Effective management of sea cucumber fisheries and the beche-de-mer trade in Melanesia

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Introduction

Sea cucumber fisheries are the second-most valuable capture-based, export fishery in the South Pacific, but sustainably managing these fisheries has proven to be very difficult over the years. In years of peak exploitation, production has been valued at over USD 50 million, but in poor years the value has been only a fraction of this. Better management, combined with (current) higher prices could increase the value of the fishery, but potential income is being lost as a result of persistent overfishing and wild swings in productivity resulting from overexploitation.

Market demand currently exceeds global supply, and prices are rising, particularly for more sought-after species of sea cucumber. Rather than strengthening the position of sea cucumber fishers, however, the lure of easy money and market forces are encouraging poor practices and mis-management. Overexploitation often results in fisheries being closed (for periods of up to 10 years or more) to allow stocks to recover.

It could be argued that this is simply "business as usual" — a valuable renewable resource is rising in value, and a range of people are seeking to profit from this unfolding opportunity — but five aspects of the current circumstances surrounding this fishery and trade are particularly disturbing.

1. The stocks are so depleted that each boom-and-bust cycle yields less than half the volume of product as it did formerly.
2. Sea cucumbers play an important role in maintaining the health of many marine habitats; where they are absent or present in low numbers, ecosystem structure and function are altered.
3. The high value of prime sea cucumber product is encouraging households to focus on sea cucumber fishing and processing at the expense of subsistence and other revenue-generating activities, and encouraging greater dependence on imported products, requiring that households earn more from sea cucumbers.
4. Market makers are struggling to find new sources of supply, and the market is entering a period with a declining rate of increase in the volume of global supplies.
5. Those involved in sea cucumber trading can make substantial short-term profit in return for limited investment and at low risk. This, in combination with lax or non-existent control on exploitation and trade, and the absence of transparency, supports corrupt and illegal activity.

Bringing the sea cucumber industry under responsible and sustainable management is of utmost importance. The key elements of management are well known, but the practicalities of putting these in place are problematic. A key priority is to break or moderate the boom-and-bust cycle typical of this industry. A more considered, strategic and coordinated approach to managing supplies could greatly strengthen the position of the industry, to the distinct benefit of national economies and rural coastal and island communities. These issues form the focus of this study.

The study

A recent study by Nautilus Consultants[6] focused on the sea cucumber fishery and its associated trade in five countries: Papua New Guinea (PNG), Solomon Islands, Vanuatu, Fiji and Tonga. The study formed part of an initiative by the Australian Centre for International Agricultural Research (ACIAR) that was implemented by SPC, and responds to concerns raised by Melanesian country leaders and more broadly by the Heads of Fisheries of Pacific Island countries and territories (PICTs).

The intention of the study was to raise the profile of sea cucumber fisheries by highlighting the potential economic returns from a sustainable fishery, and the wealth lost through inadequate management, and identify effective approaches to the management of sea cucumber fisheries in the Pacific, with an initial focus on Melanesia.

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[6] Full report available at: http://www.spc.int/DigitalLibrary/Doc/FAME/Reports/Carleton_13_BDM_Management.pdf

The scoping study sought to:

- profile the current and historic structure, operation and scale of sea cucumber harvesting and export in the five countries;
- estimate the scale of revenues being foregone as a result of persistent overexploitation and the boom-and-bust nature of the fisheries;
- identify fiscal and trade tools that could be used to better control production and trade;
- identify how management regimes could be strengthened to encourage sustainable exploitation and to boost income to peripheral coastal and island communities; and
- identify potential for regional cooperation — with a particular focus on member countries of the Melanesian Spearhead Group — in strengthening management and increasing trade revenue.

This article presents the results of the study in two parts:

Part A.
Provides a general introduction to sea cucumber fisheries and the beche-de-mer trade in the study countries; presents production estimates for each of the five countries; and presents estimates of the economic loss resulting from mis-management, which ultimately results in fishery closure.

Part B.
Discusses potential solutions to better manage these fisheries, with an emphasis on economic and trade management tools.

The commentary and data presented in this article are summaries of the report by Nautilus Consultants titled: "Effective management of sea cucumber fisheries and the beche-de-mer trade in Melanesia: Bringing the industry under rational control".

Part A: The sea cucumber industry and the beche-de-mer trade in Melanesia, and economic loss from overexploitation

An introduction to the sea cucumber industry

Beche-de-mer is the trade name for dried sea cucumber, which generally refers to the cooked and dried form of some 60 commercially traded species. The product is considered a food delicacy, especially in Asian markets, and is also used in powdered form in Chinese medicines.

Sea cucumbers inhabit a wide range of habitats across coastal shallows and reef ecosystems and play an important ecological role.

While 35 sea cucumber species are traded across Melanesia, examination of production and export records suggests that 21 species make up more than 90% of production volume, and just 8 species make up over three-quarters of production value.

Some of the most valuable sea cucumber species can be found (in healthy populations) at densities of 10–30 per hectare, whereas lower-value species can be found at densities of several hundred or several thousand per hectare. The higher-value species are typically harvested by free divers, whereas the lower-value species are more commonly harvested with less discrimination through shallow water gleaning. Specimens found in deeper water are sometimes harvested using a weighted impaling device, and some fishers use an underwater breathing apparatus (UBA), which is discouraged and illegal in Melanesian countries.[7] Not only is the use of UBA dangerous, but it results in the harvesting of larger numbers of mature adults, which adversely impacts spawning and stock recovery.

Sea cucumber harvesting most typically follows a boom-and-bust pattern of exploitation. More heavily fished stocks take longer to recover; recovery can take several decades, and some stocks may never recover. If a stock is fished before it has fully recovered, both harvest volume and average individual size will decrease. Underpinning this relationship is the fact that most sea cucumbers are broadcast spawners with a pelagic larval stage, during which larvae are carried by sea currents for up to 20 days. Therefore, stock recovery depends on having a sufficient concentration of spawning adults, the larvae finding suitable substrate on which to settle, and a sufficient proportion of young surviving long enough to recruit to the commercially exploitable population. Populations are particularly susceptible to local extinction as a result of overfishing because recruitment across large stretches of ocean is problematic.

The range of species that make up the beche-de-mer trade from the countries under study is shown in Table 1 and listed according to the estimated 2012 in-country purchase value (producer and/or processor selling to buyer and/or exporter) for A-grade dried beche-de-mer.

[7] In recent years, however, Fiji has issued a limited number of licenses for harvesting sea cucumbers using UBA gear.

Table 1. The main sea cucumber species traded in the western and central Pacific.

Code	Common name	Scientific name	Purchase price USD kg^{-1} (dried)[a]	Value group[b]	Av. weight t yr^{-1} (beche-de-mer)[c]
SF	sandfish	*Holothuria scabra*	90	H	70
WTF	white teatfish	*Holothuria fuscogilva*	84	H	159
GSF	golden sandfish	*Holothuria lessoni* [+]	60	M	-
BTF	black teatfish	*Holothuria whitmaei*	53	M	29
GF	greenfish	*Stichopus chloronotus*	50	M	19
PRF	prickly redfish / pineapple fish	*Thelenota ananas*	45	M	30
BF	deepwater blackfish / Panning's blackfish	*Actinopyga palauensis*	45	M	1
DRF	deep water redfish	*Actinopyga echinites*	45	M	8
SRF	surf redfish	*Actinopyga mauritiana*	39	M	45
BF	blackfish / hairy blackfish	*Actinopyga miliaris*	20	L	26
CF	curryfish	*Stichopus herrmanni*	20	L	53
STF	stonefish	*Actinopyga lecanora*	20	L	18
TF	tigerfish / leopardfish	*Bohadschia argus*	20	L	74
SNF	snakefish	*Holothuria coluber*	16	L	86
PNF	peanutfish / dragonfish / warty	*Stichopus horrens*	14	L	7
CHF	chalkfish / brownspotted sandfish	*Bohadschia similis* [*]	14	L	48
BSF	brown sandfish	*Bohadschia vitiensis* [*]	14	L	3
FF	flowerfish / orangefish / ripple fish	*Pearsonothuria graeffei*	14	L	97
AMF	amberfish	*Thelenota anax*	14	L	48
LF	lollyfish / reef lollyfish	*Holothuria atra*	11	VL	182
ETF	elephant trunkfish	*Holothuria fuscopunctata*	11	VL	42
PKF	pinkfish	*Holothuria edulis*	6	VL	18

Notes

[a] The estimated price at which A-grade dried product was bought from producers.

[b] Product grouped by price bracket: H = high; M = medium; L = low; VL = very low.

[c] The average amount of dried product of each species exported each year from the countries under study, based on production over 15 years (incorporating periods when fisheries closed), 1996–2012.

[+] Golden sandfish has previously been classified as *H. scabra* var. *versicolor* but has recently been re-classified as *H. lessoni*, a separate species (Kinch et al. 2008).

[*] Species with taxonomy due to be reviewed (Kinch et al 2008) – *B. similis* now renamed *B. marmorata* (Uthicke et al. 2010).

Productivity is commonly shown in terms of peak exports; however, data indicate that heavy harvesting in one year impairs productivity in future years. In four of the five countries under study, sustained high fishing pressure on stocks has resulted in fisheries closures to allow stocks to recover. To better reflect potential productivity, the average production over a period that includes at least two boom-and-bust cycles is presented. Accordingly, average exports over 15 years, including low or zero harvests when fisheries have been closed, are shown in the final column of Table 1.

