The proposed model (which considers multiple scales), the variety of ecosystems involved, the diversity of stakeholders, and the various management systems seem to be promising for a broader understanding of the state of the art of sea cucumbers fisheries in the WIO. The model and approach is intimately linked with the larger three-year project (Conand et al. 2006), and the overall results will provide information about sea cucumber fishery dynamics and future management strategies. The model can also be used for other fisheries and is not restricted to the WIO.

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**Table 1. Methods and categories to be targeted in the socioeconomic studies of sea cucumber resources in the western Indian Ocean.**

Method/categories	Fishers	Middlemen	Management authorities
Questionnaires	yes	yes	no
Semi-structured interviews (topics included in the questionnaires)	yes	yes	yes
Key informants interviews – Snowball method in the villages (let the locals point out key informants)	yes	yes	no
Focus groups discussions	yes	no	no
Network analysis		Cross cutting	

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