Solomon Islands sea cucumber resource status and recommendations for management

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by

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Executive summary

The sea cucumber fishery is a multi-million dollar industry in the Solomon Islands. The fishery provides an important source of income for rural communities, and foreign exchange revenue for the country. However, persistent fishing pressure and ineffective management has led to the overexploitation of this resource, which has placed the fishery in danger of collapse. The decision to suspend fishing efforts in 2005 was timely although the lifting of the ban in 2007 on humanitarian grounds (to assist disaster victims in the western part of the country) has weakened the ban's effectiveness. Allowing some communities to continue harvesting sea cucumbers while closing the fishery to the rest of the country has created a certain amount of distrust of the ban, this has resulted in fishing efforts shifting to other provinces and illegal fishing activities after the ban was reinstated in April 2009.

Sea cucumber production in Solomon Islands has been declining since the 1990s when production levels were high. Persistent fishing pressure and the demand for products has been a challenge for the management authority. The sea cucumber trade is a lucrative industry in the Sololmon Islands and a commodity that rural communities rely on economically. Increasing market demand in China has increased product prices in recent years. For instance, the price of white teatfish has risen from SBD 100.00 per kilo in the 1990s to SBD 300.00 per kilo in recent times. The total export value for 2013 was the highest ever recorded for Solomon Islands at over SBD 33 million, which is a 70% increase in total export value over SBD 10 million in 1992. High commodity prices reflect the shortage of product, which is a result of resource overexploitation. Low-value products now dominate production because high-value products have been depleted, as shown in the 2013 export composition with lollyfish and brown sandfish comprising 58% of total exports.

Resource assessment surveys conducted across the country in 2011 and 2012 reveal the poor state of resources, which reflects the declining trend in export production. Sea cucumber stocks in the sites assessed in Solomon Islands are present in low densities while many high-value species are becoming rare. Of the 27 species of sea cucumbers recorded from these surveys, fewer than 19 species were present at the sites surveyed. Brown sandfish and lollyfish were recorded at all the sites although their abundances were low. Wider presence of these two species explains their high productions in recent exports. When compared with the regional reference points for healthy sea cucumber abundance, most species were present in densities well below these reference points. Sea cucumbers are sedentary animals, with males and females needing to be in close proximity for successful spawning induction and fertilisation of gametes. When sea cucumber densities become low, individuals are generally too far apart for successful reproduction and breeding.

When compared with the sizes of commonly found species from other locations in the Pacific Islands, the sea cucumbers recorded from surveys in the Solomon Islands were smaller in size, indicating younger populations. The reproductive power of present populations has been diminished and populations will continue to decline without protective measures. Active recruitment from existing stocks is taking place, however, and there is potential for recovery if the fishery is effectively managed. The large reef systems in the Solomon Islands present a natural advantage for a strong recovery of sea cucumbers.

While community-based management is important, it is not working effectively enough to protect sea cucumber breeding stocks. Persistent fishing pressure has weakened community management, and poaching takes place within marine protected areas. As an export-based industry there is little that communities can do to control the buying and exporting of products, which in turn drives fishing activities. National control of the fishery through effective enforcement of the existing ban is a way forward. Once sea cucumber stocks recover, future harvesting should be based on resource surveys. In addition, harvesting strategies and product quality and price control measures should be improved. The draft National Sea Cucumber Fishery Management Plan for Solomon Islands outlines these improved measures. Finalising the plan and associated regulatory measures, and implementing it should be a priority of the Solomon Islands Ministry of Fisheries and Marine Resources.

1. Introduction

Solomon Islands is one of the largest independent Pacific Island countries, with a population of just over 500,000 people spread across nine provinces and many islands. Geographically, the Solomon Islands are within the "Coral Triangle" of the Asia-Pacific region, an area known for its high biodiversity. The rich marine environment supports a diversity of marine resources that in turn support the social and economic livelihood of Solomon Islanders. The sea cucumber fishery is the second most valuable capture-based export fishery in Solomon Islands, and is a multi-milion dollar industry. Sales of beche-de-mer provide an important source of income for coastal communities and foreign exchange for the country. However, persistent fishing pressure and ineffective management has led to the overexploitation of resources, which has placed the fishery in danger of collapse. The lack of effective management and monitoring system for sea cucumber fisheries has been the main challenge faced by the fisheries management agency (Carlton et al. 2013). Data on resources, catches and exports are not collected or evaluated in a timely manner so as to advise management actions.

The decision by the Solomon Islands government to close the sea cucumber fishery in 2005 was timely, although enforcement of the ban (to allow full recovery of resources) was difficult because of significant pressure to open the fishery. A tsunami in 2007 reduced income earnings in many communities in the western part of the country, which forced the lifting of the ban in May 2007. Although the closure was reinstated in 2009, fishing and buying activities continued in other areas of the country. The depletion of stocks in many areas of Solomon Islands is negatively impacting potential income sources of coastal communities, and is affecting the sustainability of sea cucumber fisheries in the long term.

In an effort to improve management of the fishery, a joint effort by the Secretariat of the Pacific Community (SPC) and the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR) began in 2011 to assess the state of resources and fishing activities, and propose ways forward to effectively control the sea cucumber fishery. SPC's assistance includes trainings to develop the skills of MFMR staff to better manage the sea cucumber fishery.

This report presents the results of these assessments conducted in eight provinces of Solomon Islands from August 2011 to September 2012. The first two sites assessed were part of the initial training provided by SPC with funding from the European Union through the "Scientific Support for the Management of Coastal and Oceanic Fisheries in the Pacific Islands Region" project. MFMR completed the surveys in six other provinces. The findings and recommendations of this report will assist the renewed effort to improve sea cucumber management in Solomon Islands, and provide the basis of recommendations on: 1) establishing more effective management measures; 2) improving catch and export data collection and analysis; 3) improving compliances and enforcement of regulations; 4) supporting regular resource assessments; and 5) supporting community management of sea cucumber resources.

2. Purpose and objectives

This report presents the final results of resource assessments conducted at fifteen sites to assess the status of sea cucumber stocks and the impact of existing management measures. Sea cucumber catch and export production quantities and values, and species composition were assessed to provide an understanding of fishing activities. Where necessary, available information generated from past surveys was used for temporal analysis of densities and species diversity, especially for Marau, Ngella, Rarumana and Chubikobi where the same surveys have been used.

An advisory report released in 2012 provides management recommendations that are based on the preliminary resource assessment results for Marau, Sandfly, West Guadalcanal and Russell Island. At the same time, a draft national sea cucumber fishery management plan for Solomon Islands was provided by SPC to MFMR for consultation. The management measures provided in the draft sea cucumber management plan are provided in this report as the main reference document for the plan. Specifically the report presents:

- the status of sea cucumber stocks in terms of species present, density and population structure, which are important indicators of stock health;
- baseline information on sea cucumber resources in those sites for future monitoring;
- species that are threatened or endangered from fishing activities and which need to be protect to prevent local extinctions;
- the location of stocks and their conditions, which is useful information for community management, and as a source of breeding stock for mariculture development;
- an assessment of the trend in export quality, value and species composition to compare with the resource assessment results; and
- improved management measures to be incorporated in the national sea cucumber management plan for Solomon Islands.

3. Sea cucumber resources and fisheries

3.1 Sea cucumber resources

A combination of common and Asian trade names and local names for sea cucumbers has been used in Solomon Islands. These names have appeared in fisheries records such as in the beche-de-mer export records for 2013, and in existing reports (Kinch 2004a,b; Ramofafia 2004; Kinch et al. 2008; Ramohia et al. 2010). This inconsistency and misidentification of species has affected the record of species and products within the trade in Solomon Islands. For instance, Kinch et al. (2008) reported 28 species while Ramofafia (2004) reported 32 species. An assessment of species records from existing reports and recent assessments (Table 1) serves to correct the existing misidentification of sea cucumbers in Solomon Islands. As provided in Table 1, the local common names used by fishers, processors and exporters in Solomon Islands are composed of standard local names and product processing stages, which has been the cause of confusion. The common trade names provided here are the correct common names of sea cucumbers and should be used in the future to avoid such confusion.

The number of sea cucumber species present in an area is not uniform across Solomon Islands; more species tend to be found where there are a variety of suitable habitats. Earlier resource assessments (McElroy 1973) documented 15 species in the shallow waters of Ontong Java Atoll. Assessments conducted by SPC (Friedman et al. 2009) reported 18 species (commercial and non-commercial) at Ngella (Central Province), 16 species at Marau (Guadalcanal Province), 14 species at Rarumana, and 17 species at Chubikopi (Western Province).

Solomon Islands has benefited from support provided by several non-governmental organisations such as the WorldFish Center, The Nature Conservancy, Conservation International, and Foundation of the People of the South Pacific. Resource assessments conducted by these groups in several sites found pinkfish and flowerfish to be the most common species while prickly redfish, stonefish, greenfish, white teatfish and curryfish were present in low numbers, and blue sea cucumber, surf redfish, snakefish, sandfish, chalkfish, dragonfish, dragonfish type (*Stichopus pseudohorrens*) and candycanefish were rare (Ramohia 2006). Sea cucumber densities at Marovo Lagoon were low (Kinch et al. 2006), and similar low densities — 13 individuals per hectare (ind ha^{-1}) to 18 ind ha^{-1} per sites for all species present) were recorded by SPC surveys at Rarumana, Chubikopi, Ngella and Marau (Friedman et al. 2009).

3.2 Harvesting sea cucumbers

Countries in Southeast Asia and the Pacific Islands region are traditionally the main sources of wild-caught sea cucumbers. Solomon Islands has been one of the leading sea cucumber exporting countries in the previous two decades (Kinch et al. 2008). The people of Ontong Java were first taught how to catch and process sea cucumbers into beche-de-mer by the Japanese prior to World War II. Ontong Java then became the largest producer of beche-de-mer in Solomon Islands. Traditional outrigger sailing canoes were used to reach distant fishing areas, and sea cucumbers were collected by hand and free diving. Weighted spears (bomb or torpedo) on lines or long spears were used to harvest sea cucumbers in deep water. A sea cucumber bomb or torpedo spear consists of a weighted harpoon with a monofilament line attached to it and then dropped into deep water. A long spear is a long bamboo or wooden pole with a metal barb attached at one end. Young males around the ages of 12 to 24 were considered to be the best sea cucumber divers, and were capable of free diving to depths greater than 20 meters (Gillett and Lam 1998). Figure 1 illustrates the different sea cucumber fishing techniques and the reef habitats where the methods are used. All of the methods indicated are practiced in Solomon Islands. The use of underwater breathing apparatus (UBA) to collect sea cucumber is prohibited in Solomon Islands although illegal use has been reported. The use of UBA (scuba and hookah) was reported to be widespread in 2004 (Ramofafia 2004).

Table 1. Sea cucumbers present in Solomon Islands and the various local names used.

Common trade name	Abbreviation	Solomon Islands local names	Species name
Amberfish	AF	Amberfish	*Thelenota anax*
Black teatfish	BTF	Blackteatfish (l), blackteatfish (sm)	*Holothuria whitmaei*[1]
Blue sea cucumber	BSC	n/a	*Actinopyga caerulea*
Brown curryfish	BCF	Brown curryfish	*Stichopus vastus*
Brown sandfish	BSF	Brown sand four fish (l), brown sand four fish (sm), brown sandfish (a), brown sandfish (b)	*Bohadschia vitiensis*
Candycanefish	CCF	Lemonfish, orangefish, rainbowfish	*Thelenota rubralineata*
Chalkfish	CHF	Chalkfish, chalkfish processed	*Bohadschia marmorata*[2]
Curryfish	CF	Curryfish, yellowfish	*Stichopus herrmanni*
Deepwater blackfish	DWBF	Deepwater blackfish	*Actinopyga palauensis*
Deepwater redfish	DWRF	Deepwater redfish	*Actinopyga echinites*
Dragonfish	DF	Peanutfish	*Stichopus horrens*
Dragonfish	DF	Peanutfish	*Stichopus pseudohorrens*
Elephant trunkfish	ETF	Elephant trunkfish	*Holothuria fuscopunctata*
Flowerfish	FF	Flowerfish, ripplefish	*Pearsonothuria graeffei*
Golden sandfish	GSF	Golden sandfish	*Holothuria lessoni*[3]
Greenfish	GF	Greenfish, green surf redfish	*Stichopus chloronotus*
Grey snakefish	GSNF	Hong pay fish, house pig, hongpai fish, tulele	*Holothuria* sp.
Hairy blackfish	HBF	Blackfish, hairy lollyfish, stonefishblack	*Actinopyga miliaris*
Kingfish	KF	n/a	*Synapta maculata*
Lollyfish	LF	Lollyfish (l), lollyfish (sm), deepwater lollyfish, mohe	*Holothuria atra*
Peanutfish	PNF	Peanutfish (l), peanutfish (sm)	*Stichopus monotuberculatus*
Pinkfish	PF	Pinkfish, red lollyfish, lollyfish red	*Holothuria edulis*
Prickly redfish	PRF	Prickly redfish (l), prickly redfish (sm), pricklyfish, pineapplefish	*Thelenota ananas*
Red snakefish	RSF	Red snakefish, snakefish red	*Holothuria flavomaculata*
Sandfish	SF	Sandfish (l), sandfish (sm)	*Holothuria scabra*
Snakefish	SNF	Snakefish	*Holothuria coluber*
Stonefish	STF	Stonefish (l), stonefish (sm)	*Actinopyga lecanora*
Surf redfish	SRF	Surf redfish (l), surf redfish (sm)	*Actinopyga mauritiana*
Tiger tail	TTF	Tiger tail	*Holothuria hilla*
White snakefish	WSNF	White snakefish, white snake	*Holothuria leucospilota*
White teatfish	WTF	White teatfish (a), white teatfish (b), white teatfish (c), white teatfish (d)	*Holothuria fuscogilva*

[1] *Holothuria whitmaei* was previously *Holothuria nobilis*.
[2] *Bohadschia marmorata* was previously *Bohadschia similis*.
[3] *Holothuria lessoni* was previously *Holothuria scabra versicolor*.
n/a = Solomon Islands local name not available.
l = large, sm = small, a = a grade, b = b grade, c = c grade and d = d grade.
Note: The use of the common trade names is encouraged because some of the Solomon Islands local names are confusing.