At current purchase prices, 15-year average production for the 5 countries under study is valued at some USD 20 million per year, rather than upwards of USD 50 million, which has been ascribed to one-off peak production from all PICTs.

The broad scale of harvests and exports is shown in Figure 1, where the 15-year average annual value of exports of beche-de-mer by species is shown, together with the equivalent volume of sea cucumbers harvested (live weight estimates). Interestingly, the largest biomass harvested is of the low value lollyfish sea cucumber and the second-largest is of the very high-value white teatfish.

Regional beche-de-mer production

The beche-de-mer industry is a complex multi-species, multi-layered industry that requires analysis at multiple levels (from global to local). Good datasets on the total volume of exports by each country under study are available (early figures for Tonga are absent) and the species composition of exports is available, but inconsistent

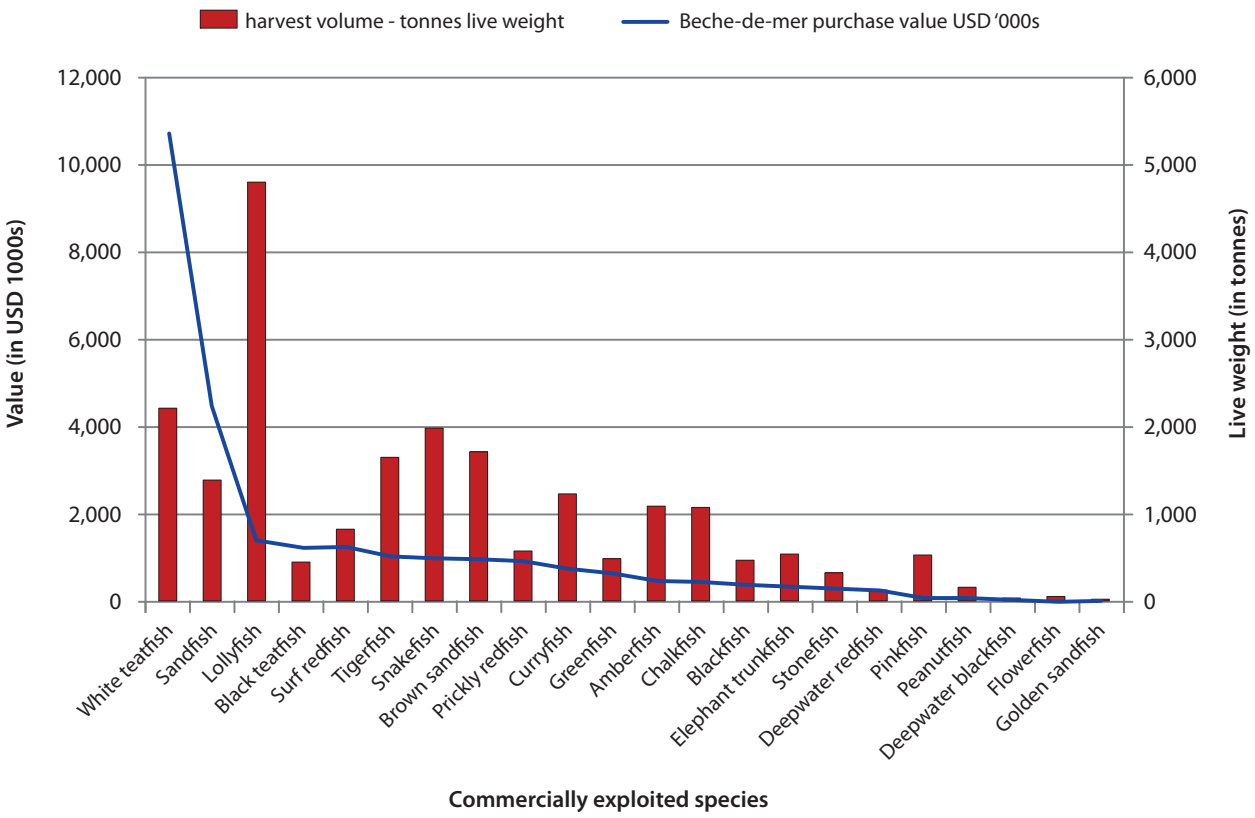


Figure 1. Sea cucumber species ordered by value of average harvests, also showing the equivalent harvest volume (tonnes live weight for five countries under study). Notes: Not all beche-de-mer purchased by traders is A-grade; purchases comprise a range of sizes of animals and are processed to different standards. Accordingly, the prices used in calculating value have been discounted from those shown in Table 1, discounted by 20% for white and black teatfish, and 30% for all other species.

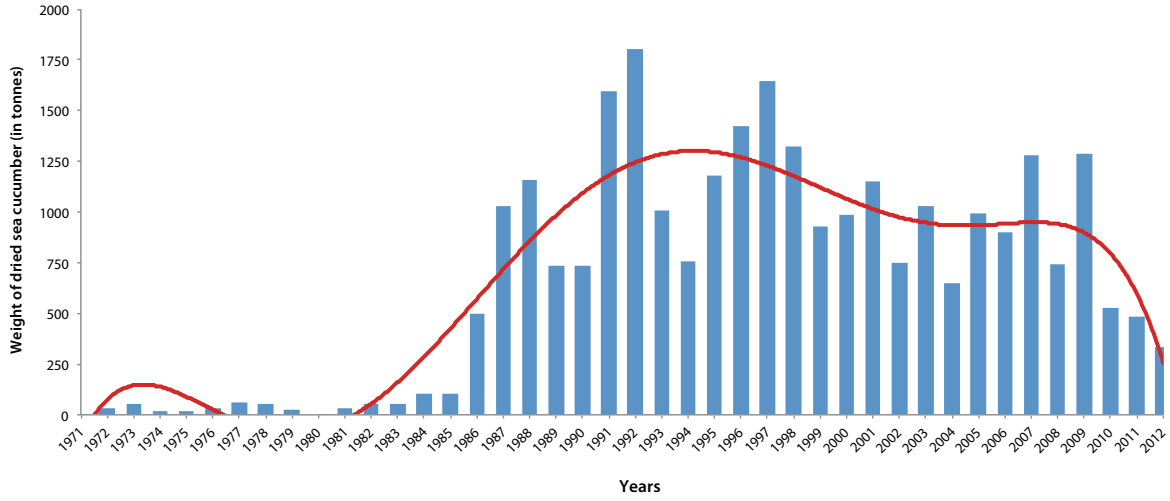


Figure 2. Exports of beche-de-mer from the five countries under study, 1986–2012, tonnes of product (dried weight). Source: Fisheries Department statistics from Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu.

across the data series (species-discriminated data for Vanuatu are poor).

When looking at the management of sea cucumber fisheries, national-level statistics are too general and greater disaggregation is required. To better inform such analysis, the study consolidated production and harvest statistics, by species, at the provincial level (see Fig. 5).

Figure 2 shows the combined exports of beche-de-mer for the five countries over the period 1971–2012. The graphic has been overlain with a polynomial trendline,

reflecting the broad changes in export across this time series. In broad terms, the evolution of the fisheries has been low-level exploitation through the 1970s, with steady growth of exploitation in the 1980s that reached a peak in the early 1990s. Harvests dropped off after this but a secondary, lower-level peak was reached in the late 1990s. Concerns about widespread overfishing of stocks resulted in the closure of fisheries in the Solomon Islands (2006), Vanuatu (2008) and PNG (2009); the Tongan fishery was closed from 1997 for 10 years. In the late 2000s, with most fisheries subject to a moratorium, regional production was being provided by Fiji and Tonga only[8] stocks in both of these countries are now thought to be overexploited, and fishing pressure will have to be reduced to allow for stock recovery.[9]

The increasing demand for beche-de-mer can be largely ascribed to the increased demand from China, resulting from economic growth and rising incomes. As beche-de-mer supplies from traditional sources are reduced, the trade has sought new sources, but these in turn have also been overexploited (Purcell et al. 2012; To and Shea 2012). The result has been substantial upward pressure on market prices: pries for lower-value species have typically increased by two to three-fold over the last seven years, while higher-value species have increased four or five-fold. Given this, buyers and exporters encourage fishers to focus on exploiting high-value species — attractive because these are low-volume, high-mark-up products — although high-volume, low-markup species, such as lollyfish, have particular merit from a socioeconomic perspective.

Over the period illustrated in Figure 2, prices have strengthened, so while volume has declined, in dollar terms the overall value of production has generally increased, which creates a false sense of security around the status of stocks. Furthermore, the species mix has shifted to lower-value species and the overall volume has decreased substantially (for many species the average size of individuals harvested has declined as well). Recent harvests have declined in scale and quality, and even with "rest" periods, stocks are not returning to the levels found in the 1980s.

Figure 3 shows the same dataset disaggregated by country, noting that four of the five fisheries were subject to a moratorium late in the data series.

Given its geographic size, PNG is consistently the highest sea cucumber producer among the five countries, with significant but lesser volumes produced by Fiji and the Solomon Islands. Production from Tonga in 2008 and 2009 exceeded that of Fiji, but it is clear that despite the ten-year moratorium and the setting of provincial fishing quotas (which were considered conservative at the time), the fishery has been all but fished-out over the course of two seasons.

