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**FISHERIES AND MANAGEMENT OF BECHE-DE-MER FISHERIES IN WESTERN  
PROVINCE OF PAPUA NEW GUINEA**

by

**Paul Lokani**  
Department of Marine Biology,  
James Cook University of North Queensland,  
Australia.

and

**Philip Polon and Ray Lari**  
Department of Fisheries and Marine Resources,  
Konedobu,  
Papua New Guinea

# Fisheries and Management of Beche-de-mer Fisheries in Western Province of Papua New Guinea

Paul Lokani<sup>1</sup> Philip Polon<sup>2</sup> and Ray Lari<sup>2</sup>

1. Department of Marine Biology,  
James Cook University of North Queensland,  
Australia.

2. Department of Fisheries and Marine Resources,  
P.O. Box 165, Konedobu,  
Papua New Guinea

## Abstract

The artisanal fisheries for beche-de-mer in the Warrior Reef, Torres Strait Protected Zone, Papua New Guinea is described with preliminary analysis of biological data. From this information management strategy of the fisheries is outlined. Yield from the fisheries peaked at 11 kg/hectare and dropped to 2 kg/hectare just before its closure in 1993. The present yield is estimated to be 55 tonnes. No significant differences were detected for densities of sandfish at Auwomaza (244 bdm/hectare) and Wapa (136 bdm/hectare). Minimum size limit and gear restrictions did not prevent overfishing. Management of the fisheries using a combination of management regimes is discussed to maintain stocks at Sustainable levels.

## Introduction

The tropical fisheries for beche-de-mer is centered in the rural coastal areas of the Asia Pacific region (Conand, 1990). Africa and South America also support fisheries for beche-de-mer. One problem common among all beche-de-mer fisheries is the lack of management and overfishing.

Conand, (1988, 1990) highlighted the need and requirements, both biological and fisheries related for the management of beche-de-mer fisheries, some of which have been elucidated in some parts of the South Pacific (Conand, 1990, 1991a, 1991b, 1993; Shelly, 1981, 1985, Harriot, 1984). The use of these information in applied management of beche-de-mer fisheries in specific fisheries are limited. These information still need to be updated to the specific requirements of the stocks concerned, for it to be used effectively in management. There is currently insufficient knowledge to develop models for rational management of beche-de-mer fisheries (Conand, 1990). Management in Fiji (Adams, 1993), Tonga, (Anoni, 1993), Papua New Guinea (Lokani unpub.), Queensland (Harriot 1984) lack biological knowledge of the local fisheries and stocks. These are first steps in management but they can only be useful if they are evaluated with their respective objectives and improved with the availability of new and updated fisheries and biological information. Banning the use of SCUBA gear (e.g. Fiji, Maldives, Papua New Guinea, Tonga) has been justified as enabling the protection of brood stock existing in deeper waters. There is currently no scientific basis that the so called brood stock in deeper waters actually produce significant recruits to the population if at all. However, its existence is reassuring to the managers that something is being done.

The artisanal beche-de-mer fisheries in Western Province of Papua New Guinea needs both biological and fisheries information for it to be managed effectively. Current management of minimum size limit, gear restrictions which applies to the whole of Papua New Guinea and a 1 year closure is inadequate. Minimum size limit and gear restriction which were enforced quite effectively did not prevent overfishing. Brief descriptions of the fisheries and ecological information form the basis of a management regime which is discussed in this paper. The management regime is being developed and has not yet been enforced.

### Fisheries

The fisheries for beche-de-mer in Western Province, Papua New Guinea commenced in 1990. Fishing was greatest in the Warrior Reef complex. This was due in part to the limitation in reef growth among the coastline which has been restricted by freshwater runoff from the Fly river, swamp lands and numerous streams along the coast. The fisheries in Western Province in discussed here in the context of how it occurred and affected stocks in the Warrior Reef system.

Motorised banana boats, averaging 19 feet made of fibre glass and driven by outboards was the common vessel used by fishermen. Outrigger canoes driven by sail and outboards (Prescott, 1986) ) were also used. The vessels were used as transport and freight carriers from Daru to the Warrior Reef. Actual fishing was by walking on the reef flat during low tide and snorkeling, while hand collecting sea cucumber into old flour bags. The catch was landed in Daru the same day where it was processed, normally by assistants belonging to the family.

### Catch Composition and Catch Rates

Sandfish (*Holothuria scabra*) was the targeted species. It formed 100% of the catch in 1990 and 1991 and dropped only because of depleted stocks (Lokani, pers. obs.) (Table 1). Other species harvested were principally of the genus *Actinopyga*. These could not be separated because fishermen identified them by one common name (Table 1).

**Table 1. Species composition of the Daru based beche-de-mer fishery by year.**

SPECIES	1990	1991	1992	1993
<i>Holothuria scabra</i>	109,380	192,647	159,760	39,302
<i>Actinopyga</i> sp.	0	0	2,937	73,816
TOTAL	109,380	192,647	162,697	113,118

Increased production of *Actinopyga* species occurred in 1992 and 1993 corresponding to the drop in production of the main species sandfish (Table 1). Similar trends were experienced in the Tigak islands (Lokani, 1990), and Fiji (Preston et. al. 1988) where reduction in the high value species production shifts effort to low value species.