Gillett and Lam (1998) report that in Ontong Java, five sea cucumber divers died from diving-related accidents between 1996 and 1998. In 2009, a group of 13 sea cucumber bomb and/or torpedo free divers disappeared at Ramos Reef in Malaita Province (Peter Ramohia, University of the South Pacific, Solomon Islands Center, pers. comm. 2011). Increasing incidences of diving-related deaths in the late 1990s forced fishers on Ontong Java to develop non-diving methods such as trawling in deep water (Gillett and Lam 1998). Trawl gear is locally made from steel-reinforced bars and old discarded purse-seine nets. Weights attached to the sides of the bars help stabilise the gear as it is dragged along the sea bottom (Fig. 2). As the trawl net is dragged along the sea bed, sea cucumbers and other sedentary invertebrates are scooped from the sea floor in the same way a mechanical trawler does (Ramofafia 2004). Fishers in their middle ages who no long dive to great depths use trawl equipment for harvesting sea cucumbers (Gillett and Lam 1998). In shallow water areas, reef gleaning by wading and snorkelling is practiced mostly by women and families.

Figure 1. Common sea cucumber fishing methods: gleaning in shallow areas; snorkelling with the aid of canoes or boats; and using fishing equipment such as torch, sea cucumber bombs, long spears, and underwater breathing apparatus (Illustration by Youngmi Choi, SPC).

Figure 2. Sea cucumber trawl net ready to be dropped (top left), trawling underway (top right), and retrieval of sea cucumbers (bottom pictures) at Ontong Java Atoll, Solomon Islands (Photos: Peter Ramohia and James Teri 2010).

3.3 Processing and exporting beche-de-mer

Processing sea cucumbers into beche-de-mer involves gutting, boiling and drying, and is done by fishers, middlemen and also exporters. Dedicated sea cucumber processors process all their catch to a fully dried stage. Processing campsites are often set up near fishing grounds, sometimes on uninhabited islands where families can be based for some time to complete the processing of beche-de-mer products, as on Ontong Java (Crean 1977) and in Isabel Province (Kinch 2004b). In recent times, agents (i.e. middlemen) in rural areas prefer to purchase unprocessed sea cucumbers from fishers and process these themselves to a final stage. Middlemen buyers and processors are agents of the main export companies. The link between processors and middlemen has ensured production of good quality products as opposed to products processed by fishers themselves.

On Ontong Java, sea cucumber processors operate small retail outlets that provide credit to sea cucumber fishers so that they can purchase basic necessities; cost is recovered from the value of the next sea cucumber catch. These arrangements lock the fisher and the processor together into a continuous cycle of fishing to pay off the credit. Dried products are packed in copra sacks and sold to agents or shipped to an exporter based in Honiara. Well processed beche-de-mer has a relatively long storage life and the product may be stockpiled before being sold or exported. In areas near to the main commercial centres of Honiara, Gizo, Munda and Auki, fresh or partly processed products are sold directly to processing and exporting companies. The network of fishers, buyers, processors and exporters can be complex and making it difficult to trace products to the fishing ground. An analysis of the trend in the number of export licenses and historical trend in the export of beche-de-mer from Solomon Islands is further examined in section 4.1.

3.4 Socioeconomics of sea cucumber fisheries

Sea cucumber fisheries are important to fishing communities in Solomon Islands, and in some cases, the major source of income (Ramofafia 2004). Sea cucumbers are not featured strongly in the diet of Solomon Islanders, although some communities in North Malaita are known to consume sandfish (*Holothuria scabra*) (Simon Foale, James Cook University, pers. comm. to Kinch et al. 2008). In addition, several species of sea cucumber — prickly redfish, white snakefish, tigerfish, and tiger tail — are collected and exported as ornamentals in the aquarium trade (Kinch 2004a); the main production, however, is for the beche-de-mer trade. In areas where income sources are limited, the sea cucumber fishery directly affects the sociological and economic well-being of communities, and this is evident in the community of Ontong Java Atoll.

According to the 1999 census, 12% of the coastal households surveyed sold beche-de-mer, and close to 6,000 households were involved in harvesting and selling sea cucumbers (Kinch et al. 2008). The sea cucumber fishery is more important in the smaller island groups of Ontong Java, the Reef Islands and Temotu, and especially in the Western Province. The number of people fishing for sea cucumbers is believed to have increased greatly after the 1999 census as ethnic tension closed down national systems for exporting copra and cocoa, leaving many rural communities with no other source of income. In the Rennell and Belona islands, where cyclones have at times destroyed coconut plantations, beche-de-mer remains the main source of cash, while at Ontong Java, beche-de-mer has been the main source of income for decades (Gillett and Lam 1998). The majority of people on Ontong Java indicated sea cucumber fishing was a positive event in the community, and the ban on the sea cucumber fishery and flooding caused by king tides, as the worst events for the community (Hilly et al. 2010). The same study found that 79–100% of respondents indicated sea cucumber harvesting as the main source of income during the ban, and 25–40% indicated the importance of sea cucumber harvesting during the ban (Hilly et al. 2010). The harvesting of sea cucumber at Ontong Java continued during the national ban, simply because there were no other comparable income-earning opportunities available to the community.

In 1999, a quarter of all households in Marovo Lagoon obtained cash from the harvesting of sea cucumbers (Donnelly 2001). Another assessment in 2004 by the International Waters Project, determined that 63% of household income at Mbili Passage and 27% percent of household income for Chea community came from the sale of beche-de-mer (Kinch 2004b). The community of Kia also relies heavily on the beche-de-mer fishery for income (Ramofafia et al. 2007). Heavy fishing pressure on sea cucumbers in the Solomon Islands has resulted in a downward shift in species composition in harvests, and decreasing catch rates over the last decade. Levels of personal debt among sea cucumber fishers (and others), even in remote village communities, are quite high, mainly to local business entrepreneurs. Because of the heavy reliance on sea cucumber harvesting, the ban enforced in 2005 caused economic hardship for many fishers who were unable to service debts made from sea cucumber income (Nash and Ramofafia 2006). In Isabel Province, parents found it difficult to pay for school fees, particularly for those children studying at the secondary level. Some students were temporarily removed from schools until their school fees were paid up.

The beche-de-mer trade is a lucrative business; prices have increased over the years yet there has been little effort to improve earnings to fishers from fishery. In Solomon Islands, beche-de-mer prices have increased 18 fold, on average, between 1991 and 2004. This increase in the economic value of beche-de-mer has made this product more lucrative than in the past. Further assessment of the trend in export values of the fishery is provided in Section 5.1.

3.5 Past resource surveys

Several resource assessment surveys have been used in the Solomon Islands to either assess the potential of the sea cucumber fishery or to assess the status of fished stocks. Species diversity and abundances are affected by habitat type and quality but this is often not captured in assessment surveys. The use of different sample area sizes affects the outcome of stock abundance estimates, and the lack of habitat knowledge contributes to limited understanding of species diversity. Resource assessment surveys for sea cucumbers conducted in 2006 (Ramohia et al. 2006), 2009 (WorldFish 2009), and 2010 (Ramohia et al. 2010) used 100 m x 8 m transects for shallow water surveys and 400 m x 20 m transects for deepwater timed searches. The width of each transect is determined by the number of surveyors per station at in a 2 m width; the total species observed were the main data recorded. Size data were not consistently collected to assess recruitment condition. Data were entered and analysed using an Excel spreadsheet, and no database system was in place for managing the data. The invertebrate resources surveys promoted by SPC in Marau, Sandfly, Chubikobi and Rarumana introduced improved sampling methods (Friedman et al. 2009), and recommended manta tow and reef benthos transects for assessing invertebrates and sea cucumbers. However, uptake of these improved methods has been slow since the assessments in Solomon Islands in 2007. Consistent use of the same sampling methods, improved resource data collection and understanding of resource status has been problematic in Solomon Islands prior to the present assessment.

3.6 Management measures

Previously, fisheries management in Solomon Islands was reactive rather than proactive, and usually addressing a problem after it had arisen (Purcell 2010). Despite the sea cucumber fishery showing signs of overfishing, little effort has been made to address these warning signs, nor to proactively investigate alternative means of providing communities with a source of income (Kinch et al. 2008). The ban on fishing for sandfish (*Holothuria scabra*) was introduced in 1998, but despite its importance in protecting this high-value species, the regulation was repealed in 2000.

The sea cucumber fishery (and the export of beche-de-mer) was closed in December 2005 to allow stocks to recover. A tsunami in April 2007 dramatically reduced the income of communities in the western part of the country, and as a result, the sea cucumber ban was lifted in May 2007. In 2007, an interim management plan for the fishery was developed, stating that the fishery would stay open until December 2007, after which it would be reviewed and operated under a more permanent set of management arrangements. Harvesting activities spread to other provinces over the next year and a half. The ban was reinstated in April 2009, although effective enforcement has been a challenge for MFMR. Fishing for and buying, stockpiling and exporting sea cucumbers has occurred since the ban, and some of these infringements have been prosecuted. Inadequate fishery monitoring systems and the lack of regulatory measures has hindered efforts to manage the situation. The interim sea cucumber management plan has been progressed beyond a draft stage since then. As in other Pacific Islands sea cucumber fisheries, a lack of a management plan in Solomon Islands has hindered efforts to formulate regulations such as minimum harvest size limits for sea cucumbers.

Locally based management is actively practiced in Solomon Islands to manage reef resources, including sea cucumbers. Previously, Ontong Java elders and local authorities have managed sea cucumber and trochus fisheries through a system of alternative species harvest periods. Fishing for beche-de-mer is closed for one-year, and during the closure, trochus are harvested. However, an Ontong Java sea cucumber fisher reports that in recent times Ontong Java's population and its need for income have grown significantly (Cosmo Kauolisi, former Ontong Java sea cucumber fisher, pers. comm. 2013). As a consequence, there is pressure to keep the beche-de-mer and trochus fisheries open; coupled with this, is the growing disregard and lack of respect of elders and local authority management systems.

4. Method of assessments

4.1 Fisheries data collection

Sea cucumber fisheries data includes annual beche-de-mer export quantity, export prices and sea cucumber catch by area and buying price from Solomon Islands. Beche-de-mer export information is sourced from the literature (Kinch et al. 2008; Kinch 2004a), and is based on information provided by MFMR. Recent beche-de-mer exports for the 2013 open fishing season were provided by MFMR, and come from export permit forms submitted by exporters. Catch data are not available for many areas in Solomon Islands, except for information collected for some areas in Isabel and New Georgia provinces (Kinch 2004b) and Ontong Java (Hilly et al. 2010; MFMR 2010; Ramohia et al. 2010). Analyses of the fishery information follow the procedures for assessing fishery indicators, which are found in the Sea Cucumber Fisheries Managers Toolbox (Friedman et al. 2008).