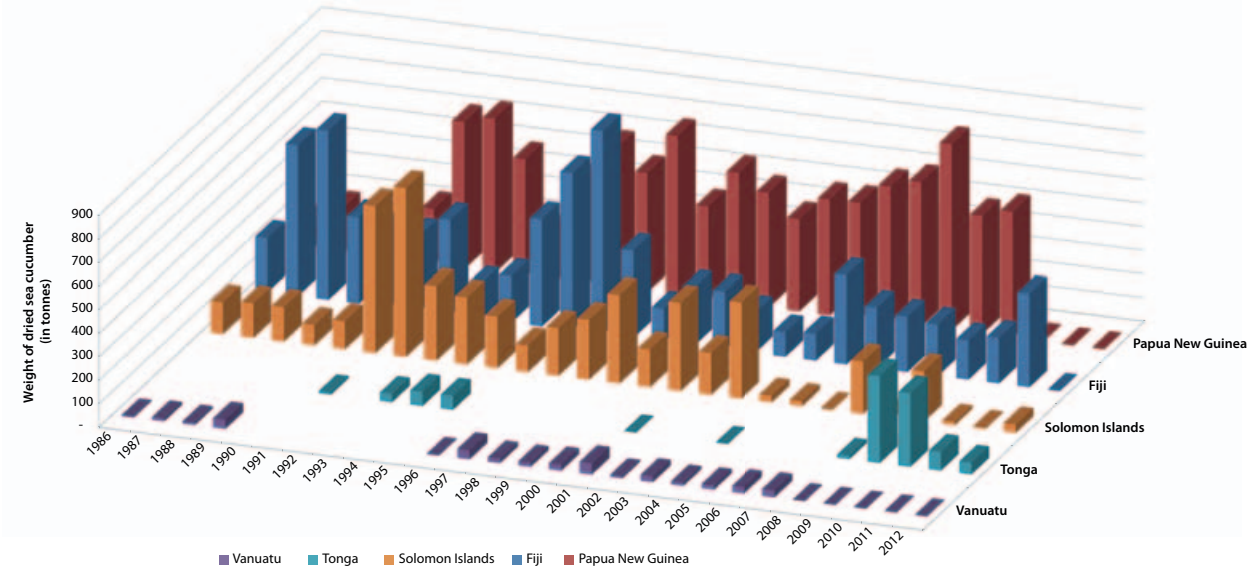


Figure 3. Export volume of beche-de-mer, 1986–2012, tonnes of product (dried weight).

[8] Note that New Caledonia, not included in this study, is a significant regional beche-de-mer producer and exporter.
[9] The Tonga fishery has been closed again as from the beginning of 2013.

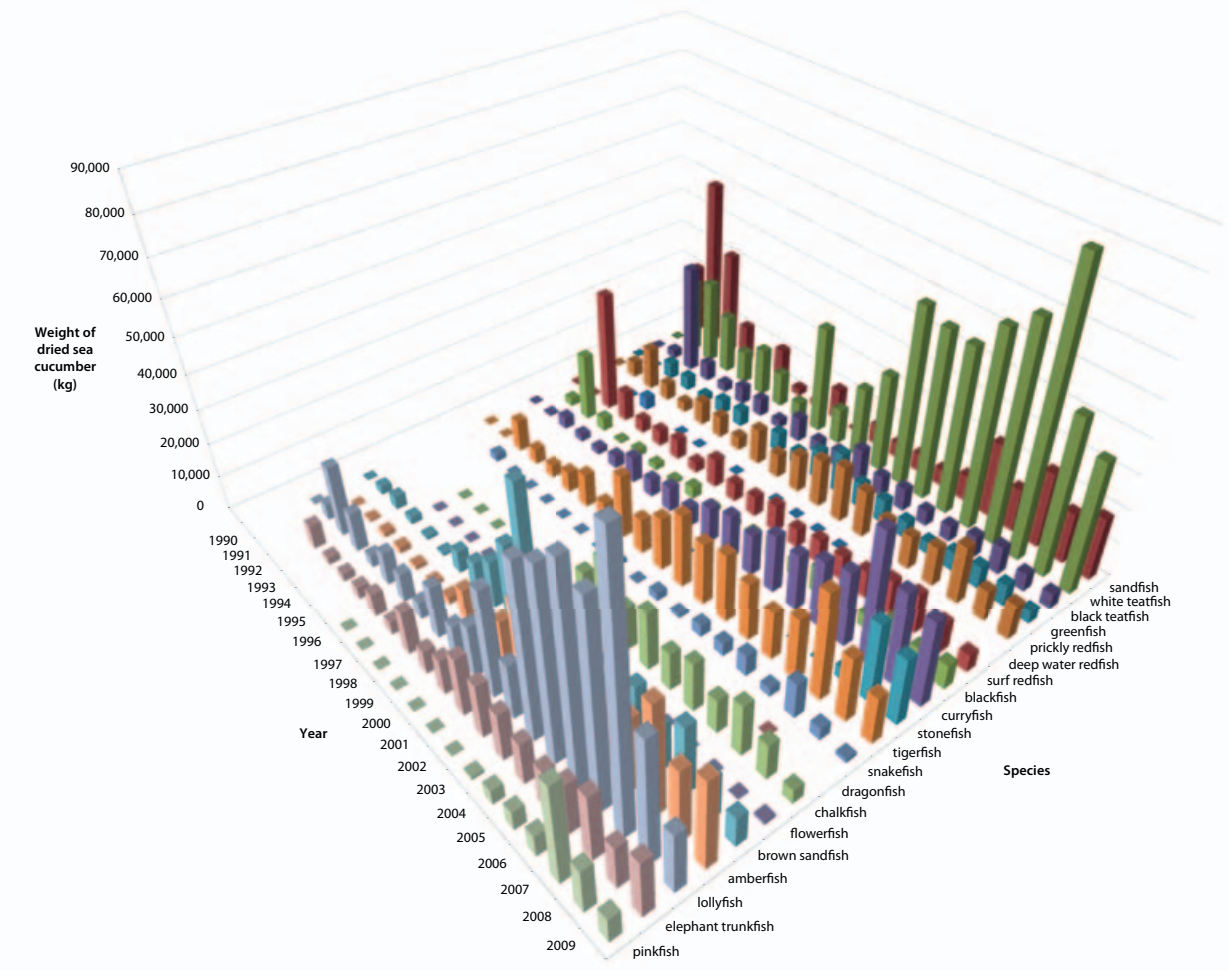


Figure 4. Estimated volume of dried beche-de-mer exports originating from Milne Bay Province, Papua New Guinea, by species.
Source: Papua New Guinea's National Fisheries Authority trade database.

Figure 4 gives an example of production data at the provincial level (Milne Bay Province, PNG), where it is evident that much effort was put into harvesting sandfish in the early period of this time series, with harvests quickly dropping off and not building up again until about 10 years later. By the late 1990s, white teatfish and lollyfish had clearly become the main targets of fishing effort, which were accompanied by high harvests of black teatfish, greenfish, prickly redfish, tigerfish and brown sandfish, but these harvests quickly decreased as the resources became depleted.

Analysis of the boom-and-bust cycles typical of sea cucumber fisheries shows that, in general, the heights of earlier cycles are rarely repeated; by all indications, stocks do not fully recover. Analysis of the changing harvests of the different species over time also confirms this pattern. Anecdotal evidence suggests that the larger specimens available at the outset of a boom are soon exhausted and that the average size of each species harvested decreases over time. Accompanying the decline in average sea cucumber size is a shift to exploit lower-value species.

Overall, the indications are that historic levels of exploitation are not sustainable, and that different harvesting strategies could sustain both higher biomass extraction, and higher average value of sea cucumbers extracted.

The study compiled data at the provincial level for each country, and Figure 5 shows provincial and district boundaries. Production by province is shown in Figure 6, where the reported volume of beche-de-mer exports over the 15-year period 1997–2011 has been averaged, and then valued, based on a representative species mix for that province. The value of production is shown on the basis of the following categories: high-value, medium-value and low-value species (see Table 1).

Figure 5. Division of area according to existing administrative boundaries.

1 Western (Fly)	*10 New Ireland*	*19 Guadalcanal*	*28 Shefa*
2 Gulf	*11 Morobe*	*20 Rennel & Belona*	*29 Tafea*
3 Central	*12 Oro (Northern)*	*21 Malaita*	*30 Western*
4 Sandaun (West Sepik)	*13 Milne Bay*	*22 Makira-Ulawa*	*31 Northern*
5 East Sepik	*14 AR Bougainville*	*23 Temotu*	*32 Central*
6 Madang	*15 Choiseul*	*24 Torba*	*33 Eastern*
7 Manus	*16 Western*	*25 Sanma*	*34 Vava'u*
8 West New Britain	*17 Isabel*	*26 Penama*	*35 Haapai*
9 East New Britain	*18 Central*	*27 Malampa*	*36 Tongatapu*

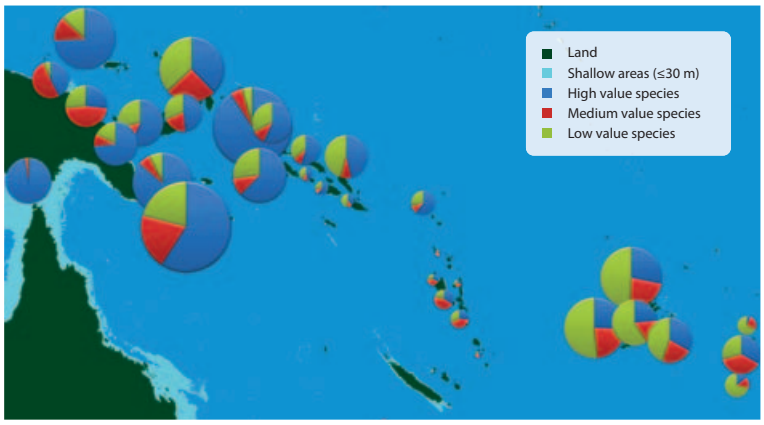


Figure 6. Fifteen-year average value of sea cucumber production by administrative area. Note: Milne Bay Province (the largest roundel) represents a value of USD 2.9 million.

