Socio-economic and bio-economic indicators for rational exploitation of trochus: general considerations

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Introduction

Trochus and sea cucumber have the longest history of commercial exploitation of any of the Pacific Island's coastal fishery resources.

Beachcombers brought them into the market economy in the nineteenth century with the establishment of the first trading posts, even before the sandalwood traders began to call. This was the first example of globalisation in the Pacific Islands and the first example of the islands being integrated into international trading circuits (Doumenge 1966; David 2003). It produced the first business-based lingua franca, Pidgin English, which was called Bislama in Vanuatu in reference to bêche-de-mer. This also became the language of the trochus trade. Rocheteau (1968) reports that Bislama was still being used in the 1920s in the northern tip of New Caledonia, which was the main trochus trading centre on the island.

Despite this long tradition, there have been few changes in the commercial exploitation of trochus. Harvesting requires little capital investment, the only requirement being a diving mask. It is also the least costly form of commercial harvesting, only limited by the time and energy that fishers devote to it. With this background, it is hardly surprising that this activity occurs in even the region's most remote islands.

While trochus resources may be locally abundant, they are still vulnerable to any form of intensive exploitation (Nash 1993) and should be subject to strict management regimes. Such management requires the introduction of measures to reduce fishing effort (fishing season, total allowable catch) or make it more selective (size limits). The implementation of these measures should be the responsibility of individual national fishery services. However, management requires data. Without data, it is impossible to assess the effectiveness of management measures and whether changes are needed for greater efficiency. To manage the trochus resource, the relevant data on the resource and its exploitation needs to be managed. This task is made much easier if the information collected is processed into a synoptic form that can be used to provide indicators.

Rational exploitation of fisheries and guidance for fishing systems

In previous research on Vanuatu (David 1991), I showed the value of considering reef fishing as a system. It seems that this finding could be extended to all small Pacific Island countries and territories, which show many similarities in terms of coastal fishing (Wright and Hill 1993; Dalzell and Adams 1995). In every country, the village and its adjacent reef area form the smallest geographical unit by which the fishing system can be understood. In the pre-colonial era, this unit encompassed the functions of production, consumption and fishery resource management. At present, the latter two functions are managed nationally, or at the international level when overseas markets are involved, but the village remains the place of production. However, the dual nature of these functions, in terms of level and fishery resources, can result in serious malfunctions in the development and management of resources. Thus, the village is frequently a theatre of contradictory economic forces: villagers are anxious to retain full enjoyment of the natural resources in their area, while the public authorities, claiming sovereignty, purport to organise the exploitation of these resources for the benefit of the national community under rules that they have set.

The village and country therefore form two interlocking levels within which the fishing system can be conceptualised. In Vanuatu, as throughout the South Pacific (David 1999), the system consists of three subsystems: the market system, commercial/subsistence system, and subsistence system proper. The latter two together make up the overall subsistence system. As outlined below, the basic differences between market and subsistence systems relate to their structure:

As the successor to the traditional fishing system, the subsistence system is part of the informal sector. Fishers enjoy total control over their production resources. They also control the distribution of their catch even when it is sold because they deal directly with the purchaser, who lives in the same village or nearby.

The commercial system, on the other hand, is part of the formal sector. Fishers are less able to make

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independent decisions about their catch and its distribution. The cost of the fishing gear is high. It usually exceeds fishers' self-funding capacity and may have been acquired as part of an artisanal fishery development programme subsidised by the government. This programme may sometimes continue to provide technical support to fishers through extension officers in the islands. The use of such gear requires the regular purchase of inputs, such as fuel, ice and possibly bait, from specific supply lines. Distribution of the catch is also part of an organised chain, the structure of which expands with the distance between the landing site and the consumer's home.

Although it is part of the market sector, since it stems from the desire to sell, trochus harvesting is an atypical form of commercial activity. As already mentioned, it is a low-cost activity that is carried out irregularly and is not usually a specialisation. The non-standard nature of trochus production is due to the fact that, in contrast with most fishery products, the item being marketed is not a fresh product but a shell that can be stored for several months or even years without deteriorating. This long storage period encourages trochus buyers to prefer harvests to take place at well-spaced intervals enabling large quantities of shells to be purchased at once, rather than frequent harvests producing only small quantities. As a result of these large-scale but infrequent sales, fishers consider this form of trochus harvesting not as a source of regular income but as an intermittent financial windfall that enables them to cover occasional outgoings such as school fees for their children. This is a major constraint for the rational exploitation of trochus resources in the Pacific Islands region.