4.2 Resource survey methods

Underwater sea cucumber surveys began with a training conducted by SPC at Marau in Guadalcanal and at Sandfly in Ngella Islands in August and September 2011. MFMR continued with the surveys of two sites per province in the eight provinces of Solomon Islands under the "Mekem Strong Solomon Islands Fisheries" project funded by the New Zealand Aid Programme. The surveys are based on maximum coverage within the allocated time and resources available for each site. Data from these past studies (Friedman et al. 2008) were used to assess temporal comparability of species presence and densities. Two invertebrate resources survey protocols were adopted: the broad-scale assessment using manta tow (Fig. 3), and the fine-scale survey using shallow water transects to collected information on sizes and aggregations of species in intertidal zones (Fig. 3).

Manta tow: Manta tow stations were conducted over the back reef, shallow lagoon and lagoon slopes where coral, hard bottom and sand substrates predominate. These areas are representative of habitats suitable for tigerfish, black teatfish, prickly redfish and brown sandfish. Manta surveys were conducted in depths of 1–10 m, depending on visibility, but mostly around 1.5–4.0 m. Manta tow surveys could not be conducted in areas that were too shallow for an outboard powered boat (< 1 m), murky waters where visibility is poor, adjacent to wave-impacted reefs (e.g. reef tops) and the outer reef fronts where it is often unsafe for slow-moving boats. Manta tow transects were 300 m long and 2 m wide, covering an area of 600 m^2 per transect or 3,600 m^2 per station. Details of this survey method are found in Friedman et al. (2009) and in an invertebrate resource survey manual currently being produced by SPC (2014).

Reef benthos and soft benthos transects: Reef benthos and soft benthos transects use the same methodology but are differentiated from one another by their respective habitat types. Reef benthos transects were conducted over hard bottom habitats where lollyfish, greenfish and surf redfish aggregate. Soft benthos transects were conducted over soft bottom seagrass and seaweed beds, where hairy blackfish, chalkfish, dragonfish, golden sandfish, brown sandfish, red snakefish and sandfish are commonly found. Both methods are conducted in shallow water (0–3 m) by snorkelling or wading at low tide at intertidal zones including back reefs, reef flats, and seagrass beds. Six 40 m by 1 m wide transects were examined per station by two observers snorkelling on either side of the transect line and recording benthic invertebrates within each transect.

Figure 3. Two methods are used for sea cucumber surveys in Solomon Islands: manta tow survey (A) and reef transect survey (B).

4.3 Data analysis and reporting

The underwater resource data for Marau and Sandfly were entered into the Reef Fisheries Integrated Database (RFID) in Noumea during an attachment training attended by two MFMR officers in March 2012. The database has been installed at MFMR but has not been fully utilised. Data collected by MFMR for the remaining 12 sites were submitted to SPC and entered into RFID by officers from SPC's Coastal Fisheries Science and Management Section. After data entry and checking are completed, the summaries of species presence by sites, species densities, mean sizes and species size frequencies were extracted from the database queries and organised into presentable forms in graphs and summary tables. Beche-de-mer export information was presented into a bar chart of historical exports to assess export trends in quantity and value as presented in Section 3.3. The catch quantity, composition and value for Isabel and Ontong Java have been analysed and presented to indicate changes in the fishery that is impacting the livelihood of these two communities. A preliminary result of the first assessments was used to prepare an advisory report and submitted to MFMR as an output of the attachment raining attended by two MFMR officers in March 2012.

4.4 Community and general public views

Meetings were held with tribal leaders of Marau and the Resource Owners Association of the Sandfly area in Ngella, in September 2011. Additional information was gathered by talking to fishers during fieldwork and from the training participants based on their experiences. In Honiara, a consultation meeting was held at MFMR and was attended by officers from MFMR's Research, Extension, Enforcement and Licensing Sections. At the meeting, the preliminary results of the surveys and the status of sea cucumber management in the Pacific were presented, and this generated discussion.

5. Results

5.1 Fisheries and export production trend

5.1.1 Local production of sea cucumber

National census data for 1999 indicate that sea cucumber fishing is ranked the second most important fishing activity after finfish fishing in eight of the nine provinces of Solomon Islands. A large percentage of the households (> 30%) targeting sea cucumber fishing were in the Central, Choiseul, Isabel, Temotu and Western provinces. However, catch data for many provinces are not available. The combined sea cucumber and trochus shell production for Isabel Province for the years 1991–2004 (Kinch 2004b) was used to assess potential economic return to the community (Fig. 4). In Isabel Province, sea cucumber and trochus were important fisheries commodities, estimated to contribute SBD 125,000 for 1991–1995 and SBD 155,000 in 2001 in annual income flow to the local community.

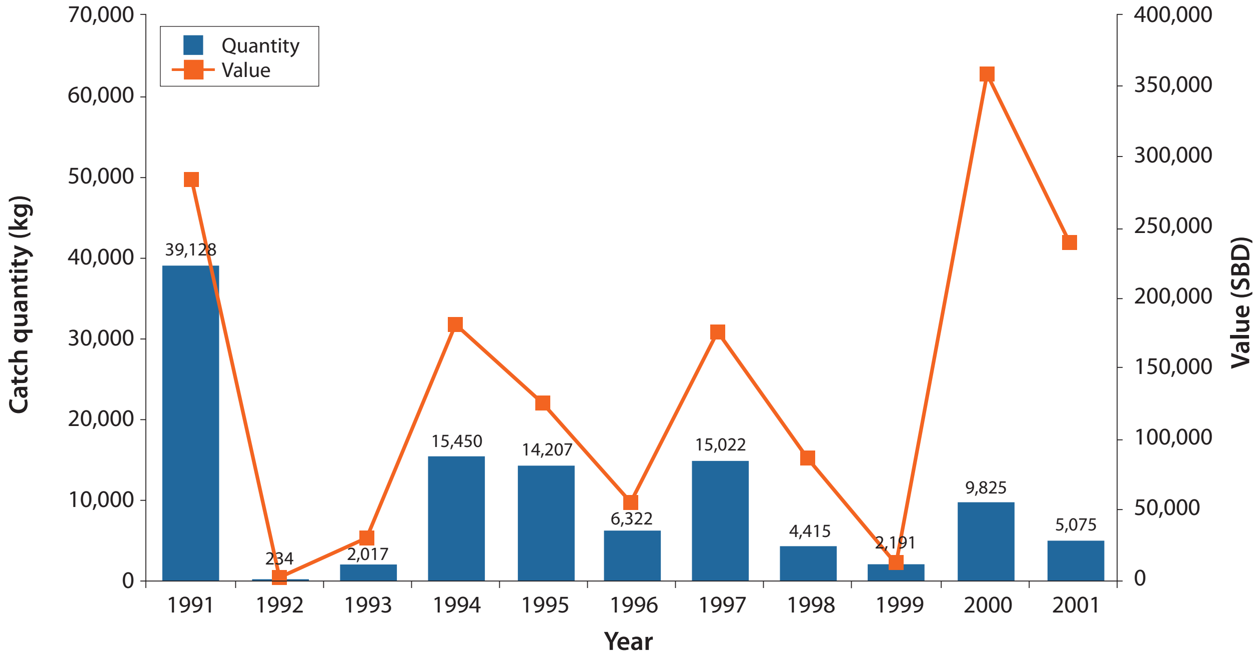

Figure 4. Sea cucumber production in Isabel Province, 1991–2001.
Reproduced from Kinch (2004) with permission.

Catch sampling conducted by the MFMR team in 2010 at Ontong Java Atoll (Hilly 2010) provided useful indication of catch composition and income flow to the community (Fig. 5). Analysis of catch information collected during this visit revealed a quantity of 2,809 kg of beche-de-mer valued at over SBD 530,000, based on product prices provided by a local processor on the island. Golden sandfish, brown sandfish, curryfish and white teatfish comprised the bulk of the production value (82%), and golden sandfish comprised 37% of the total catch value. These are mid- to deepwater species that are harvested using bombs and a trawl, which are used in Ontong Java's lagoon. Golden sandfish has been misidentified as chalkfish, but it is a superior type of chalkfish that is worth much more. Closer examination of photos of trawl catches revealed the species to be golden sandfish (*Holothuria lessoni*).

5.1.2 Export operators and licenses

The number of licenses issued for exporting beche-de-mer is not available during the period 2007–2009. Based on the available data, the number of export companies in Solomon Islands increased in the period

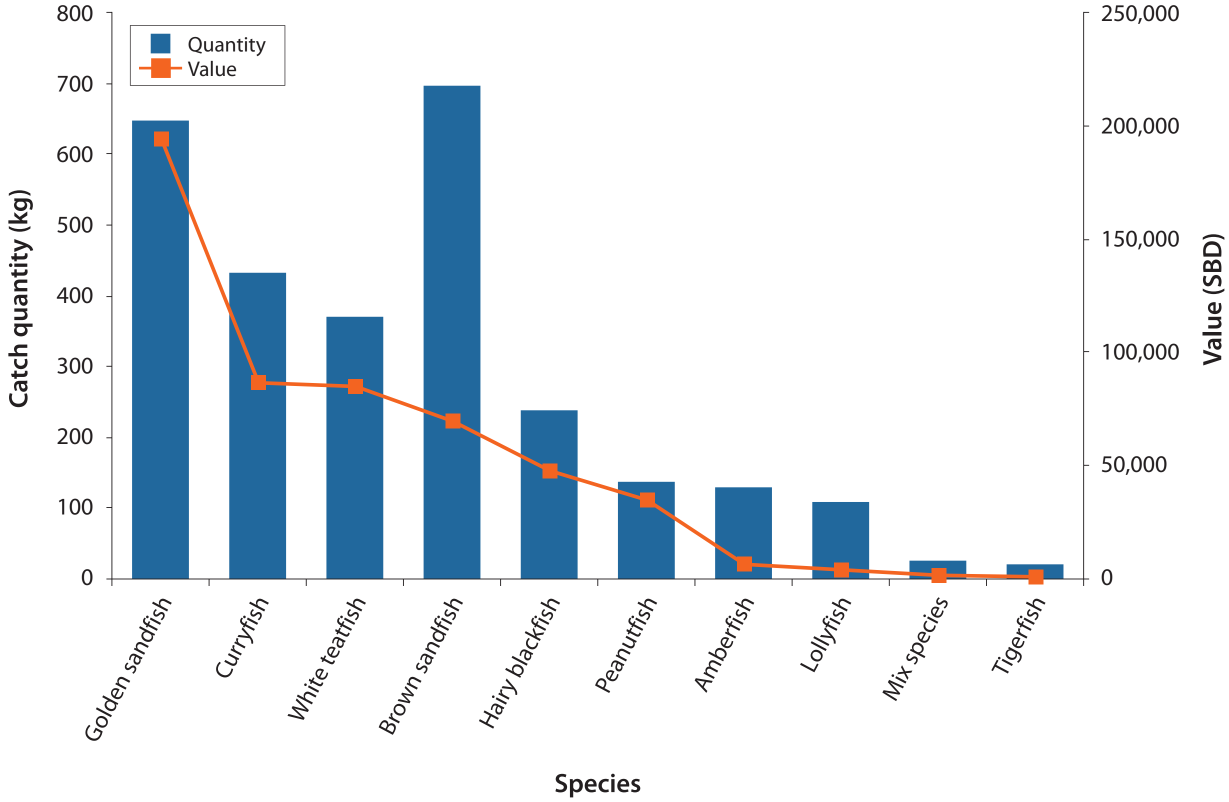

Figure 5. Beche-de-mer catch values for Ontong Java, 2010.
Source: Solomon Islands Ministry of Fisheries and Marine Resources.

2002–2004 and in 2013 (Fig. 6). Fluctuations in the number of export companies was noted in 2004 (Ramofafia 2004) as a result of the non-renewal of licenses by some exporters due to competition and the dwindling supply of product. Total income received from license fees alone in the 2013 open season was close to SBD 2 million[1]. During this open season, 6 of the 18 companies licensed did not export beche-de-mer. As is common in other Pacific Island countries, middlemen buyers and processors are not licensed, and these operators act as agents for a main licensed exporter based in the capital (Honiara). Although export figures were available for the years 2005 to 2012, no information was provided on the number of export operators, which highlights an existing information gap.

5.1.3 Export quantity and value

Beche-de-mer is an old commodity in the Solomon Islands, dating back to 1844 (Ward 1972). Exports in the early days were transhipped through Australia where products from the Pacific Islands region and Australia were consolidated for re-export to Asian markets. Average annual beche-de-mer exports from Solomon Islands for three years from the late 1870s to early 1880s were around 90 tonnes (Bennett 1987). Since then there has been little information on beche-de-mer trading activities until after 1966 when beche-de-mer trading re-emerged (Sachithananthan 1971a,b).