Figure 7. Relative area of shallow water surrounding each administrative area. Note: Data extracted from NASA seaWIFS bathymetry graphics. Shallow water areas selected using colour coding; areas calculated from pixel estimates.

As a cross-check, shallow water area (<20 m) was estimated for each province. These data are illustrated graphically in Figure 7 and show good general correlation with the data in Figure 6.

Examination of potential production

Coastal communities rely heavily on sea cucumber harvesting, because it is one of their few sources of cash income. This encourages exploitation of the resources at unsustainable levels, resulting in significant reductions in the total biomass of each species that can be harvested in subsequent boom-and-bust cycles; it significantly slows stock recovery, makes it necessary to impose long moratoria on fishing and trade.

The relative impact of the different types of exploitation patterns is illustrated in Figure 8 (using notional values only). Stable exploitation — either retaining the same level each year or retaining a low–level, boom-and-bust form — gives the highest overall yield, and ensures a steady and predictable income to fishing communities year after year. Putting resources under very heavy fishing pressure results in slower stock recovery, and leads to lower harvest levels, which yields less and less product, and increasingly longer recovery periods. Taken to its extreme, this results in an exhausted fishery yielding very low returns with long periods of low or no production.

For illustrative purposes a tonnage figure has been added for each exploitation pattern, representing the summation of all harvests under each system over a 30-year period. In this fictitious example, an exhausted fishery yields less than one-third of the biomass of a well-managed fishery. Added to this, sustainable exploitation yields a steady income each year, whereas even with a regularly managed boom-and-bust cycle, communities would have little to no income for 6 of the 30 years. With a declining boom-and-bust fishing cycle,

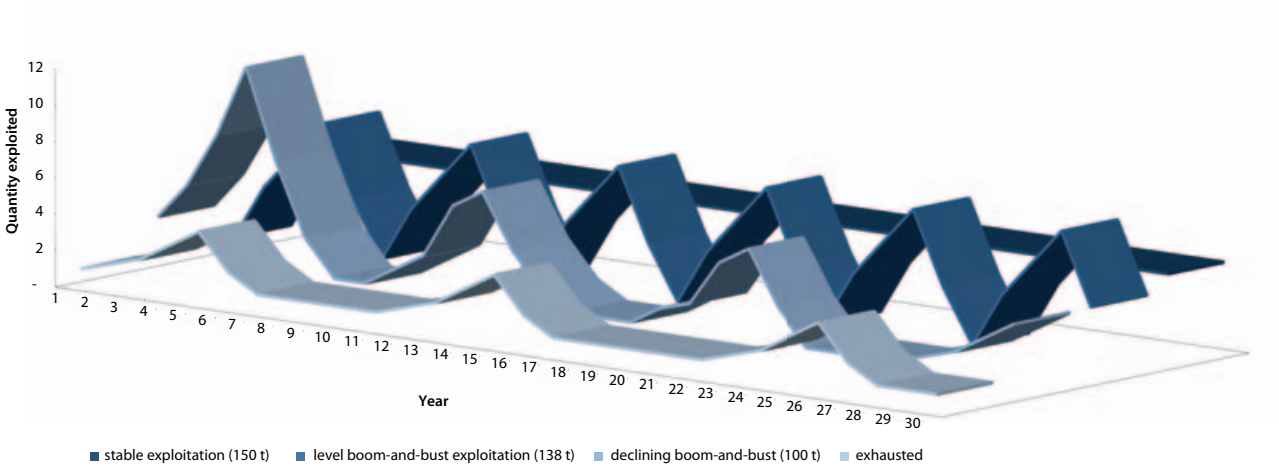


Figure 8 . Example of the resource yield from different exploitation patterns.

there would be 9 years of little to no income, and the exhausted fishery would produce 15 years of little to no income. In addition, the unit value of catches achieved each year is likely to decline across each boom-and-bust cycle as larger specimens are removed from the fishery and the focus shifts to smaller and lower-value species.

In practice, in the countries under study, the evolution of sea cucumber fisheries — as supported by the statistical record, anecdotal evidence from interviews, and illustrated in Figures 2 and 4 — is as follows:

- Fishing effort steadily increased in the early years, going beyond levels that could be readily replaced and building to levels of extraction beyond the replacement capacity of the resource.
- In subsequent years, harvests of the primary target species were much reduced (both in volume and in size) and effort shifted to other species; the latter target species were subsequently fished down.
- Exploitation of lower-value species proceeded throughout the cycle, but increased once higher-value species became difficult to find; over time, these resources were also depleted, and effort shifted to species that were not previously exploited.
- As high-value stocks recovered, this attracted more fishing effort; following a long period of relatively flat prices, from the mid-2000s prices for most high-value species steadily increased, which encouraged fishers to dedicate more effort to harvesting high-value species, with extraction again far beyond sustainable levels.
- At this point in the exploitation cycle, most countries found it necessary to close exhausted fisheries in order to allow them to recover; in Fiji, where no closures have implemented, the statistical record indicates that the underlying scale of harvests is declining steadily, and has been buoyed up, to an extent, by the official licensing of UBA fishing.

Clearly, the potential economic impact on coastal and island communities can be highly significant because unsustainable practices lead to the stock being systematically depleted through fishing. To put this into perspective, the example of Tonga is a salutary lesson (see Fig. 9). Long-term overexploitation of the sea cucumber fishery forced the government to call for a 10-year moratorium in 1997. The fishery was re-opened for a month in 2008, seven months in 2009, three months in 2010 and four months in 2011. From harvest and trade statistics,

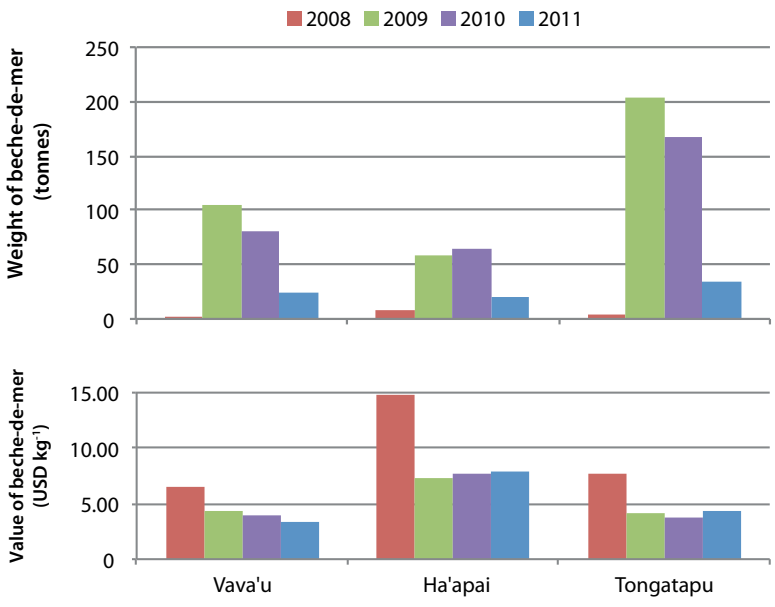


Figure 9. Evolution of sea cucumber harvests in Tonga.

it evident that the main stocks were all but fished out by the end of 2010, particularly higher-value species. The subsequent two years of harvests focused on very low-value species and the fishery was closed at the beginning of 2013. It is unclear when this will be re-opened, but the extent to which stocks have been depleted suggests the need for a 5–10 year period for stock recovery.

Regularly depleting stocks results in lower revenues than could be achieved using alternate harvesting and management strategies —specifically, harvesting stocks at lower annual levels so that both the scale and quality of harvests can be sustained over medium and longer terms.

Much can be done to strengthen the long-term scale and value of harvests, and therefore many benefits from these fisheries have been foregone as a result of recent and current systems of management. This is illustrated in Figure 10, using actual harvest figures. To remove the issue of rising prices across the time series, current constant prices are applied.

This exercise suggests that more sustainable management[10] might yield 10% less in export volume, but 25% more in export value without the processing discount (valued at buy-in price), and 50% more if the processing discount is applied. Limited to the time series covering the last 15 years, the difference is still greater — about a 5% increase in volume over the period — but an 80% increase in value without the processing discount, and a 100% increase in value with the processing discount.

Using constant prices (based on current buy-in prices), this suggests that annual income to coastal and island communities would have ranged from between USD 24 million at the highest peak in the late 1990s, down to a current level of some USD 4 million. Under the more precautionary and sustainable scenario described above, this would translate into an annual value of between USD 16 million and USD 22 million every year.