The expression "rational exploitation of fisheries" is a new one. It would appear preferable to "balanced resource management" or "sustainable resource management", which are no longer in common use, or the "precautionary approach", which associates resource conservation and ecosystem protection and is becoming a fashionable concept in the sphere of fisheries resource management (FAO 1995; Richards and McGuire 1998). These expressions ignore the role of people as a core management component (Larkin 1988) and have a standard-setting connotation that could be controversial because only the opinions of ecologists and fishery biologists are taken into account. However, as pointed out by Quensière and Charles-Dominique (1997), the biological, economic and social optima of a fishery activity often vary. I will therefore not attempt to define rational exploitation of fisheries in terms of objectives because these are difficult to define in a context marked by the complexity of the processes and diversity of the players involved (Gascuel 1995), but rather using a method based on the assumption that *fishing is a complex system whose dynamics imply that it experiences crises*. Rational exploitation of fisheries therefore involves guiding the fishery system in such a way as to minimise the impact of crises. It could also be described as a system of 'good governance'.

Any form of management of a renewable resource requires good knowledge of both the resource itself and the people exploiting it, as well as the dynamics informing the 'resource-exploiter' relationship. To be usable, such knowledge must be summarised in a form that is concise and easy to use. These qualities are provided by indicators, which can be organised in the form of a control panel or graphic representation of a set of indicators.[2]

Use of indicators to minimise the risk of a crisis

Each of the three subsystems (subsistence, subsistence/commercial, market) that make up the fishery system can be associated with bio-economic and socio-economic indicators. Morand (2000, p. 10) provides two complementary definitions of an indicator: *"a statistic that facilitates the interpretation and assessment of the situation of an element of the world or a society"* and *"an item of information that has been constructed using an explicit and consensus-derived or interpretative data model. This means that everyone will infer the same information from the same data set, which can therefore be termed an indicator"*. Fishing systems therefore have many potential indicators but not all offer the same value. In this connection, Morand stresses that, generally speaking, an indicator should have the qualities of any piece of information. In other words, it should be (a) integrated into the user's reality; (b) enjoy the user's confidence (i.e. be considered accurate and reliable); (c) recent; (d) clear and easy to interpret; and (e) unambiguous. *"But it must also possess specific qualities: conciseness and simplicity of expression; reproducibility and objectiveness (not dependent on the person who collects or processes the data); and feasibility (not based on data that is unavailable or impossible to collect). If it possesses all these qualities, an indicator will be able to play a full role in communication and assist in decision-making"*.

Personally, I consider that there are two main criteria that make it possible to differentiate between indicators: effectiveness and cost.

To be effective, an indicator must be relevant and accurate. The states or processes that it characterises should reflect the objectives of the indicator and estimations should be sufficiently accurate.

The cost of an indicator depends on the duration of implementation of all the resources mobilised to

2. This method offers interesting prospects, especially for bio-economic and socio-economic aspects. It has already been successfully used for retrospective analyses designed to compare fishery development projects based on fish aggregation devices in Comoros, Reunion Island and Vanuatu (Rey et al. 2000).

record it and the mean daily cost of these; the number of person-days required is a good way of estimating this.[3]

The function of an indicator is another essential selection criterion (Fig. 1). The indicators chosen must make it possible for the manager to guide the fishery system at "cruising speed" in a crisis situation, which implies that these crises may be planned for, or that their possible occurrence has been foreseen and their potential impact on the operation of the system has been estimated. A set of indicators must therefore go beyond a simple description of a system and include a range of functions. It can then be evaluated on the basis of the criteria of effectiveness and cost.

Generally speaking, three types of crises may disturb the fishery system:

- those whose occurrence is haphazard, whether they occur within the system or "contaminate" it from outside;
- those generated by internal malfunctions of the system;
- those arising from the system's environment and that comply with its own inherent forms of logic.

By definition, the first type of crisis cannot be predicted. However, two types of responses can be planned on a preventive basis. One goal is to maximise the system's adaptability so that it can satisfy Ashby's Law of Requisite Variety[4] to the best of its ability and also avoid any chronic internal malfunction that could hinder the circulation of flows in the system. Fisheries managers operating such a system must first recognise as quickly as possible that a crisis is arising, and secondly must pass on their decisions to all undamaged parts of the system. Preparing for a fishery system crisis without knowing where or when it is going to occur requires firstly that the system operates perfectly when in cruising mode. To be sure of this, the manager must have indicators for assessing the system's overall performance. The primary indicator required is information on the quantity of fishery items captured by operators. Generally speaking, there is a lack of effective indicators for estimating fishery production other than surveys at the point of landing — a research field to explore. This is an arduous task, but recently developed methods for participatory assessment of fishery stocks (Medley et al. 2005) show that significant progress can be achieved if boldness