Prior to 1986, beche-de-mer exports from Solomon Islands averaged around 21 tonnes per year (Kinch 2004a). Exports increased dramatically in later years, with peak exports of 622 tonnes in 1991 and 715 tonnes in 1992 (Fig. 7). This marked the peak of the fishery's boom period. Exports gradually declined until the end of 2005 when the fishery was closed to allow stocks to recover. Beche-de-mer exports for the period 2005–2013 was marked by fluctuations in production, which reflected the opening of the fishery in 2007 to April 2009 and the unauthorised fishing and exporting activities that went on after the ban was reinstated (Fig. 7).

[1] SBD 1.00 = USD 0.14

The species targeted in the past included white teatfish, black teatfish, hairy blackfish, prickly redfish and deepwater redfish. The number of targeted species increased from 15 in 1988 to 18 in 1991 (Adams et al. 1992; Holland 1994 a and b). By 2008, most sea cucumber species were harvested commercially (Kinch et al. 2008). The record of 29 commercial species exploited in the Solomon Islands (Ramofafia 2004) includes some species that were identified by various common trade names used in the Solomon Islands. In 1999, the high-value white teatfish contributed 50% of exports from Solomon Islands but dropped to 2% in 2002. In comparison, the low-value lollyfish made up 22% of exports in 2000, which increased to 60% in 2003 (Ramofafia 2004). In 2004, several exporters did not renew their trading licenses due to dwindling catches, and a moratorium was placed by the Solomon Islands government on harvesting and exports in December 2005 (Nash and Ramofafia 2006).

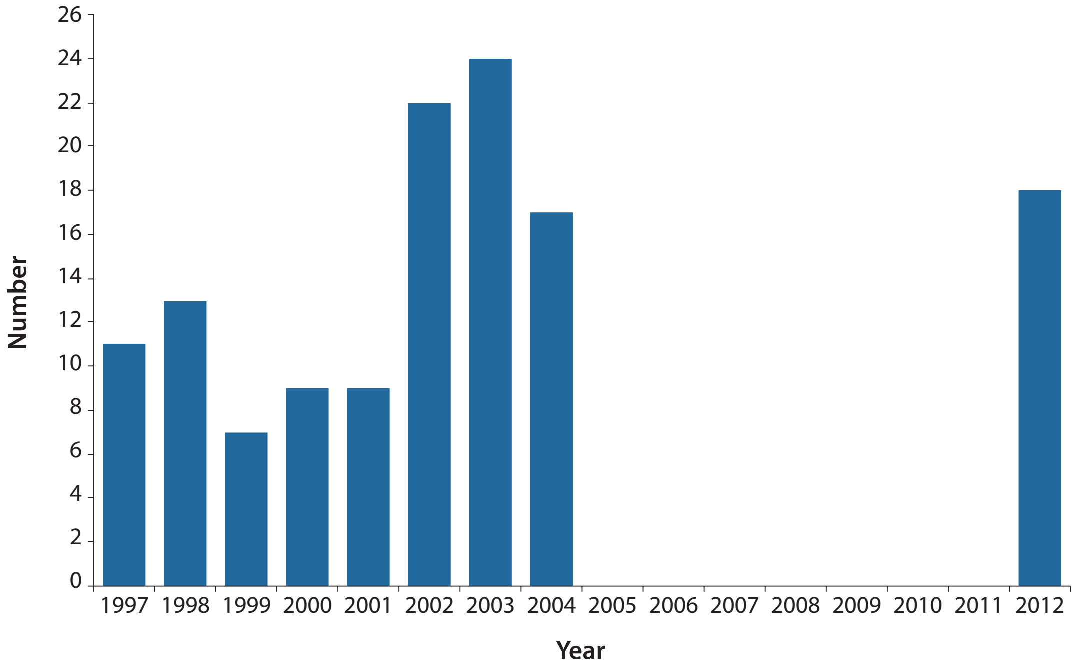

Figure 6. Licensed sea cucumber export companies in Solomon Islands (1997–2004: Ramofafia 2004; 2013: MFMR). No export company records are available for the years 2005–2012.

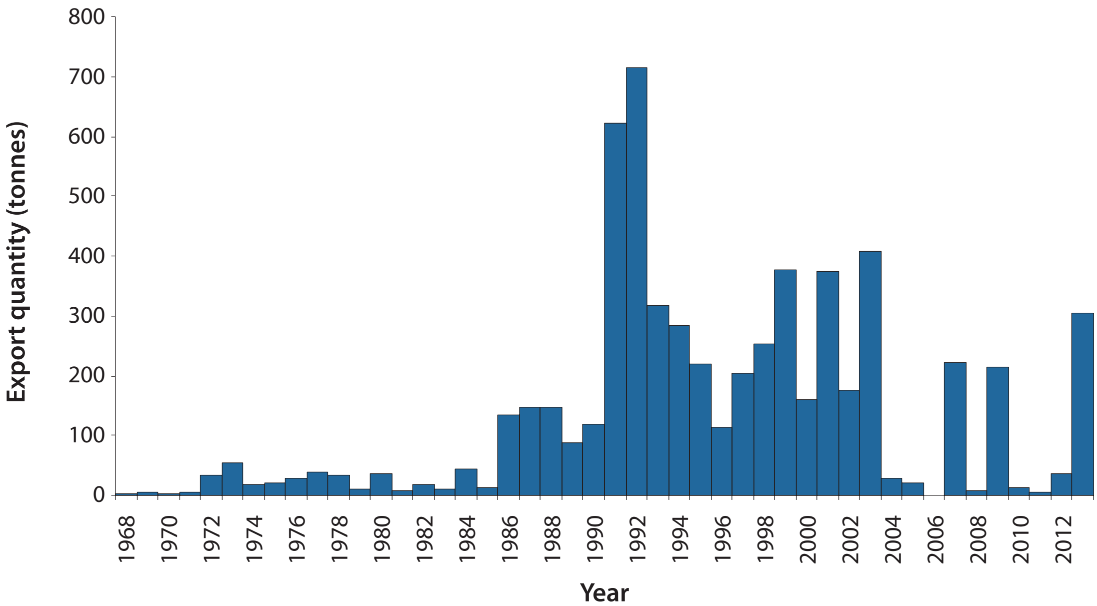

Figure 7. Solomon Islands beche-de-mer export quantities.
Source: Solomon Islands Ministry of Fisheries and Marine Resources, Kinch 2004b, and Carleton et al. 2013.

Total export value of beche-de-mer is one of the least accurate pieces of information on sea cucumber fisheries in the Pacific Islands. The exported value of beche-de-mer is a closely guarded secret of Chinese exporters who dominate beche-de-mer exporting activities in the Pacific Islands. Most often the declared value in the export permits and export information recorded by Customs and Statistics Officers are often underpriced and not consistent. The export value information provided here is based on data available from literature, which are based on export data provided by MFMR. As indicated (Fig. 8), export values were not available for the years 1968–1964, and for the period 2004–2012 export values were only available for 2008.

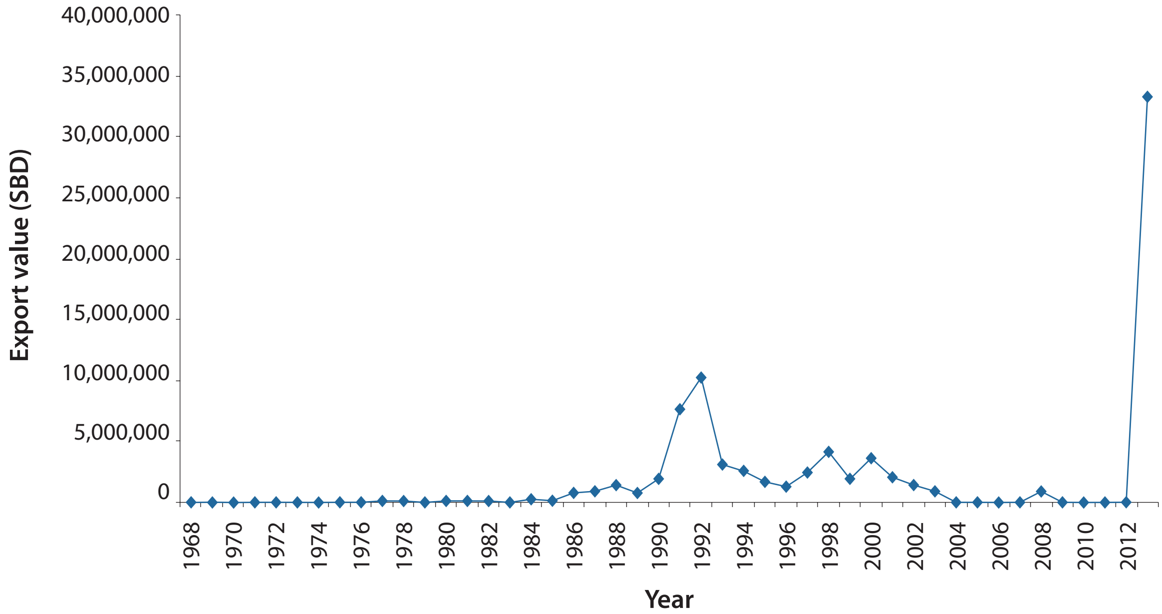

Figure 8. Solomon Islands beche-de-mer export value.
Source: Solomon Islands Ministry of Fisheries and Marine Resources, Kinch 2004b, Ramofafia 2004, and Carleton et al. 2013.

In total, 305 t of beche-de-mer were exported from Solomon Islands in 2013 at a total export value of SBD 33 million. Of the 23 species traded in 2013, the low-value products (e.g. brown sandfish and lollyfish) comprised the bulk of the exports at 37% of total export quantity, and 21% of the total export value. However, the very high-value group (white teatfish, golden sandfish, black teatfish and sandfish) comprised 9% of total export production quantity and 25% of the total export value (Fig. 9). The open season in 2013 lasted four months, although beche-de-mer were stockpiled by some traders and exported during the short open season. Caution should be taken when interpreting these figures due to ongoing product identification issues for sea cucumbers in Solomon Islands. As an example, the value of dragonfish (locally known as peanutfish) is unusually high, and future analyses should pay attention to proper product identification.

A feature of sea cucumber fisheries in the Pacific Islands is the large difference in prices for the processed product. Prices vary according to geographical location, by product processing stages, species, and by different buyers. Price variations were noted in 2004 for Isabel Province and Honiara (Kinch 2004b), the Western Province in 2009, and Ontong Java in 2010 (Hilly et al. 2010). The shortage of beche-de-mer is resulting in rising prices and in the grading of products by size, weight and appearance. In addition, species that were considered to be of low and medium value in the past have experienced a rise in prices in recent times. For example, white teatfish was marketed in four product grades in recent times with prices from SBD 70 kg^{-1} for D-grade product, SBD 120 kg^{-1} for C-grade, SBD 250 kg^{-1} for B-grade, and SBD 300 kg^{-1} for A-grade (MFMR 2010).

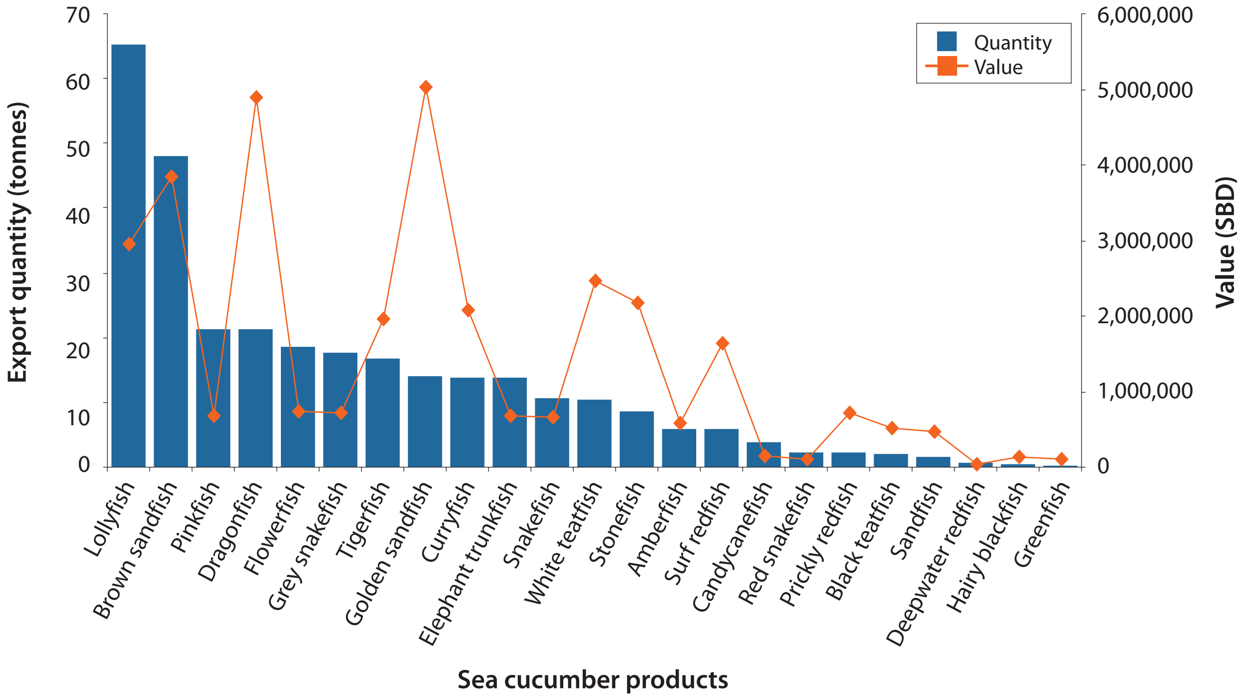

Figure 9. Beche-de-mer export quantity and value composition from Solomon Islands for 2013.