Across the most recent 15-year time series, this translates into revenue generation of some USD 160 million under current circumstances, and USD 320 million under more precautionary management and improved standards of processing. Clearly, the difference is huge, but it also comes with other distinct advantages:

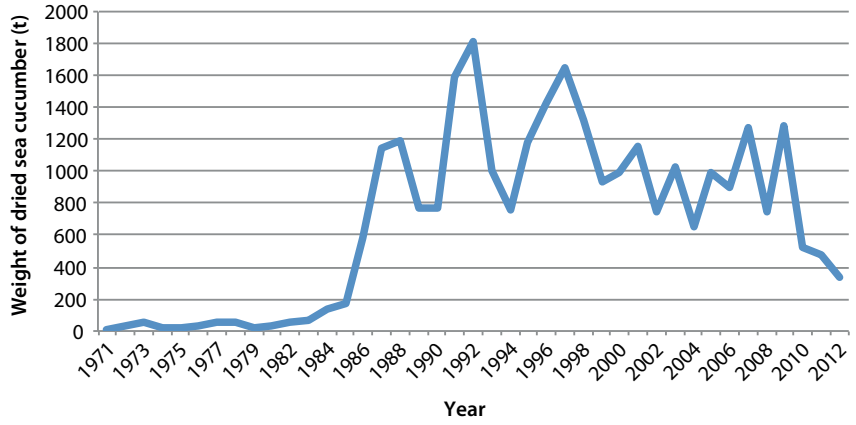
- Under the more precautionary management regime there is no need for moratoria, so coastal and island communities can generate income from sea cucumber harvesting and processing every year, and the harvesting regime becomes more predictable; bearing in mind that many of these fisheries are currently overexploited and/or in recovery, this more stable management regime would need to be preceded by a period of managed stock recovery.
- There is arguably less pressure to engage in illegal, unreported and unregulated fishing.
- More consistent and predictable levels of income are likely to provide greater incentive for coastal and island communities to take increased control over their fisheries..
- The provincial focus is likely to provide impetus for significant improvement in the capacity of provinces to manage and monitor coastal fisheries.

On this basis, regional harvests in 2006 totalled 930 tonnes (t), representing a current value of USD 15.8 million. Under a more moderate exploitation regime, we estimate that the harvest volume could have been on the order of 850 t, representing a current value of USD 18.4 million. In subsequent years, the sea cucumber fisheries of PNG, Solomon Islands and Vanuatu were closed to allow stocks to recover, and to compensate for previous excessive harvests. Tonga's sea cucumber fishery was opened, but was all but exhausted by the end of 2012, and Fiji's fishery has remained open, but harvests have been well below those achieved in the 1980s and 1990s. From 2007 to 2012, the five countries under study exported an average of 600 t of beche-de-mer per year, whereas under the precautionary management regime this would have been closer to 1,000 t per year, and increased annual revenues by about USD 13 million.

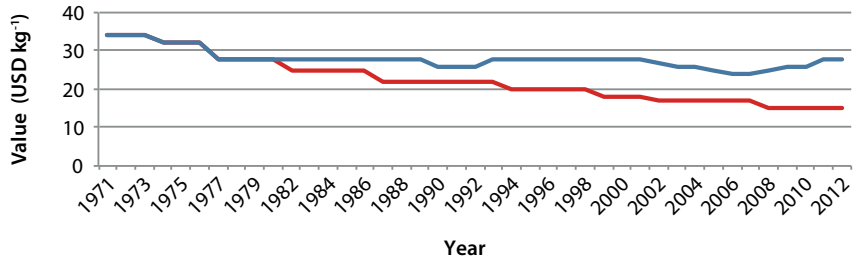
This exercise demonstrates the significant economic loss that results from overexploitation (a high proportion of lower-value species, smaller animals and poor processing practices), which ultimately results in fishery moratoria where no revenues are realised. More precautionary production levels, with improved processing and fishery management, increase economic value (a higher-value species mix and larger sea cucumbers) with no need for moratoria, and so revenues are realised every year.

Part B hereafter discusses management strategies that facilitate improved fishery and trade management, which translate to higher economic return value derived from these important fisheries.

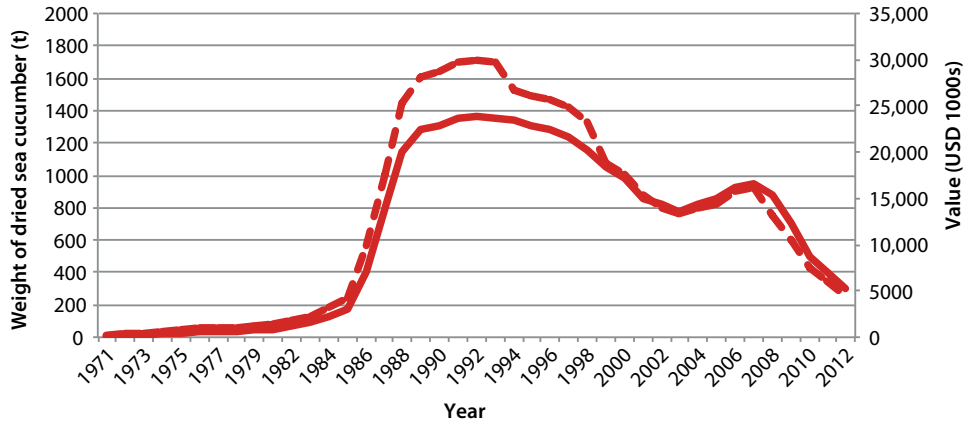
[10] It should be stressed that this analysis is based primarily on the trade record, albeit with some recognition of biological processes. In terms of determining a biologically sustainable level of exploitation, key data (size, distribution of animals, and the area over which they exist) that would enable the calculation of stock size, biomass, and maximum sustainable yield (MSY) are missing, except in the work currently being undertaken in Vanuatu, where stock assessments are being prepared on a small-area basis (Leopold et al. 2013 and Duvauchelle 2010). As an alternate approach to modelling stock size, stock condition and MSY, we have undertaken preliminary modelling of the trade and value record (with encouraging results), and are of the strong view that this warrants further work. The figures emerging from this modelling, which was based on the trade series for Milne Bay, bear credible similarity to exploitation levels proposed by NFA, but we would caution that further work needs to be undertaken to bring these approaches together in support of a single fishery management proposal.



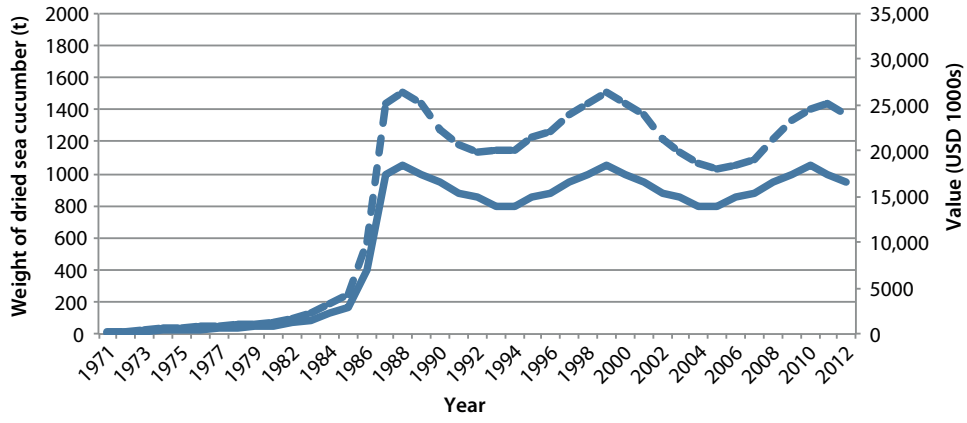
Regional exports of beche de mer (tonnes of dried weight). Taken from export statistics for the five countries under study.



Likely average unit buy-in price at today's prices (USD kg^{-1} of dried weight) (i.e. price reflects changes in species mix and size).
Red = overexploitation
Blue = sustainable exploitation



Smoothed production curve under current overexploited scenario. Solid line is production (tonnes of dried weight; left-hand axis); dotted line is value, including 20% discount for poor processing (USD 1000s; right-hand axis).



Smoothed production curve under sustainable scenario. Solid line is production (tonnes of dried weight; left-hand axis); dotted line is value, including 20% discount for poor processing (USD 1000s; right-hand axis).

Figure 10. Illustrations of valuation of beche-de-mer exports under different assumptions.

Part B: Managing sea cucumber fisheries and the beche-de-mer trade

Approaches to managing sea cucumber fisheries

This section introduces global experiences in managing sea cucumber fisheries, including an assessment of the strengths and weaknesses of alternative approaches, and opportunities to reinforce implementation of these approaches through economic and fiscal measures.

Status and pressures

Experience of sea cucumber fisheries management in the Pacific and globally has been reviewed and summarised by Kinch et al. (2008), Purcell et al. (2013), and Anderson et al. (2011). Many management issues are also addressed in Purcell et al. (2012). According to these and other studies, the key management issues pertaining to sea cucumber fisheries include the following.