**Table 2. Mean catch rates (dry weight) per fishing unit from May to August, 1991.  
(data compiled purchase record of 1 trader only)**

Month	mean	n	se	Total wt (kg)
May	10.63	222	1.42	2,361
June	19.14	127	2.82	2,431
July	5.93	95	0.64	564
Aug	10.80	56	11.96	595

Mean catch rates based on the sale of products to a single trader ranged from 5 to 11 kg (Table 2). Mean catch rate per boat in the Australian jurisdiction of the Warrior Reef by PNG fishermen was 491.66 kg (se=47.42, n=12). This is equivalent to 49.17 kg dry weight. Given the mean number of fishermen per boat was 5 per banana boat, each fishermen collected 9 kg of product. This catch rate fell within the range recorded in Table 1.

To monitor catch and effort it is proposed that traders will issue a standard receipt to the fishermen to enable standard collection of catch and effort data when purchasing products from the fishermen.

### Yield

Estimated yield per hectare from the fisheries was relatively low when the fisheries commenced in 1990 increasing by almost 100% in 1991 (Table 3). By the time the fisheries closed in 1993, yield had dropped to a low of 2 kg per hectare. Yield estimate from a survey in December 1994 was a slight improvement from the 1993 yield. It is not known if this improvement was due to natural variations of the population or growth and therefore recovery of the population.

**Table 3. Yield Estimate for sandfish only, from 1990 to 1994**

Year	Yield (kg/ha)	Source
1990	6	Fishery
1991	11	Fishery
1992	10	Fishery
1993	2	Fishery
1994	3	Survey

## **Biology - Preliminary Results**

Updating and improving knowledge on the biology and ecology of sandfish in the Warrior Reef for management purposes is the subject of a study on the distribution and abundance, reproduction, growth and movement study which commenced in May 1994. Some of the preliminary analysis representing data from May 1994 to December 1995 is presented here to support a preliminary management regime.

### **Distribution & Abundance**

In a survey by Lokani and Lari (unpublished) sandfish was found throughout the reef flat, with densities ranging from 0 to 2,562 bdm/hectare. Mean densities at Auwomaza and Wapa were 244 and 136 bdm/hectare respectively. There were no significant differences in densities at Auwomaza and Wapa but significant differences were apparent for different zones (windward, midreef and leeward sites). Populations at both reefs had contagious distributions.

Size distribution at Auwomaza was bimodal with a mean size of 18 cm while that of Wapa was unimodal with a mean size of 20cm. The mean sizes at both reefs were relatively small being good only for C or D-sized processed products. The relative small size at both reefs is attributed to overfishing of the large size products which were the target of fishermen (Lokani pers. obs.).

### **Reproduction**

The reproductive biology of sandfish in the Warrior Reef is being studied, by observations and histological processing of the gonad tissue. Histological results are not ready for presentation here. One of the aim of the reproductive study is to determine the spawning season of sandfish. Graphical display of the gonad index from May to December suggest spawning would occur around December to February period.

At least 6 species of sea cucumber are known to reproduce asexually. Sandfish has not been observed to reproduce asexually. Initial trials to induce fission in sandfish by constriction was successful after at least 1 week. Growth after 2 months was at least 2 cm for the anal portion growing the head portion. Proper experimentation of induced fission needs to be carried out.

### **Movement**

Recruitment in sandfish is not known. Patterns of movement may shed light on recruitment patterns. Two movement are possible in sandfish, horizontal movement above the substrate and vertical movement associated with burrowing behaviour.

Mean speed of 12 cm/minute was achieved by sandfish. Preliminary analysis of orientation suggest that movement is not random and which has existed since the 1970's.

may be orientated towards specific areas. If this is common then it may have a bearing on recruitment patterns where settlement is restricted to certain areas of the reef. It was common for example to find that where large sizes were common and smaller sizes were very rare.

## **Management**

Management regulations currently exist in the form of size regulations, gear restrictions, permit requirements. These management measures were introduced in response to various resolutions passed by the National Fisheries Councils which called for the management of sedentary resources, of which beche-de-mer was one of the main fisheries. Management measures discussed below only relate to the objective of achieving Maximum Sustainable Yield. A more comprehensive discussion of the management measures are discussed in Anon (Undated).

## **Size Limit**

The current size limit of 15 cm is based on the size at first sexual maturity as calculated by Shelly (1981) for populations at Bootless Bay in Port Moresby. This size limit will be reviewed as soon as the reproductive study is completed. This limit was enforced on the dry product which were inspected by Fisheries Officers at Daru just before export.

Size limit is favourable in maximising the economics of the fishery, but it depends on proper modeling. Sizes of sandfish are bought according to size, with the larger sizes being more valuable (Conand and Sloan, 1989, Conand, 1990, Lokani and Kubohojam, undated).