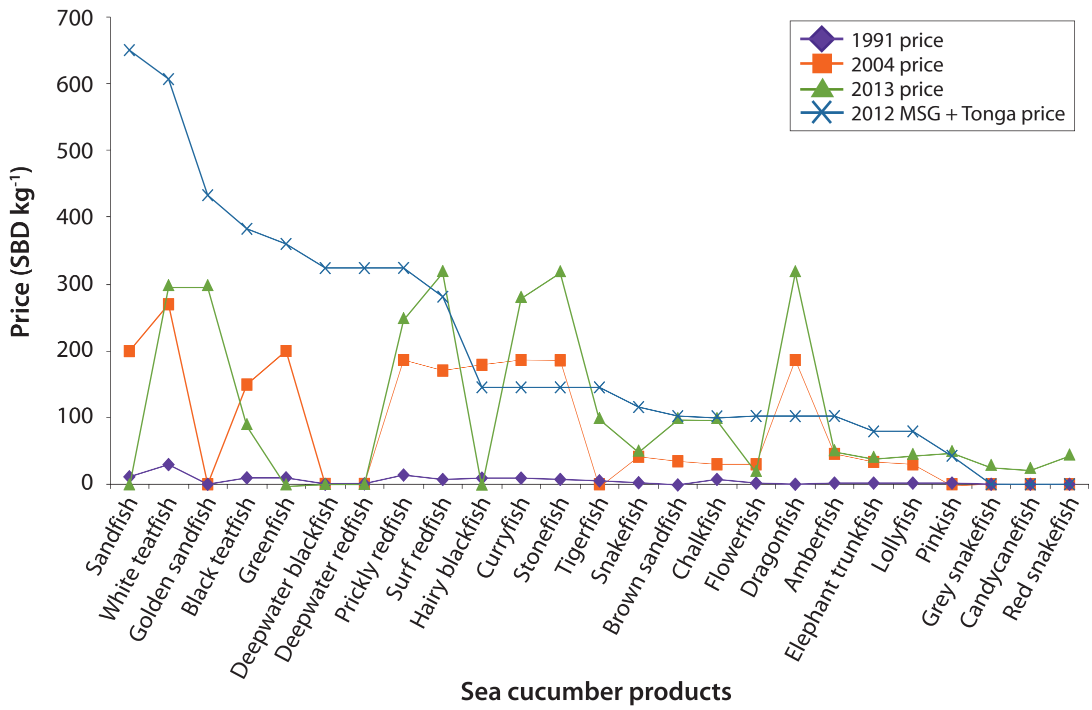

Figure 10. Beche-de-mer prices in Solomon Islands and mean prices for MSG + Tonga.

Figure 10 shows a comparison of sea cucumber prices in Solomon Islands for 1991, 2004 and 2013 with average prices for Melanesia Spearhead Group (MSG) countries (Fiji, Papua New Guinea, Solomon Islands, Vanuatu) plus Tonga (or referred to as MSG + Tonga) for 2012. A recent economic assessment of sea cucumber fisheries in Fiji, Papua New Guinea, Solomon Islands, Vanuatu and Tonga[2] provides purchase price estimates for high quality (A-grade) beche-de-mer (Carleton 2013). The 2004 prices for Honiara are from Kinch 2004; 1991 prices are from Adams et al. (1992); and beche-de-mer export prices for 2013 were provided by MFMR. As noted in Figure 9, prices for very high-value species (i.e. sandfish, golden sandfish, white teatfish and black teatfish) were lower than the MSG + Tonga mean prices during 2012. The prices that fishers received in Solomon Islands for 36% of the species (9 products) were higher than the MSG + Tonga prices, with curryfish, stonefish, chalkfish and peanutfish experiencing high prices (i.e. SBD 136–219 kg^{-1}). This is indicative of a shift in the value category as the supply of high-value products drops along with the overall drop in production of all products as a result of resource overexploitation in the fishery.

5.2 Unauthorised fishing activities

It has been a challenge for MFMR to effectively control the ban on sea cucumber exports since the ban was re-instated in April 2009. Some traders continue to buy sea cucumber and beche-de-mer products, and fishers continue to collect and sell their produce. This was confirmed by community leaders at Marau and by members of the Resource Owners Association at the Sandfly area at Ngella Island in October 2011. According to the leaders of these communities, it is beyond their control to stop their own people from fishing sea cucumbers because of the rising need for an income and lack of other opportunities available for their people. Instead, they blame the buyers and exporters for continuing to buy sea cucumbers, which encourages people to likewise continue fishing and selling. MFMR's Enforcement Section has seized quantities of beche-de-mer stockpiled by a middlemen and an export company in Honiara (Solomon Times 2010; Hilly et al. 2010). Bags of stockpiled beche-de-mer have been seized by the MFMR enforcement team (Fig. 11) but this has not deterred other traders from continuing to buy and stockpile beche-de-mer. One of the challenges faced by MFMR's Enforcement Section is the slow process of prosecuting existing cases and the involvement of some higher level leaders in the business that has made it difficult for MFMR to take infringement cases to court. In 2013, a four months open season was declared in order to facilitate the exporting of beche-de-mer that were illegally harvested and stockpiled by some exporters. The situation has made it extremely difficult to combat the illegal trade of beche-de-mer in Solomon Islands.

Figure 11. Illegally harvested beche-de-mer seized by MFMR enforcement officials in 2011.

[2] Throughout the report this is abbreviated to MSG + Tonga.

5.3 Resource survey results

5.3.1 Survey coverage

In total, fifteen sites were assessed across eight provinces of Solomon Islands at 2 sites per province between August 2011 and September 2012 (Fig. 12). In total, 458 survey stations were completed, covering 67 hectares (ha) of reef and lagoon habitats. These sites include marine protected areas as in Marau, West Guadalcanal, Russel and Sandfly, while the rest of the sites cover non-marine protected areas. The majority of stations (291 stations) were surveyed using fine-scale benthos transects (reef benthos and soft benthos), covering an area of 6.7 ha. Manta tow surveys covered 90% (167 ha) of the total survey area covered by both survey methods. It was not possible to maintain a fixed sampling coverage (12 manta tow and 20 reefs transect stations per site) based on the timing of surveys per sites and resources made available for each site. The sites were spread from west to east across the country and targeted the main sea cucumber areas that are inaccessible to transportation links. The number of sampled stations and the survey coverage areas are presented in Table 2.

Table 2. Sea cucumber survey sites assessed by province and survey coverage area, Solomon Islands 2011–2012.

Province	Site	Number of stations and area (ha)			
		Manta	Area (ha)	RBt / SBt	Area (ha)
Choiseul	Tapazaka	6	2.2	8	0.2
Choiseul	Taro	11	4.0	13	0.3
Western	Rarumana (New Georgia Is.)	12	4.3	20	0.5
Western	Chubikobi (New Georgia Is.)	14	5.0	14	0.3
Isabel	Kia	20	7.2	29	0.7
Isabel	Tatamba	6	2.2	18	0.4
Central	Sandfly MPA (Ngella Is.)	3	1.1	6	0.1
Central	Sandfly non-MPA (Ngella Is.)	13	4.7	30	0.7
Central	Russell Is.	13	4.7	29	0.7
Guadalcanal	Marau MPA	5	1.8	8	0.2
Guadalcanal	Marau non-MPA	19	6.8	35	0.8
Guadalcanal	W. Guadalcanal MPA	2	0.7	5	0.1
Guadalcanal	W. Guadalcanal non-MPA	7	2.5	17	0.4
Malaita	Central Malaita	-	-	12	0.3
Makira	Star Harbour	6	2.2	10	0.2
Makira	Ugi	6	2.2	5	0.1
Temotu	Reef Islands	16	5.8	26	0.6
Temotu	Santa Cruz	8	2.9	6	0.1
Total		**167**	**60.3**	**291**	**6.7**

W. Guadalcanal = Western Guadalcanal; MPA = marine protected area; RBt = reef benthos transect; SBt = soft benthos transect.

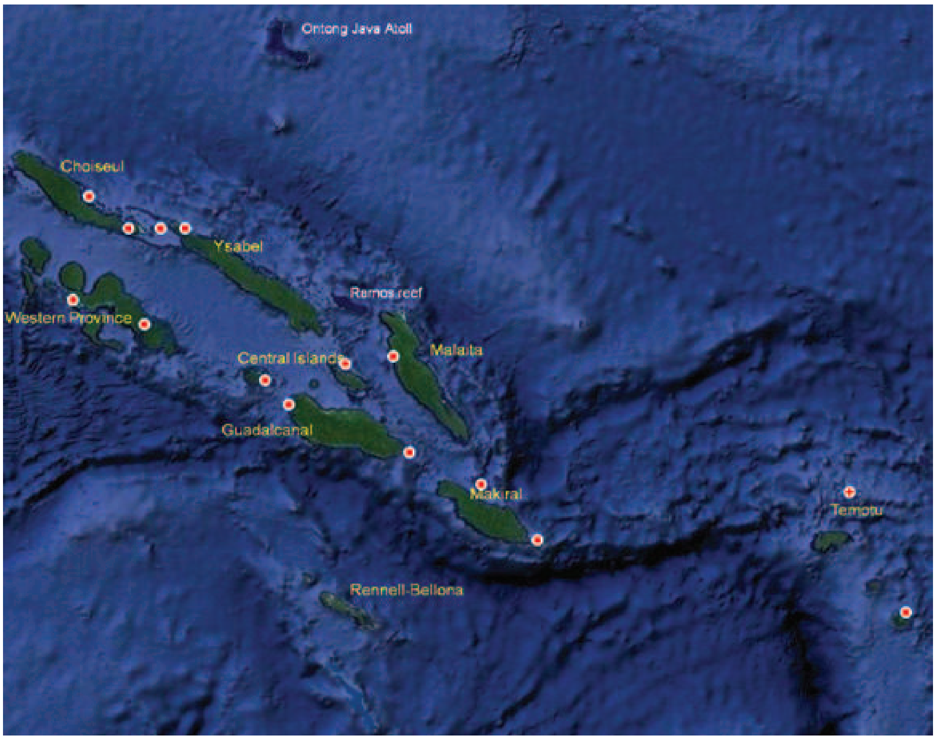

Figure 12. Locations of sea cucumber survey sites (red dots) in the eight provinces of Solomon Islands. Map source: GoogleEarth 2013.

5.3.2 Species presence

Based on commercial export records, 31 commercial species of sea cucumbers have been exploited in Solomon Islands. Of these, 27 species were recorded from underwater surveys conducted by SPC in 2007. The number of species present by sites was compared with the total number of species recorded from underwater surveys (Table 3). Overall, fewer than 19 species of sea cucumbers were recorded at each site, including marine protected areas and open access areas (Table 3). Furthermore, fewer species were recorded in marine protected areas at Marau, Ngella and Western Guadalcanal (Table 3 and Fig. 13) than in non-marine protected areas. These marine protected areas comprise a relatively small area of the reef in these sites relative to non-marine protected areas, which explain the lower number of sea cucumber species found in marine protected areas. In addition, widespread harvesting and poaching — which has been reported in some of these protected areas — may have contributed to low densities.

The present species diversity did not reflect the rich habitat systems supporting sea cucumbers in most sites in Solomon Islands. In a separate assessment conducted in 2010 at Ontong Java Atoll, 10 sea cucumber species were recorded, in contrast to a higher number of species recorded in the past (Ramohia et al. 2010). Lollyfish was the most commonly observed species, with 5,086 individual observations (Table 3). Sandfish was the second most recorded species, with 977 specimens present at 9 of the 15 sites. White teatfish was recorded at 13 sites, with between 1 and 19 individuals observed per site. The highest number of lollyfish was recorded at Kia in Isabel Province, comprising 90% of the total individuals recorded for that site.