1. Significant problems associated with managing sea cucumber species, with many or most species showing signs of overexploitation. For example:
   - 38% of sea cucumber fisheries globally are currently overexploited (Purcell et al. 2013), and many of these in the Pacific;
   - regional assessments have revealed that population declines from overfishing occurred in 81% sea cucumber fisheries, average harvested body size declined by 35%, harvesters moved from near to offshore regions in 51% and from high- to low-value species in 76% of sea cucumber fisheries;
   - 38% of sea cucumber fisheries remain unregulated, and illegal catches were of concern in half of these (Anderson et al. 2011).
2. Pressure on fisheries in recent years has been increasingly intense, and is associated with:
   - improved market access and high prices;
   - increased use of boats, which allow for the exploitation of previously virgin stock; and
   - poverty[11] coupled with income generating aspiration, which results in an incentive to fish even when sea cucumber densities are extremely low.
3. Sea cucumbers are highly vulnerable to overexploitation because they are:
   - sedentary, shallow water animals and readily accessible to harvesting;
   - long-lived, slow maturing, broadcast spawners dependent on minimum densities for successful reproduction; and
   - harvested as mixed-species fisheries. When target species dip below commercial densities, fishers continue to fish. Although they are targeting other species, they nonetheless continue to catch the previous target species, pushing these further below viability, and possibly towards local extinction.

Management response

A wide range of management instruments have been applied, mediated through customary marine tenure, provincial and national government initiatives, aid projects and non-governmental organisations. They have included size limits, gear restrictions, spatial and temporal closures, quotas and marine reserves.

The use of different management measures in sea cucumber fisheries worldwide has been reviewed by Purcell et al. 2009, and the frequency of use of these measures is summarised in Table 3.

Table 3. Use of different management tools in sea cucumber fisheries worldwide (after Purcell et al. 2009).

Management tool	Proportion of sea cucumber fisheries
Moratoria	39%
Gear restrictions	39%
Minimum size limits	34%
Catch quotas	28%
Fleet controls (numbers or size of vessels)	22%
Rotational harvest strategies (industrial fisheries only)	5%

[11] Stock depletion and overexploitation has been shown to be correlated with low human development index and poor enforcement of regulations (Purcell et al. 2013).

Generally speaking, these management tools have failed to curb overfishing. The main reasons relate to powerful drivers and the ease of overexploitation as described above, as well as more practical issues of limited funds and lack of enforcement, especially where large numbers of widely dispersed fishers are involved.

This management failure has led to crisis management in the form of moratoria, which have been introduced in many countries in the Pacific and elsewhere, including the Commonwealth of the Northern Mariana Islands, Costa Rica, mainland Ecuador, Egypt, Fiji, India, Mauritius, Mayotte (France), mainland Panama, Papua New Guinea, Solomon Islands, Tanzania, Tonga, Vanuatu and Venezuela (Purcell 2010). Despite these extreme measures, populations of some species have failed to recover; in some examples no recovery has occurred even 50 years after fishing stopped (Battaglene and Bell 2004), and local extinctions have been reported (Friedman et al. 2011).

There are, however, some examples of what appear to be sustainable sea cucumber fisheries, and Purcell et al. (2013) concluded that success relates to a number of factors, including enforcement capacity, number of species harvested, fleet (vessel) controls, limited entry controls, and rotational closures. It is, however, unclear that these factors apply to sea cucumber fisheries in Melanesia.

There is also a widespread view, especially in the Pacific Islands, that more effective management will depend on empowering local management systems with help, support or advice from central government fisheries administrations, although successful instances of this are limited. According to Purcell et al. (2009), co-management systems existed in just 12% of sea cucumber fisheries, although a greater emphasis is anticipated. Given the very strong incentives that encourage overfishing, however, and the high vulnerability of sea cucumbers to overexploitation, it is clear that empowering local communities is likely to be only one part of a more comprehensive approach to regulating and managing sea cucumber exploitation.

It is notable that the use of fiscal and economic tools to reinforce fisheries management is hardly referred to in the literature on sea cucumber management; and indeed, is little discussed in the general fisheries management literature, except in relation to quota valuation and trading.

Stock assessment

One of the weaknesses of management to date has been the lack of a clear relationship between the state of the stock and management response. This relates in large part to the difficulties of stock assessment, which in turn is related to:

- the number of species involved;
- the difficulty of identifying larvae;
- cryptic juveniles;
- the difficulty of tagging soft-bodied animals;
- there being no clear age-weight relationship; and
- difficulties in establishing recruitment to the spawning stock.

Young and adult sea cucumbers (excluding juveniles) are, however, relatively easy to find, measure, weigh and count, and size distributions and density mapping by species is relatively straightforward. Estimating potential productivity from habitat mapping coupled with some biological characteristics may offer a way forward, but is complicated by the limited availability of habitat maps, and the fact that the relative distribution of different sea cucumber species is not clearly delimited by habitat (although there are clear differences in the probability of finding a particular species in one habitat over another). Nonetheless, the combination of habitat mapping and density surveys might enable rough estimates of productivity and stock status (see Hamel and André-fouët 2010; Hajas 2011; Skewes et al. 2010; Skewes et al. 2006; Skewes et al. 2004; Preston and Lokani 1990) and possibly modelling estimates of target reference points.

In Melanesia, the stock health has been periodically monitored through surveys focused on recording the densities of different species in different habitats. Over time, these data have been used to develop threshold values of what might be considered indicators of a healthy stock.

The study explored the potential use of species trade data (an index of catch) and value data (a proxy for effort) as a means of assessing stock size and MSY (using a methodology adapted from Vasconcellos and Cochrane 2005). Acceptable model fitting was achieved, yielding estimates of stock size, MSY and the likely impacts of different harvest control rules (HCRs). The conclusion was that this is a valid and practical means of estimating key stock parameters where good time series trade data (discriminated by species) are available. The value of such modelling could only be further strengthened where additional datasets were available, indicating the size composition of exports, and the spatial distribution of each species (linking to habitat data).

Regulations and potential HCRs

Depending on the information available and the management institutions in place, general restrictions or more specific HCRs or targets for the country, district, lagoon or reef may be set.

Density limits

Minimum viable population density has been discussed as a possible HCR. Bell et al. (2008) review the limited research on minimum viable densities for successful fertilisation in sea cucumbers, and speculate that the "threshold densities to avoid depensation for most tropical sea cucumbers will be in the range of 10–50 individuals ha^{-1} over substantial areas, depending on species and location". Purcell (2009) suggests the following rules of thumb: <100/ha = low; <30/ha = near critical for population maintenance. Higher target densities based on target reference points would depend on more sophisticated stock assessment models.

The objective of any such HCR would be to maintain a minimum viable density to ensure recruitment.

Reserve areas and geographic closures

Reserves or marine protected areas (MPAs) are widely discussed as a possible way forward. Based on analysis of the movements of sandfish, Purcell and Kirby (2006) suggest that reserves of a couple of hundred hectares would probably be sufficient for preserving and promoting breeding populations of sea cucumbers, giant clams and trochus, and that these could serve as sources of larvae for fished sites.

Seasonal closures and open seasons

The limited movement of these organisms and other life cycle characteristics is such that there is limited rationale for a seasonal closure to protect spawning stocks (e.g. breeding aggregations) or vulnerable juveniles. A limited nationally or regionally coordinated open season may, however, serve as a simple rough measure to limit total catch and to maximise product availability at times of highest demand.

From the perspective of monitoring and enforcement at the point of export (where product concentration occurs and where monitoring, control and surveillance [MCS] resources can be most easily focused) it would be difficult to police the situation where different parts of a country were subject to different open and closed seasons. In this context, opening the fishery for very brief periods only (pulse fishing) offers a more appropriate means of controlling fishing effort (a measure examined by Friedman et al. 2011). Activity at the community level could be restricted to a few short fishing seasons, each lasting a few days or weeks.

While there is no obvious rationale for having a closed season to protect spawning stock, allowing buyers and exporters the opportunity to do business across the year is likely to undermine more local management measures, and add to the costs of MCS, and should be seen as non-precautionary. Clearly, trading outside the season would raise questions, although the ability to store beche-de-mer makes strict policing of closed seasons at the point of export difficult. It is for this reason that the use of national closed seasons should be accompanied by the application of per-species export caps as a means of making stockpiling and contravention of other less commercially attractive controls. Accordingly, it is for the purposes of controlling trading rather than fishing activity that it is recommended that national closed seasons should be maintained, ideally lasting between six and nine months or more.

Size limits

Sea cucumbers generally become sexually mature when they reach a significant size and the limited data available on this issue (Conand 1993) suggest that simple size rules relating to groups might be feasible (e.g. fresh weight limits).

In principle, inspecting consignments for size at key trading posts and/or at the point of export should be possible, and economic disincentives (taxes or fines) are applicable.

Gear bans

Some countries implement bans on the use of scuba or hookah in order to protect a reservoir of larger animals in deeper water. Gear bans are not easily enforced at the national level but should be relatively easy to implement at the local or provincial level by confiscating gear.

Catch targets and quotas

Quotas may be set for individuals, families, boats, communities, lagoons, provinces or even countries, and may be implemented as bag limits, total quantity limits or as management targets to be achieved through other means. Controls at the point of export have been applied with a fair degree of success (all export shipments are required to be accompanied by comprehensive documentation and subject to inspection), but only when beche-de-mer is exported through formal channels.

Setting appropriate limits on catches from the sea cucumber fishery or of a particular species is difficult given the limited state of knowledge of population dynamics and stock productivity. To be more effective, a quota would necessarily have to be accompanied by several HCRs, including a "move-on" rule (e.g. once catch rates or observed densities per species fall below threshold levels, fishers need to move on to other fishing grounds).