## **TAC**

Total Allowable Catch (TAC) equivalent to the maximum sustainable yield level is desirable. Initial levels of the TAC will be set at levels to be determined by a simple criteria of;

1. TAC will be 90% of the estimated yield.
2. Yield is calculated from 17 cm plus sizes

The yield will be determined by visual census using line transects with the precision of the estimate initially set at 20%. The percentage of the yield is initially suggested to offset any underestimate of the yield caused by survey methods and processing methods used.

It has been rightly stated by Conand and Sloan (1989) that diverse social and organisations and coastal-area tenure systems make management measures of catch quotas, closures and licensing unrealistic where they exist. The Warrior Reef presents a unique opportunity to apply the catch quota in the form of a TAC together with closures and licensing because none of the complications highlighted by Conand and Sloan (1989) would affect the fishery. There is a lobster dive fishery in the same reef which has existed since the 1970s

## Closure

Acting on pressure from the Australian authorities on the frequent illegal fishing of PNG fishermen on the Australian side of the Warrior Reef, the Minister for Fisheries imposed a 3 months closure on the fisheries. This was later extended to a full year until March the following year after a survey revealed that stocks were very low (see Mobiha, undated).

Use of a closed season is seen as an effective strategy to control effort and limit yield to sustainable yield levels. It is anticipated that the closed season will commence when the TAC is reached. Considerations for the closure during the spawning season is desirable to maximise reproductive output. Preliminary tests on diurnal movement related to burrowing behaviour suggest that more sea cucumber are exposed during spawning thus making them more susceptible to fishing. High fertilisation success in *Cucumaria miniata* has been attributed to high population density (Sewell and Levitan, 1992). This has not been investigated in sandfish but it is appealing that conservative measures are taken. Use of the closed season in China is associated with the spawning period (Conand and Sloan, 1989)

## Gear Restriction

Enforcement of a ban on underwater breathing gear restriction is unlikely to have an effect on the stocks of sandfish, as the depth distribution is relatively shallow. The deeper species of white teatfish and prickly redfish may require underwater breathing gear but this is unlikely to be attractive to the fishermen at present. Underwater breathing gear in the form of hookah is currently being used in the lobster fishery on the same reef. Its inclusion in the Western Province beche-de-mer fishery to make it consistent with the current ban throughout PNG.

## Permits and Licensing

A licensing system is proposed for the buyers of beche-de-mer from the fishermen and boats. The number of licenses issued to the fishermen will depend on the TAC level. Licenses to the buyers will enable them to buy beche-de-mer in Western Province. They will still comply with the current requirements for an export permit for each shipment of export. A requirement of the license will be issuing of receipts by the buyers.

It is proposed that boats fishing for beche-de-mer from the Warrior Reef will be licensed, with limits on the size of the boats to 23 feet fibre glass boats. The licensing of boats is seen as making surveillance and minimising illegal fishing on the Australia side of the Warrior Reef. Papua New Guinea and Australia have a ratified treaty known as the Torres Strait Treaty which includes provisions for the joint management (e.g lobster) and cooperation in surveillance activities.

## Receipts

A simple log book system in the form of receipts will be issued by the buyer of products as part of the license. The receipts will be able to yield catch and effort information of individual fishermen and boat. Buyers need to issue receipts to the fishermen as proof of purchase or trade in any case. The idea of the receipts is to standardise the format and collect additional information on the fishery. By doing so buyers and fishermen participate in monitoring activities that are there to help the fishery and themselves.

Reliable standard statistics on the fisheries (Conand and Sloan, 1989) are needed to make reliable assessment of the stocks. Conand (1990) could only get the co-operation of one trader in collecting fishery statistics, possibly because of the competition from other traders.

## Research Needs

The possibility of enhancing and increasing yield through stock enhancement have not been investigated in sea cucumbers. Teleost fishes and sedentary organisms such as giant clams and trochus have been successfully been reared and used for farming or restocking purposes. The three possible stock enhancement techniques that can be investigated are;

1. Relocation of recruits
2. Induced fission
3. Hatchery rearing

Relocation of recruits and young recruits from areas of high abundance to areas of low abundance. This is a simple labour intensive method that requires study. This study will need to investigate the growth rate at various levels of density. If growth is density dependent then the level of density with the highest growth may be taken as the starting density level for relocation. Relocation in the form of sea ranching was recommended by a review of the Maldivian beche-de-mer fishery (Joseph, 1992).

Initial trials (Lokani, pers. obs) on induced fission on sandfish are encouraging. Fission was successfully induced within a week of initial constriction with growth of about 2 cm of the mouth portion within a month. Investigation on induced fission need to focus on induced fission at various sizes and the rate of growth for fissiparous products. Similar directions of research for mariculture purpose was said to have been initiated in the Maldives (Reichenbach et al., 1994).

Hatchery rearing is well established in teleost fish, giant clams and trochus. Investigations into rearing sandfish or any other sea cucumber species is probably the best source of recruits for stock enhancement or culture. A cold water species Sticopus japonicus has been successfully reared for stocking or culture purposes (Arakawa, 1990).

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