Some rare sea cucumber species have been reported in Solomon Islands (Fig. 14). One of the species, identified locally as hongpayfish, is exploited commercially in some parts of Solomon Islands. By its physical appearance it shares some features of snakefish (Fig. 14, top left), having a light brownish underside and a greyish upper body. However, it also excretes thin cuverian tubules, which puts it outside of the commonly known snakefish group. It has been given a new common name in this report — “grey snakefish” (*Holothuria* sp.), although its taxonomic description is not available at this stage. A dragonfish/peanutfish type of sea cucumber is also present in Solomon Islands in two morphological variations (Fig. 14, top right). Close

Table 3. Sea cucumber species present and the number observed by sites assessed in Solomon Islands.

Common name	Sea cucumber survey sites																					
	Tapazaka	Taro	Rarumana	Chubikobi	Kia	Tatamba	Ngella	*Ngella MPA*	*Ngella non-MPA*	Russell Islands	Marau	*Marau MPA*	*Marau non-MPA*	W. Guadalvanal	*W. Guadalcanal MPA*	*W. Guadalcanal non-MPA*	Central Malaita	Star Harbour	Ugi	Reef Islands	Santa Cruz	Total records
Amberfish		7		1	20		3	*3*		2	7	*1*	*6*	2		*2*					1	**43**
Black teatfish	3	4			8	2	3	*1*	*2*	1	2		*2*				1		1	1	1	**27**
Brown curryfish		1	1	1	1															2	1	**7**
Brown sandfish	99	40	12	19	12	10	3	*2*	*1*	25	26	*1*	*25*	7	*1*	*6*	1	20	15	58	56	**403**
Candycanefish						17																**17**
Chalkfish				2						1	18	*5*	*13*	10	*10*		9	1				**41**
Curryfish		6	1		7	4	2		*2*		7	*6*	*1*					8	1			**36**
Deepwater blackfish																				13	3	**16**
Deepwater redfish										18							9	174				**201**
Dragonfish											1		*1*					2				**3**
Elephant trunkfish	1		3	3	9	1	3		*3*		9	*3*	*6*	6		*6*	1	1	3		14	**54**
Flowerfish		5	3	13	24		13	*7*	*6*	1	15	*2*	*13*					2	1	2	2	**81**
Greenfish					89		1	*1*		2				2		*2*				3		**97**
Golden sandfish	1	9		1							2		*2*	1		*1*		80			1	**95**
Hairy blackfish		1	4	9	1	1	1		*1*		1	*1*						6		1		**25**
Kingfish				6			4	*4*		39	1	*1*		6		*6*						**56**
Lollyfish	257	91	77	299	2,094	323	308	*139*	*169*	209	95	*16*	*79*	205	*37*	*168*	20	473	46	83	506	**5,086**
Pinkfish			12	6	23		1		*1*		7	*1*	*6*					3	5	4	10	**71**
Prickly redfish		9		1	12	5	9	*1*	*8*		18	*9*	*9*	10		*10*		2	9			**75**
Red snakefish				1																		**1**
Sandfish	19	5	2				10		*10*		51	*37*	*14*	4	*2*	*2*	5	880		1		**977**
Snakefish											8	*1*	*7*	3		*3*	1				7	**19**
Stonefish						1	1		*1*										3			**5**
Surf redfish	32				2		2	*1*	*1*	1				1	*1*		1	2			1	**42**
Tigerfish	37	32	5	5	25	8	33	*11*	*22*	18	37	*12*	*25*	29	*2*	*27*	3	285	9	69	36	**631**
White snakefish										2												**2**
White teatfish	1	9	7	4	7	19	10	*2*	*8*	8	15	*7*	*8*	1		*1*			1	2	3	**87**
Total	**9**	**13**	**11**	**15**	**15**	**11**	**17**	***11***	***14***	**13**	**18**	***15***	***16***	**14**	***6***	***12***	**10**	**15**	**11**	**12**	**14**	**27**

Note: Marine protected areas and non-marine protected locations (italicised text) were assessed in Ngella, Marau and Western Guadalcanal sites.

examination of the photographs shows it to be *Stichopus monotuberculatus* rather than *S. horrens*. Red snakefish (*Holothuria flavomaculata*) was reported in a buyer's record although a living specimen has yet to be recorded in Solomon Islands. The highly priced golden sandfish was confirmed to be present at 7 sites (Table 3), with a relatively good number (80 specimens) recorded in Star Harbour in Makira Province.

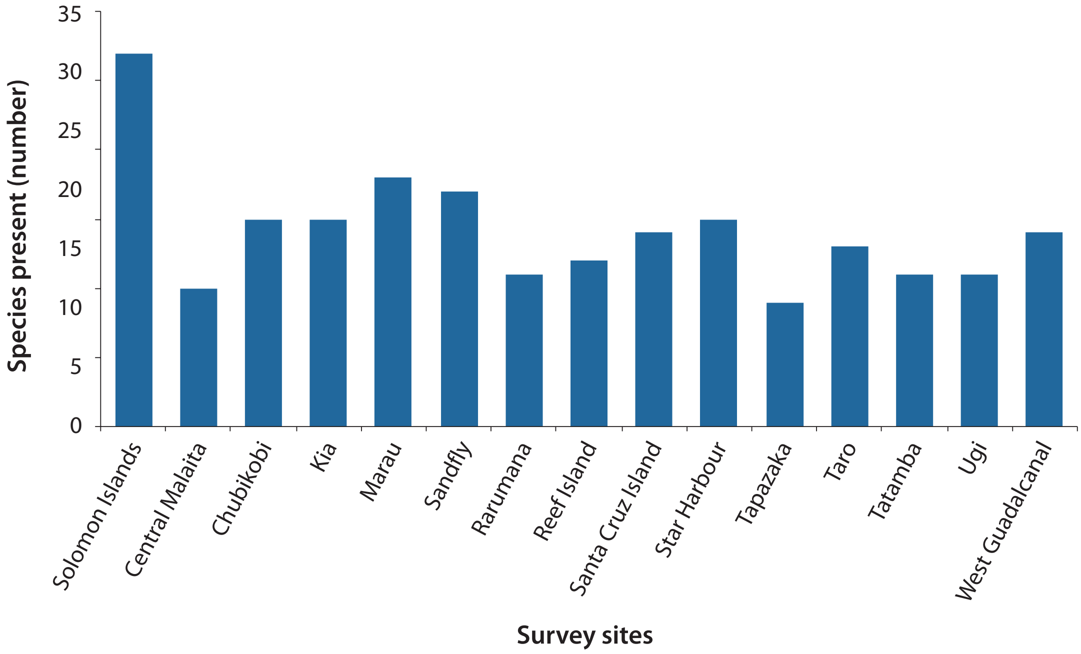

Figure 13. Sea cucumber species diversity by sites in Solomon Islands based on the 2011–2012 surveys.

Figure 14. Rare sea cucumber species present in Solomon Islands: grey snakefish (*Holothuria* sp.), top left (Photo: Jeff Kinch); 2 morphs of peanutfish (*Stichopus monotuberculatus*), top right (Photo: Sylvester Diake Junior); red snakefish (*Holothuria flavomaculata*), bottom left; and golden sandfish (*Holothuria lessoni*), bottom right (Photo: James Teri).

Golden sandfish (*Holothuria lessoni*) was identified from a trawl catch in Ontong Java in 2010 (MFMR 2010) (Fig. 14, bottom right), indicating for the first time the presence of this valuable species in Ontong Java's lagoon. Golden sandfish inhabit both the soft bottom mangrove habitat in sheltered lagoons and the clean soft sandy lagoon bottom down to 15 meters. The large lagoon system of Ontong Java could support significant stocks. Golden sandfish has been misidentified by local fishers in Ontong Java as a larger and highly valued chalkfish.

5.3.3 Threatened and endangered species

The International Union of Conservation of Nature (IUCN) has placed 16 species of sea cucumbers under the IUCN Red List of Threatened Species (IUCN 2013). Nine of these species are present in the Pacific Islands region, including Solomon Islands. Four of these species — sandfish (*Holothuria scabra*), golden sandfish (*H. lessoni*), black teatfish (*H. whitmaei*) and prickly redfish (*Thelenota ananas*) — are listed as "endangered with extinction" or species that are facing a very high risk of extinction. The other five species — deepwater redfish (*Actinopyga echinites*), surf redfish (*A. mauritiana*), hairy blackfish (*A. miliaris*), white teatfish (*H. fuscogilva*) and curryfish (*Stichopus herrmanni*) — are considered to be "vulnerable to extinction", or species that are likely to become endangered if no management measures are taken in the short to medium term (Fig. 15). All nine species are shallow- to mid-water species; golden sandfish, sandfish, hairy blackfish and deepwater redfish are restricted to very shallow mangrove-influenced and seagrass habitats. Use of these threatened species for aquaculture development must take this listing into consideration and ensure the use of wild stocks for breeding purposes. Any introduction or translocation should be accompanied by a proper risk assessment analysis.

Figure 15. IUCN Red Listed sea cucumber species present in Solomon Islands; golden sandfish (GSF), sandfish (SF), black teatfish (BTF), prickly redfish (PRF) are endangered with extinction, and curryfish (CF), white teatfish (WTF), deepwater redfish (DWRF), surf redfish (SRF) and hairy blackfish (HBF) are vulnerable to extinction.

5.3.4 Sea cucumber density and references points

Appendices 1 and 2 provide mean density and associated statistics for each species from benthos and manta assessment by site. Lollyfish is the most abundant species of sea cucumber in Solomon Islands, with densities ranging from 35 ind. ha^{-1} in Taro to 3,250 ind. ha^{-1} in Santa Cruz based on fine-scale assessments (Table 4). It should be noted that sea cucumber species were recorded from few survey stations at many of the sites, despite the increased sample size (number of stations) at some sites. Figure 14 illustrates the overall mean density and present mean density for sea cucumber species in non-marine protected areas at three sites (Russell, Ngella and Marau). Overall mean density is the overall relative abundance, and is lower than present mean density, indicating the patchy distribution of sea cucumbers in Solomon Islands (Fig. 16).

Mean densities for sea cucumbers from the two assessments at all sites assessed in Solomon Islands were far lower than regional reference densities for healthy sea cucumber populations. Healthy species densities were assessed for 17 species by fine-scale assessment (Table 4) and by broad-scale assessment (Table 5). Regional reference densities for sea cucumbers are the mean densities for the upper 25% of densities taken from 90 sites assessed across the Pacific Islands from 2002 to 2012. These regional mean densities are used as a guide for determining healthy stock populations based on a "rule of thumb" for management use.

While a few species are present in densities greater than regional reference densities (e.g. elephant trunkfish in Kia, Santa Cruz and Ugi; brown sandfish in Santa Cruz, Tapazaka and Ugi; and white teatfish in Marau marine protected area, Taro and Tatamba), they comprise only 11% of the total commercial sea cucumber species present in these sites and, therefore, do not provide a true picture of healthy abundance. Caution should be exercised when interpreting density information due to the wide variance (standard error) associated with the mean site density estimates. Appendices 2 and 3 provide mean density and associated statistics for each species from benthos and manta tow assessments by site.

Improvements in species densities inside marine protected areas are rare for most sea cucumbers (Fig. 17). The exceptions are for lollyfish and sandfish: mean density for lollyfish species was better inside the marine protected area at Sandfly in Ngella, while sandfish at Marau were in high densities inside the marine protected area near the Marau Airstrip. At West Guadalcanal, there was no difference in lollyfish density inside or outside the protected areas (Fig. 17). Overall, the mean density for lollyfish for all sites was well below the 5,600 ind. ha^{-1} reference density for healthy abundance (Fig. 18). For species where mean densities were higher — such as for brown sandfish at Santa Cruz, Tapazaka and Ugi, white teatfish at Marau and Marau MPA, Taro and Tatampa — assessing size composition is important for determining stock health.

On the whole, based on mean density indicators, the abundance of sea cucumber resources at the sites assessed in Solomon Islands are very low, indicating a severely depleted resource. The same low mean species density results were seen in the previous SPC survey in 2007 at Marau, Chubikobi, Marau and Ngella (Friedman et al. 2009) at less than 20 ind. ha^{-1} for most sea cucumber species assessed by manta tow and reef benthos assessments.

Table 4. Combined sea cucumber densities from reef benthos and soft benthos transects and the regional reference densities (ind. ha^{-1}).