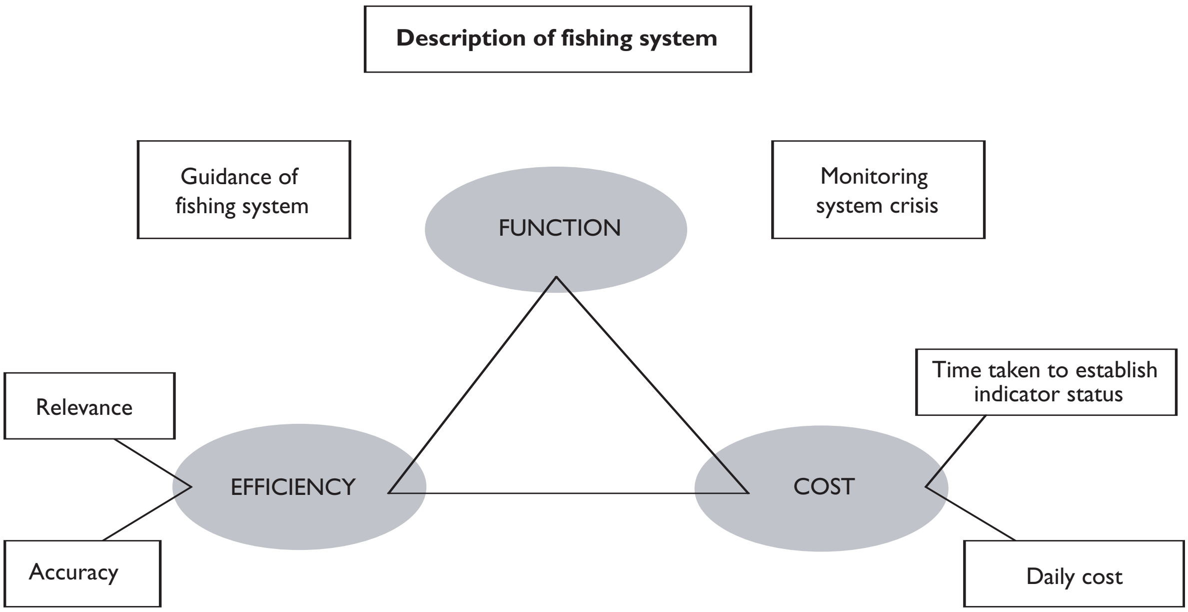

Figure 1. **Descriptive parameters of indicators relating to the fishery system**

3. For example, if the formulation of an indicator requires the mobilisation of two people full-time for 10 days, it will have a cost of 20 person-days. In the absence of a precise estimate, we must be satisfied with a gradient of 1 to 5 (the costliest).
4. According to this law, knowledge of the previous states of the environment is essential for the regulation of a system, which can only be effective on the specific condition that the system control module has at least the same freedom of action as the disturbing environment. In other words, if the control module is to impose its will on the system, the range of controls it has to hand must be at least equal to the variations in the environment (Ashby 1956).

and imagination are used and fishers are associated with the assessment process (Fig. 2).

Because of its internal nature, the second type of system crisis is easier to plan for, providing that managers have indicators available that make it possible to:

- identify risks of malfunctioning;
- estimate the vulnerability of the system to these risks.

Generally speaking, system malfunctions take the form of a very clear slowing down of the speed of the circulating flows. In such cases they can be considered similar to one or more constraints on the latter, and result from a difference between the real flow environment and the optimum circulation conditions that this environment should provide. Identifying risks of malfunctioning means that this difference must be assessed and a warning signal triggered when it is considered to have fallen below a certain threshold.

The vulnerability of the system as a whole to such malfunctions can be estimated from the nature and number of constraints weighing on the circulation of each type of flow and also from the amount of synergy existing between constraints that are liable to have cumulative negative effects. For example, the exposure of fishing grounds to strong currents, and the dominant swell and large waves when the wind is blowing, can be considered as a powerful constraint on fishery activity when associated with another factor: limited boat size and poor performance at sea.

The third type of crisis stresses the importance in guiding the system of information flows between the fishery system and its environment. This implies that system managers should not consider trochus fishing as a closed system but as a component of the village system. The logic and rationale of the latter, even though they are external to the marine environment, are liable to have a significant influence on fishery activity. For example, the marriage season in the Pacific Islands, school holidays, or the agricultural calendar may result in significant variations in fishing effort. Information flows in the system and communication between the system and the outside world should therefore be considered as part of the overall performance of the system and should be monitored using specific indicators.