Notwithstanding these reservations, a global review suggests that quotas work (Costello et al. 2008). Furthermore, modelling based on various datasets (catches, size distribution, density, prices) can certainly assist and can be further supported from practice (operation of an adaptive management regime), and more subjective survey

information (e.g. fishermen's or trader's views on catch per unit of effort, average sizes caught, and abundance).

Given the largely sessile nature of these organisms, the limited range of larval dispersion and recruitment to commercial stocks, and the very local nature of exploitation, the setting of quotas is not a precise activity, and while it should provide a useful control at national and provincial levels, it would be inappropriate to extend this particular system to the local level. We propose that local communities be encouraged to set and apply HCRs based on changes in the average size of sea cucumbers harvested, thereby shifting effort between stocks or stock groups and, where feasible, using area closures.

Implementation

There are three key elements to the effective implementation of harvest control rules:

- address the factors that drive overexploitation;
- agree on practical and effective harvest control rules; and
- strengthen compliance through legal and financial incentives or disincentives.

Most measures would be more effective if they were combined with limited fishing seasons (input control), controls on fishing methods (input control), minimum size restrictions (output control), and more effective monitoring throughout the supply chain (output control).

Broader measures

Re-stocking and stock enhancement offer some opportunities to re-establish depleted fisheries.

Limits to entry, including restricted allocation of individual quotas, are likely to be controversial for a small-scale fishery with very broad participation, such as that for sea cucumber. It is also likely to be difficult to implement unless a particular community with very strong internal ties and well-established and respected local authority systems decides to implement such a system.

Fiscal, economic and trade measures

Sector management can be improved substantially through the use of a variety of fiscal, economic and trade tools as a means of:

- regulation;
- providing incentives or disincentives to certain behaviour; and
- providing the environment within which market forces can encourage and maintain discipline.

Such tools can also be used to support and/or deliver particular policy objectives, including the potential to recoup all or part of the costs of management and regulation.

In the following section we discuss these tools under four distinct headings:

- information and its veracity — informing policy and practice;
- limiting resource access as a means of encouraging economic as well as biological optimisation — input controls and output controls;
- cost recovery mechanisms, and a subset of fiscal incentives to specific behaviour patterns and policy objectives; and
- providing disincentives to non-compliance and illegal behaviour.

Informing policy

Information

Defining, monitoring and adjusting fiscal, economic and trade measures requires access to good and dependable information. All of the countries studied have well-developed trade data collection systems, but data are collected inconsistently and not routinely used for management purposes.

Much valuable information can be obtained from trade datasets, which provide a potent basis for managing the beche-de-mer trade and sea cucumber exploitation.

The major weaknesses identified in the collection and collation of trade and harvest data are that data collection protocols are not applied consistently, and the data are not routinely checked and analysed (a process that would allow the information to be used for management purposes, and expose inconsistencies and errors). Crucial data are not routinely collected on purchases, by species and by province.

Transparency

As long as data are hidden from view, and are incomplete and unprocessed, management of sea cucumber fisheries and exports will continue to be subject to commercial and political pressures that result in activities that are at odds with established policies and plans and, more importantly, sustainability of the resource and continued revenue generation.

To improve transparency of the beche-de-mer trade, it is recommended that:

- each country make clear, unambiguous annual declarations regarding industry performance and the

rules that will govern industry performance in the subsequent period;
- fishery and supply chain data be used for management and control purposes;
- customs and fisheries departments share as much information as legal and commercial confidentiality limits allow, especially with regard to beche-de-mer shipments prior to export; and
- exporters declare the species composition and source (by province) for each shipment, with this information made available to fisheries departments.

Resource access

One of the main categories of economic control is limiting access to the resource and the product.

Licensing

Licensing fishermen is problematic in a widely dispersed, small-scale fishery that has limited management and administrative resources, and has traditionally relied on local-level, customary management. It is more practical to license the businesses that handle product throughout the supply chain (i.e. those involved in export, intermediary buyers, and processors where such activity is centralised, such as in Tonga).

When licensing, it is important to consider drafting eligibility criteria that restrict eligibility to the types of business that the national (and possibly regional) policy seeks to encourage. In the process of confirming eligibility, licensing authorities should be encouraged to enquire into who controls the companies, how they are financed, and how they can demonstrate that they are not engaged in any form of transfer pricing.[12]

Increasing the cost of an export licence may also be a means of discouraging applications from less serious businesses.

It is recommended that:

- all exporters be required to hold a valid license, and as a condition of that license be required to provide data on all purchases, by species and origin of product;
- exporters be required to provide details of the average size (length, weight) per bag of each species shipped, and that bags contain a single species to facilitate verification;
- the eligibility criteria for export licenses exclude operations unlikely to fully comply with license conditions, with greater scrutiny of the integrity and background of the business principals and partners;
- primary (i.e. excluding household and village-based consolidators) beche-de-mer buyers and processors operating at the provincial level be required to hold a buyer or processor license, a condition of which requires the provision of monthly species-based data related to volume, value and species that move throughout the processing facility, including details of the source fishery.

Production and export caps

Export caps as an economic measure

The main management issue with sea cucumber fisheries is persistent overexploitation. One of the key drivers for such behaviour is the value of the resource, and the ease with which it can be converted into cash. Downstream intermediaries such as buyers, processors, exporters and importers all profit from the beche-de-mer trade. The extent to which they profit from this business also drives these intermediaries to encourage the flow of more product along the supply chain, thereby contributing to the overexploitation of sea cucumber resources. Capping, such as limiting trade volumes, provides an effective means of reducing such behaviour and encourages other forms of profit optimisation (e.g. a focus on quality over volume).

It is recognised that deriving a numerical basis for determining sustainable levels of exploitation is difficult, expensive and time consuming; however, moderating export levels is a simple means of encouraging more responsible and sustainable behaviour, and is inherently an economic tool because it operates as a constraint on business.

While it is appropriate to set the export cap at the same level as a stock management tool, it has a different origin. Governments lack the resources to micro-manage exploitation at the local level, but placing an upper limit on exports can be relatively easily policed, and supports the work of resource managers.

Export caps should be established on a species basis, and wherever possible should be informed by information on stock management requirements. Crucially, however, export caps should be put in place as a precautionary measure even where no clear stock management information is available. Such caps can be periodically reset on the basis of feedback on stock conditions.

Species-specific export caps should, therefore, be set as a precautionary measure, even where a consensus on the status of sea cucumber stocks and harvest limits is absent. Where possible, such export caps should be subdivided at the provincial level so as to even out supply.

[12] Transfer pricing typically seeks to declare sale prices on commercial invoices, manifests and customs declarations that are substantially below the value of the product, as a means of reducing the scale of any export levies that may attach to the export, and as a means of artificially returning profits to the importing rather than the exporting country. Transfer pricing is most commonly found in trade arrangements where the importer is a major direct or indirect investor in the exporting company, through shareholding, trade financing or provision of working capital.

Cost recovery and economic incentives

Actual and potential mechanisms for cost recovery include:

- export levies on product value;
- licensing of exporters;
- licensing of processors; and
- access charges.

At present, most governments recoup some of the costs associated with managing this fishery through a levy on export value, which is based on quantity and (usually) a notional value, with the latter often under-representative of export values. This system needs to be revisited with the intention of ensuring that resulting revenues are realistic in the context of beche-de-mer market value. Customs and fisheries departments should require that a detailed commercial importer invoice form part of customs export documentation on which levies can be calculated.

Variable export levies could be deployed as a means of encouraging desired behaviour. A key issue is that in overexploited fisheries, fishers have little option but to catch and sell smaller animals. Assuming that minimum legal size limits are enforced, another management control is to apply a levy per piece of beche-de-mer exported. For example, a levy of USD 1 per piece would discourage exporters from shipping smaller sized beche-de-mer. If the levy is set at the right level, it encourages buying and selling larger beche-de-mer. Such a levy could be applied to all species, or only to those species considered threatened with overexploitation.

A secondary positive effect of such a policy would be increased pressure on customs and fisheries departments to inspect and weigh a sample of each export shipment. This would result in increased monitoring and control of the trade, and monitoring and recording of the average size of product shipped. The resulting data would help managers assess the impact and inform the adjustment of export caps, and contribute to stock assessment modelling and the setting of catch limits.

Revenues are also achieved through licensing exporters and processors.

In conclusion, it is recommended that:

- all beche-de-mer production be subject to a management levy collected at the point of export through an *ad valorem* (according to value) tariff, and that the provision of a valid commercial invoice be a prerequisite of customs clearance;
- the fee accompanying the issuing of export licenses be significant;
- to facilitate the setting of license fees, export levies and variable per-species levies be further studied (specifically, the costs and revenues associated with the beche-de-mer value chain); and
- consideration be given to applying a per-piece levy on different beche-de-mer species.

Monitoring, control and surveillance, and measures to discourage illegal, unreported and unregulated fishing and trade

Fishery closures force the trade underground

It is well known that beche-de-mer is exported illegally when sea cucumber fisheries are closed, and that in response to this, increased MCS resources are deployed in an effort to discourage and curtail such activity. The evidence (from inside the countries of this study and through discussions with traders in Hong Kong and mainland China) suggests that illegal shipments continue to be made. This is considered to be a direct result of closing these fisheries.