Common name	Sea cucumber survey sites																	
	Tapazaka	Taro	Rarumana	Chubikobi	Kia	Tatamba	Ngella MPA	Ngella non-MPA	Russell Islands	Marau MPA	Marau non-MPA	W. Guadalcanal MPA	W. Guadalcanal non-MPA	Central Malaita	Star Harbour	Ugi	Reef Islands	Santa Cruz	**Reginal density**
Amberfish				2	24														**n/a**
Black teatfish	16	3			11	5	7	3	1		2			3			2		**50**
Brown curryfish			3														3	7	**n/a**
Brown sandfish	500	70	21	10	11	23	14		33	5	26	8	5	3	79	125	90	347	**100**
Candycanefish						39													**n/a**
Chalkfish				4					1	26	14	83		31	4				**1,400**
Curryfish		13	3			9				21					33	8			**100**
Deepwater blackfish															8				**n/a**
Deepwater redfish																	21	14	**n/a**
Dragonfish									24					31	725				**n/a**
Elephant trunkfish				2	11	2				5	1			3		17		42	**10**
Flowerfish		10	6	27	22		35	6	1	10	9				8	8		7	**100**
Greenfish					138		7		3				5				5		**3,500**
Golden sandfish	5	22		2							1		2		333			7	**n/a**
Hairy blackfish		3	9	8	1	2		1		5					25		2		**150**
Kingfish							28		56	5			15						
Lollyfish	302	35	77	456	2,865	593	819	153	233	78	70	300	346	69	1,767	275	101	3,250	**5,600**
Pinkfish			30	12	24	12				5	4				4	8		14	**260**
Prickly redfish		3		2	7		7			5	3		20						**30**
Red snakefish				2															
Sandfish	99	16						14		193	17	17	5	17	3,667		2		**700**
Snakefish										5	8		7	3				49	**1,100**
Stonefish						2		1								25			**10**
Surf redfish	167				3		7		1			8		3	8				**200**
Tigerfish	167	51		4	23	16	35	17	22	36	7	8	61	10	1,167	50	91	69	**120**
White snakefish									3									69	
White teatfish	5	22	12	8	7	23	7	6	11	26	9		2			8	3	7	**20**

n/a = data insufficient to determine regional reference density; MPA = marine protected area.

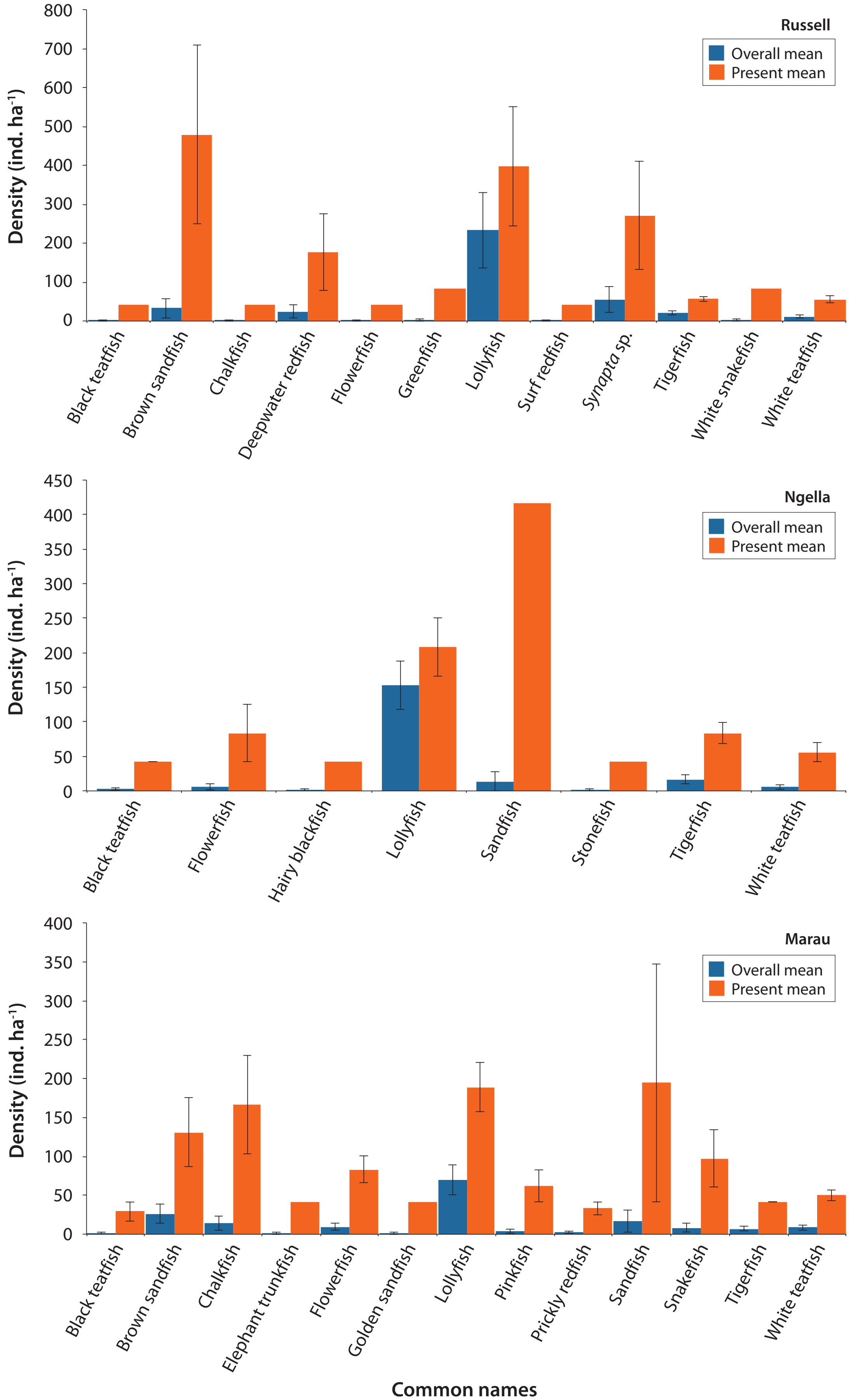

Figure 16. Overall mean density (blue bar, left) and present mean density (red bar, right) for combined reef benthos and soft benthos transect surveys completed at Russell, Ngella and Marau.

Table 5. Sea cucumber densities from manta tow surveys and the regional reference densities (ind. ha^{-1}).

Common name	Sea cucumber survey sites																	
	Tapazaka	Taro	Rarumana	Chubikobi	Kia	Tatamba	Ngella MPA	Ngella non-MPA	Russell Islands	Marau MPA	Marau non-MPA	W. Guadalcanal MPA	W. Guadalcanal non-MPA	Star Harbour	Ugi	Reef Islands	Santa Cruz	Regional density
Amberfish		2			0.4		3		0.4	0.6	0.9		0.8					**20**
Black teatfish		0.4															0.3	**10**
Brown curryfish		0.3		0.2	0.1													**n/a**
Brown sandfish	3	4	1	3	0.6			0.2	0.4		0.4		2	0.5		0.3	2	**160**
Chalkfish								0.4			0.1							**n/a**
Curryfish		0.3			1					10	0.3							**130**
Deepwater blackfish																	0.3	**n/a**
Deepwater redfish									0.2									**n/a**
Elephant trunkfish	0.5		0.7	0.4	0.1	4		0.6		10	0.8		2	0.5	0.5		3	**10**
Flowerfish		0.5	0.2		1		2				0.3					0.3	0.3	**50**
Greenfish					6			0.4										**1,000**
Golden sandfish		0.5																**n/a**
Hairy blackfish			0.2	1														**n/a**
Kingfish				2														**n/a**
Lollyfish	101	20	12	18	12	31	42	11	10	2	6	3	11	55	6	3	13	**2,400**
Pinkfish			0.5		0.8			0.2			0.4			7	2	0.7	3	**250**
Prickly redfish		2			1			1		9	2		0.8	0.9	4			**10**
Surf redfish								0.2									0.3	**20**
Tigerfish	3	4	1	0.6	1	0.5	7	1	0.6	7	3	1	0.8	2	1	2	9	**50**
White teatfish		0.5	0.5		0.3		0.9	0.4		6	0.1				0.5		0.7	**n/a**

n/a = data insufficient to determine regional reference density; MPA = marine protected area.

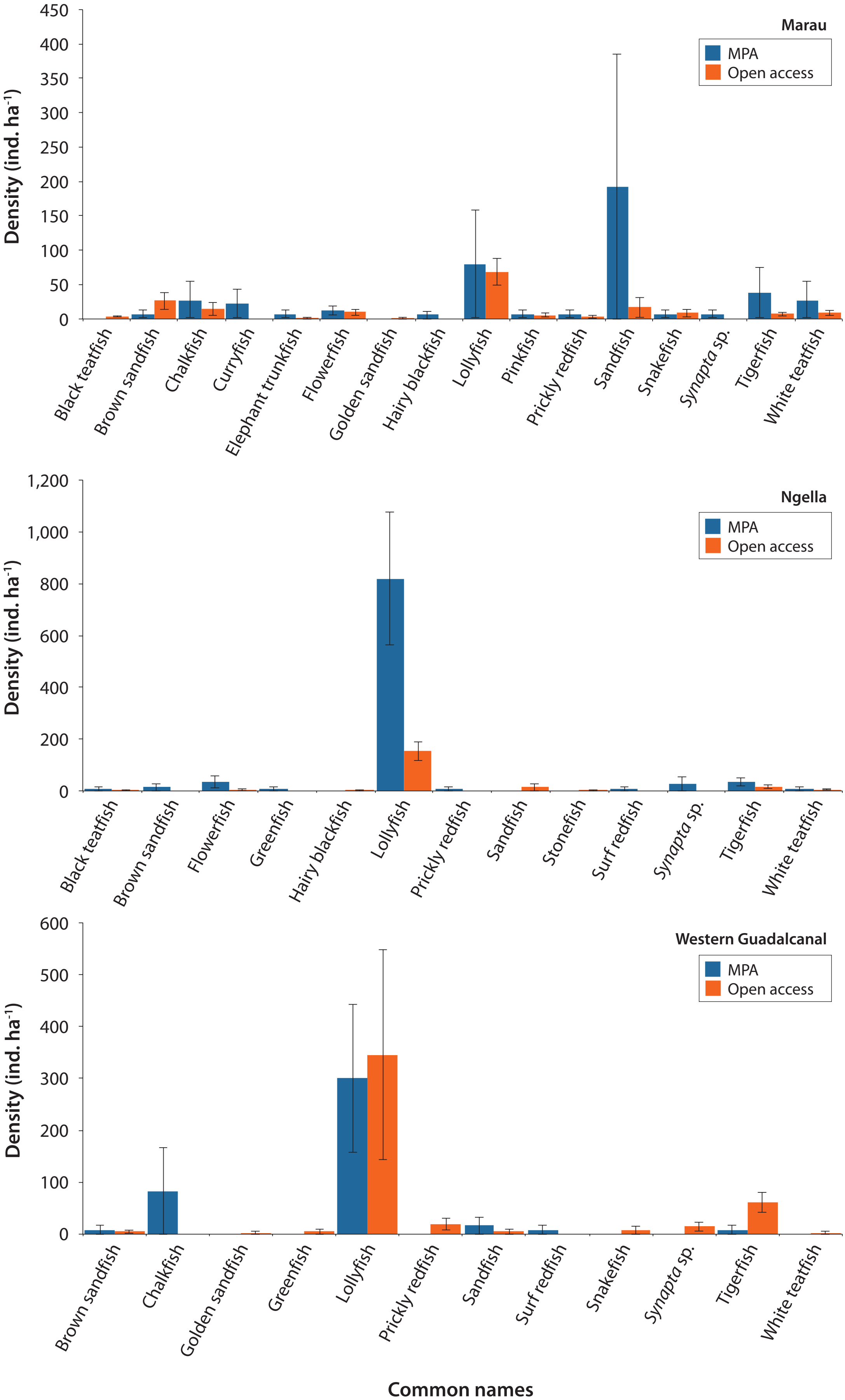

Figure 17. Sea cucumber densities inside and outside of marine protected areas in Marau, Ngella and Western Guadalcanal.