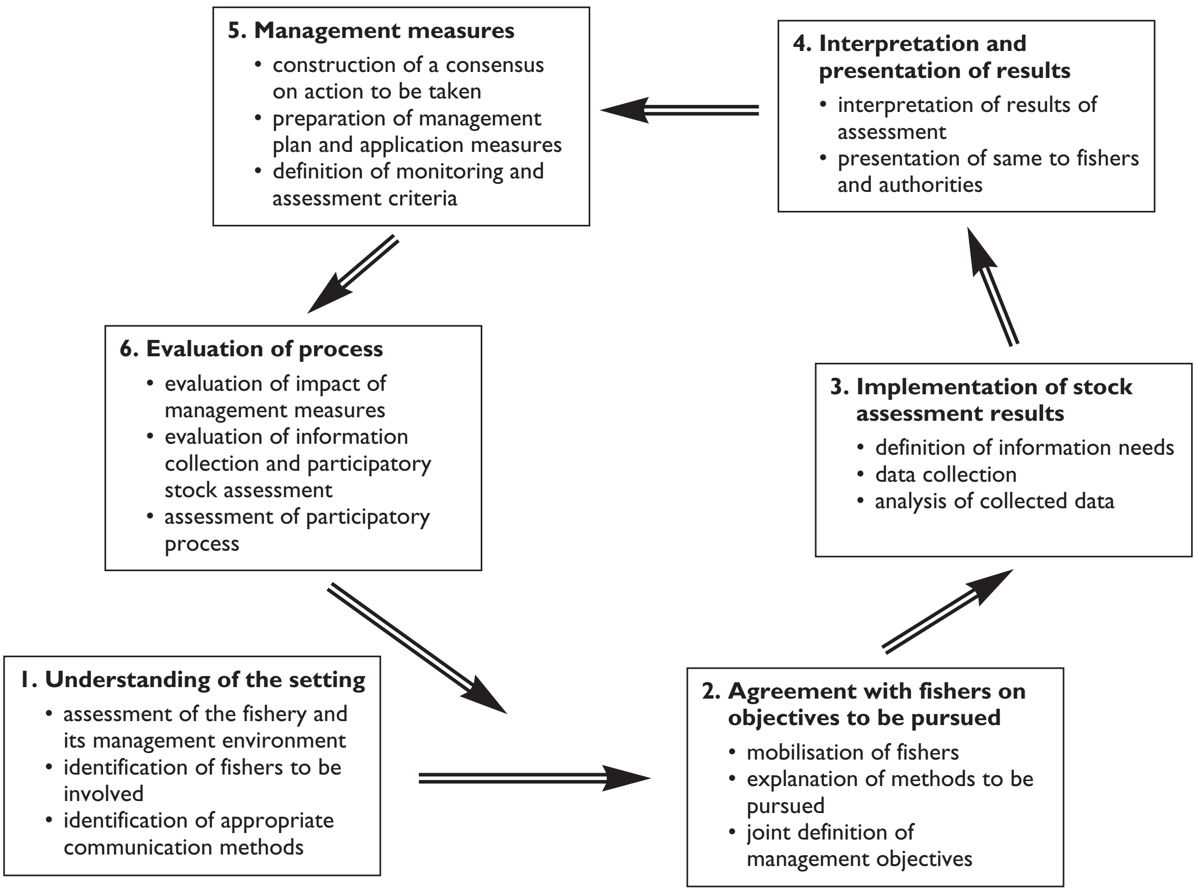

Figure 2. Stages in the participatory assessment method for fish stocks (after Medley et al., 2005)

An adequate response to a crisis requires that the action taken be proportionate to the estimated impact of the crisis rather than to the flow represented by the crisis itself. Therefore, cyclone preparedness will require a different level of effort depending on whether the dwellings under threat are made of cement or wood. After identifying the risks of malfunctions in a fishery system, and estimating its vulnerability to the crises that are most likely to occur or influence it, the final task of fishery system management in the event of a crisis is therefore to estimate the thresholds at which risks can be minimised or absorbed. This will enable the system manager to modify his or her response to the crisis depending on the expected impacts.

Conclusion

Managing a fishery system requires five kinds of indicators, covering:

- system description;
- assessment of the system's overall performance;
- identification of risks of malfunction;
- estimation of the vulnerability of the system to malfunctioning;
- monitoring of crises through establishing risk minimisation or absorption thresholds.

Management approaches to this indicator-based system for trochus harvesting will be described in an article outlining indicators that can be adopted downstream (with the fisher) and upstream (at the market level) to manage the resource more rationally. A second article will address participatory village management and the indicators needed for such participatory management.

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