For various reasons — in combination with socioeconomic and market conditions — there is strong support for shifting sea cucumber harvesting from a boom-and-bust cycle to a more level and predictable fishery, year after year. It is evident that closure of at least some fisheries simply results in the trade going underground, as communities and exporters seek to continue generating cash income and profits. This results in stocks being overfished, with all activities performed outside the law, beyond the control of fisheries managers. In addition, closing the fishery without management cost-recovery forces governments to increase MCS expenditures.

Fishing with UBA gear

The illegal harvesting of sea cucumbers using UBA gear is thought to be taking place in all countries. The deeper water sea cucumber resources are considered to provide an essential reservoir of adult breeding stock of key species, and exploitation of these stocks is thought to adversely impact recruitment and re-stocking in overexploited areas in shallower water.

Existing bans on the use of UBA gear in sea cucumber harvesting should be maintained, with increased effort to enforce the bans.

In conclusion, it is recommended that:

- sea cucumber fisheries be managed to preclude the need for closures — stocks should be rebuilt and then managed more conservatively; and
- the use of UBA gear in exploiting sea cucumber resources be banned, and the ban effectively enforced.

A sea cucumber/beche-de-mer sector management framework

Sea cucumber management experience

The record of successful management of sea cucumber fisheries has not been good, and with the ever-growing demand for beche-de-mer, the incentives to harvest remain strong.

This study did not seek to revisit past analyses, but to explore new approaches, with an emphasis on economic and trade management. Accordingly, the study explores issues associated with the structure and operation of the beche-de-mer supply chain, and whether economic tools can provide the discipline and incentives needed to moderate the boom-and-bust nature of these fisheries. It would be naïve to suggest that there is a single or simple solution to managing these fisheries, but they can certainly be better managed than is currently the case.

The overriding influences on the management and trade of sea cucumber fisheries will undoubtedly remain the extent to which local fishers' activities can be brought within and influenced by a local management regime. Local conditions, traditions and influences will dictate what management systems will work in practice, particularly given that practical management and control of sea cucumber fisheries will be a local affair. While trade and supply chain rules and interventions are amenable to application at the national and regional level, fishery management will be much more local.

However, it is clear that the incentives to quickly deplete stocks far outweigh the disincentives, because these resources are treated unrealistically as a no-cost cash crop. Such a boom-and-bust strategy might have greater credibility if the benefits of the strategy were evenly distributed across adjacent coastal and island communities, but in practice it is more usual that benefits go to a small group of individuals. Such behaviour represents significant foregone economic gain — a loss of some significance to local coastal communities as well as to the economy as a whole.

Reinforcing management through trade information

The key to reinforcing the implementation of existing management measures lies in the marketing and distribution chain.

All countries require beche-de-mer traders and exporters to be licensed; some require intermediary buyers and traders to be licensed, either at the national or provincial level. Minimum size restrictions are applied in each country and are seemingly not widely known in fishing circles, so size controls are mainly (although not always) applied by traders and exporters. Another key group of management tools applied to traders is the mandatory submission of purchase records, packing lists and shipping manifests, which provide an important formality to the trade and an example of visible oversight, and thus serves as a deterrent to overharvesting and mismanagement. Trade records also act as a potential tool to enhance compliance with quota or size restrictions.

Establishing precautionary export caps and target catches

At the beginning of 2013, the stock situation in each country was as follows:

- PNG's resources should be improving after four years of closure, with the closure extended for another three years. Illegal, unreported and unregulated (IUU) fishing is proving problematic.
- Solomon Islands' fisheries have been mostly closed for at least four out of the last seven years, and stocks should be in recovery, although there has been significant IUU fishing.
- Vanuatu's fisheries have been closed for five years, and it has recently been announced that they will remain closed for another five years;
- Fiji's fisheries remain open, but stocks are thought to be in poor condition.
- Tonga's fishery has just been closed following five years of heavy exploitation and all stocks are considered to be in poor condition.

Management framework conclusions and recommendations

The foregoing suggests a complex picture with 1) a wide range of management interventions and suggested HCRs; 2) substantial difficulty in promoting or enforcing these mechanisms at local level; 3) substantial data collection at various points in the supply chain, but limited analysis and feedback into management; and 4) very little attempt to reinforce local or provincial management measures through checks and balances at the point of export. Given the relatively limited total volume of this high-value product, and therefore the relative ease with which trade depot and/or export inspection of consignment could be done, this is a lost opportunity.

The beche-de-mer management plans in operation, and the current draft revisions, form a sound and coherent basis for sector management. There are weaknesses in dissemination and compliance, but the main shortcoming is the absence of any clear mechanism for adaptive management and for making future decisions in a way that responds to evidence regarding past actions.

The following are the four key elements required in an effective management system for sea cucumbers.

In 2006, PNG introduced a provincial quota system, setting two export caps per province: one covering high-value species and the other covering low-value species. These caps approximated the peak volumes of historical exports and are considered to be excessive. An export cap closer to the historical average exports (15-year average of 450 t) would seem more appropriate (i.e. at 380 t, some 60% of the values put forward in the 2006 management plan).It is estimated that this would yield, over time, the same volume of harvests, but would avoid a fishery closure, and species composition would comprise more valuable species and individuals of greater average size.

For the Solomon Islands, the application of a provincial export cap would go a considerable way to moderating local overexploitation, but weak provincial infrastructures and limited capacity at the provincial level place responsibility for moderating exploitation on community leaders and fishers. An annual export cap of about 140 t (15-year average is 165 t) would encourage a focus on quality rather than quantity, and generate predictable year after year production at levels well above those currently available. As more information becomes available on the biological characteristics of stocks and harvesting levels, these export caps should be modified.

Vanuatu has very limited sea cucumber resource capacity, and given its distance from other islands and it's the reduced likelihood of recruitment from outside sources, these resources are very sensitive to overexploitation. Following a period of recovery, it is suggested that an export cap of no more than 20 t per year be established (15-year average is 18 t per year).

Fiji's sea cucumber resources have been heavily exploited over a long period. Stocks need to recover, either through a moratorium or through drastically reduced production. A target export cap of 200 t of dried beche-de-mer (15-year average is 275 t) would seem appropriate, but a substantially lower ceiling might be necessary in the shorter term.

Tonga's fishery is exhausted and needs time to recover. Once it has recovered, a substantially lower export cap of no more than 60 t of beche-de-mer per year (15-year average, including a 10-year moratorium, is 55 t) needs to be introduced.

1. Engage resource users in setting overall national harvest targets and standards regulations, and developing and agreeing on local HCRs in broad conformity with these national targets.
2. Establish incentives and disincentives to promote compliance at all levels, including through inspections and economic incentives at the point of export.
3. Monitor and analyse information relating to the implementation of HCRs (and their impact on stocks) at the local, provincial and national level and feed this back into the management process.
4. Establish agreed on response mechanisms at the national and local level that take effect if data analysis suggests a decline or improvement in stocks.

Opportunities for regional cooperation

Adoption of common standards or joint activity through regional cooperation would be helpful in a number of areas. For Melanesian countries, an initiative through the Melanesian Spearhead Group (MSG) would yield dividends. Some opportunities for cooperation are highlighted below.

- Governments of producing countries should share information on the beneficial ownership of beche-de-mer trading companies that they license and that operate in their respective territories.
- Governments should be much more open in their reporting on sector performance, and the information should be consolidated in an annual regional report.
- Investigations into the functional dimensions of this trade, including statistical research, and liaison with the governments of importing countries, should be undertaken on a regional rather country-by-country basis, and research results that are not commercially sensitive should be routinely shared across the region.
- The traditional core of beche-de-mer exporting countries are Fiji, Indonesia, Philippines, PNG and Solomon Islands. Although their dominance in terms of total supplies has waned in recent years, they remain responsible for over 50% of global tropical supplies. Given the diminishing global beche-de-mer supply, producers should be trading in a "sellers" market. The Pacific Islands are not taking advantage of this situation; governments should ensure that the provision of a valid commercial invoice forms a necessary part of customs clearance procedures, and that the information provided is used by governments. This information should be shared to the degree commercial confidentiality allows, so that it can be used to better inform trade policy. Veracity with respect to prices is particularly important given that in many (but not all) businesses, the importer provides the working capital for beche-de-mer supply chain networks in-country.
- It is recommended that MSG members coordinate their fishing seasons. If open seasons are coordinated so that imports originating from Melanesia occur simultaneously, any trade outside the coordinated season would be illegal.

Acknowledgements

SPC gratefully acknowledges the many contributors to this study, including fisheries administrations, donors, consultants and sea cucumber experts who all provided valuable input to this work. The authors would like to express special thanks to the following organisations and people: Australian Centre for International Agricultural Research; Fiji's Ministry of Fisheries and Forest; Papua New Guinea's National Fisheries Authority; the Solomon Islands Ministry of Fisheries and Marine Resources; Tonga's Ministry of Agriculture and Food, Forests and Fisheries; the Vanuatu Fisheries Department; Melenesian Spearhead Group and in-country correspondents (Len Rodwell, Francis Hickey, Ravinesh Ram and Poasi Ngaluafe). The summarised version of the complete report presented here was prepared by Michael Sharp, SPC Fisheries Development Officer (Economics).

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