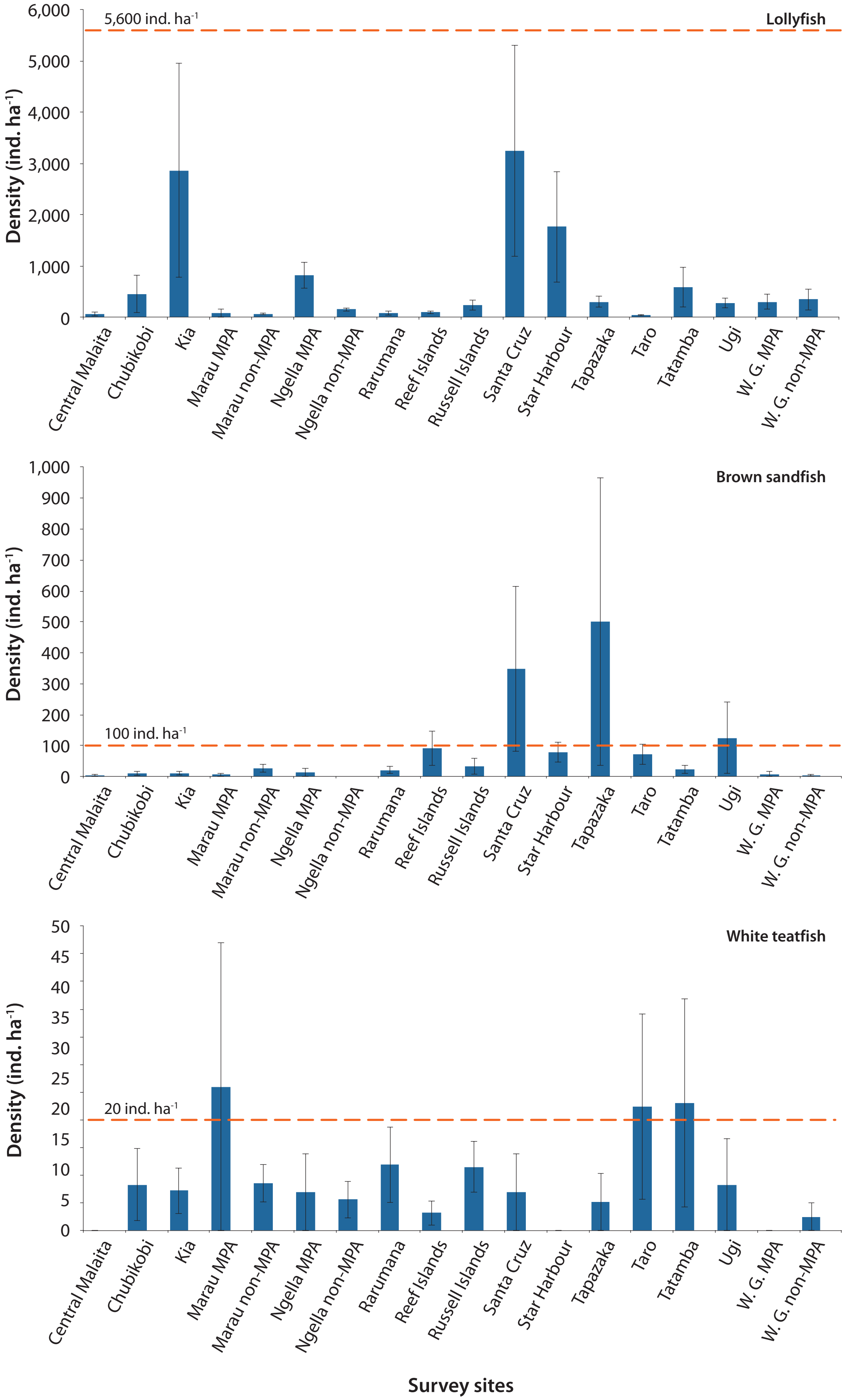

Figure 18. Density distribution for lollyfish, brown sandfish and white teatfish with regional reference density indicator (orange dashed line). W. G. = Western Guadalcanal.

5.3.5 Population structure

Mean lengths of sea cucumbers (obtained from size measurement data) provide information on stock health in terms of recruitment status, the portion of the population that have reached reproductive maturity, and the impact of fishing on population structures. The assessments were unable to obtain reasonably large samples for many species, which is important in examining site-specific length frequencies. Length data from all sites were pooled to produce an overall population size structure for four species used as indicator species: lollyfish, sandfish, brown sandfish and tigerfish (Fig. 19). These four species had relatively larger samples of length data to provide information on their stock condition at all sites assessed.

Lollyfish is a reproductively active species, adopting both sexual and asexual modes of reproduction; its density can be very high and it is a low-value product in the beche-de-mer trade. Sandfish is a high-value species with a very high buying price of USD 90 kg^{-1} (or SBD 650) for A-grade product (Carleton et al. 2013). Sandfish is also a highly reproductive species whose distribution is restricted to seagrass beds and is easily targeted by fishers. Brown sandfish and tigerfish are low density species and command a medium value in the beche-de-mer trade.

Common sizes for each species (shown in Fig. 17) are based on assessments conducted across the Pacific by SPC since 2002 (Purcell et al. 2008). Common sizes are the mean sizes of sea cucumbers that would be considered for harvest for the production of beche-de-mer. As indicated, the bulk of the population of the four indicator species are in the smaller size range, which indicates young populations. Pooled mean sizes for some species from all sites are given in Appendix 3.

Table 6 compares mean sizes for species from each site with common and maximum sizes recorded for the Pacific region, and Appendix 4 provides mean size and associated statistics for sea cucumbers assessed at all sites in Solomon Islands. Data in Table 6 and Appendix 3 do not account for records of species by sites with fewer than five specimens measured. Mean sizes for the majority of sea cucumbers in the assessed sites were smaller than their respective common sizes recorded in the Pacific (Table 6), which indicates relatively young populations in Solomon Islands due to recent harvests of larger and more valuable portions of the populations. Photos of juveniles of white teatfish, sandfish, elephant trunkfish and curryfish recorded during the recent surveys (Fig. 20) are indicative of the young populations.

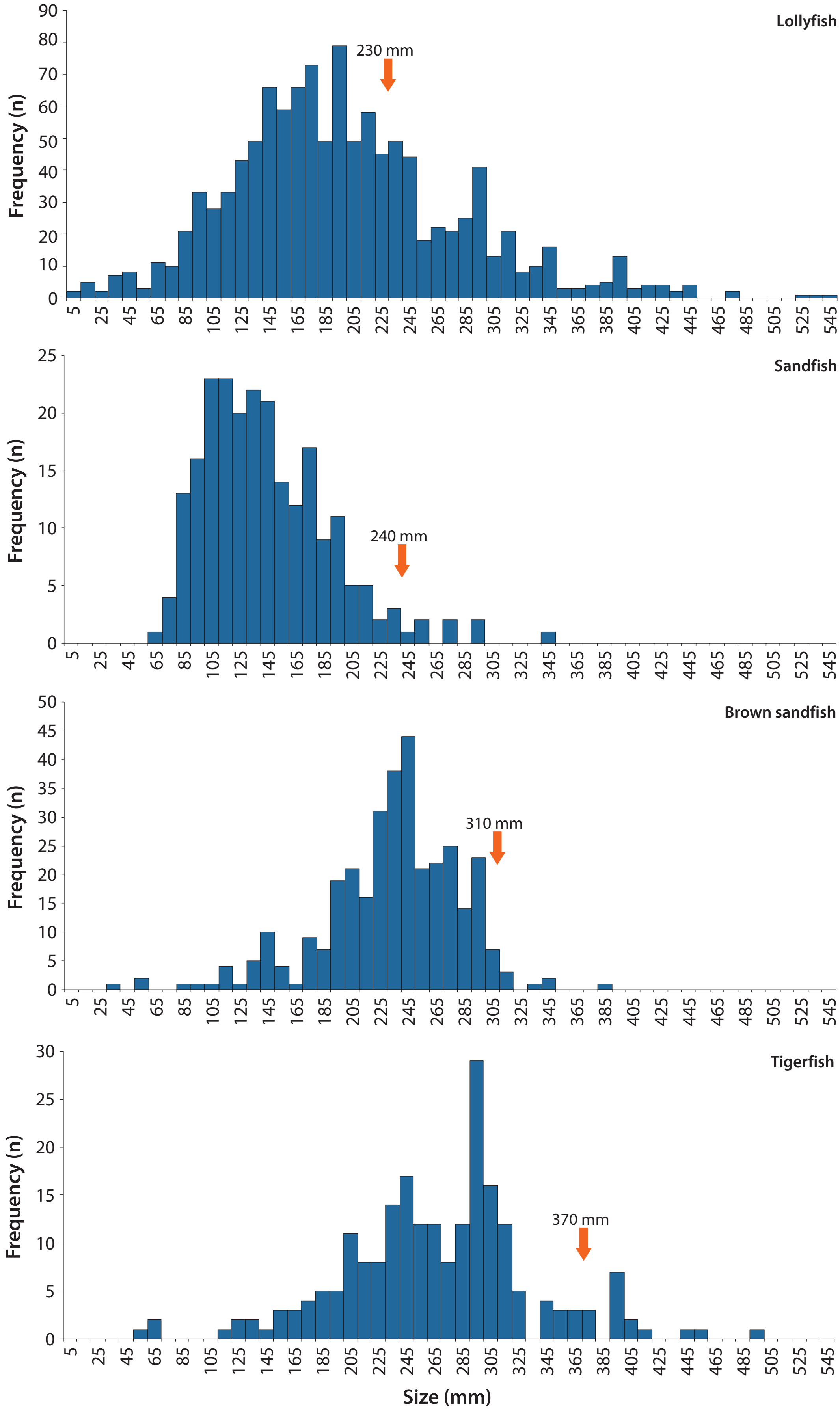

Figure 19. Pooled (all sites) length frequency for lollyfish, sandfish, brown sandfish and tigerfish from in-water surveys in Solomon Islands. Orange arrows indicate regional common size.

Table 6. Mean sea cucumber length (in millimetres) by province (Solomon Islands), Pacific regional commonly harvested size and maximum species size.

Common name	Sea cucumber survey sites																			
	Tapazaka	Taro	Rarumana	Chubikobi	Kia	Tatamba	Ngella MPA	Ngella non-MPA	Russell Islands	Marau MPA	Marau non-MPA	W. Guadalcanal MPA	W. Guadalcanal non-MPA	Central Malaita	Star Harbour	Ugi	Reef Islands	Santa Cruz	Regional common size	Regional maximum size
Amberfish				540					500										630	**890**
Black teatfish	210	240			213	180	230	240	160		270			230			170		340	**540**
Brown curryfish			420														230	280	na	**na**
Brown sandfish	238	256	263	226	223	259	235		196	210	212	130	200	220	266	261	234	252	310	**420**
Chalkfish				245					210	120	198	139		142	150				220	**320**
Curryfish		260	500			278		240		183					241	430			390	**550**
Deepwater blackfish																	148	145	na	**na**
Deepwater redfish									194					141	171				150	**360**
Dragonfish											230				165				320	**390**
Elephant trunkfish				410	336	290				570	350			290		280		408	480	**660**
Flowerfish		300	290	253	296		265	288		290	250				370	310		300	380	**480**
Greenfish					218		210		310				295				263		230	**380**
Golden sandfish	250	341		150							175		210		192			270	200	**400**
Hairy blackfish		180	235	180	270	130		180		130					172		210		230	**300**
Lollyfish	223	351	174	216	178	237	219	229	180	353	210	164	178	232	215	238	184	194	240	**650**
Pinkfish			234	244	232					260	283				260	120		265	240	**380**
Prickly redfish		500		260	350	240	450	580		750	360		326						550	**700**
Sandfish		202	95					134		132	230	160	235	184	150		300		240	**400**
Snakefish	148													200				277	400	**600**
Stonefish						140		150								227			220	**240**
Surf redfish	163				190		250	270	240			180		150	185				240	**380**
Tigerfish	231	260		285	253	207	283	313	287	257	241	260	270			295	294	312	370	**600**
White teatfish	160	300	258	248	324	219	320	217	179	235	209		150	323		290	240	190	410	**550**

n/a = data insufficient to determine regional maximum size; MPA = marine protected area.

Figure 20. Juveniles of white teatfish and sandfish recorded at Marau (top photos)
and elephant trunkfish and curryfish at Sandfly (Ngella) in 2011
(Photo of white teatfish: Sylvester Diake Junior; Photos of sandfish, elephant trunkfish and curryfish: Kalo Pakoa).

6. Discussion

Solomon Islands is one of the top three important sea cucumber producers in the Oceania Pacific Islands region along with Papua New Guinea and Fiji. However, findings presented in this report indicate that the health of sea cucumber stocks in Solomon Islands has steadily declined over time. Average sizes for most species (Table 6; Appendices 3 and 4) are small, indicating that most sea cucumbers recorded are likely to be below the size at reproductive maturity. This means that most of the population is unable to reproduce and that stocks will continue to decline unless these small individuals are protected from fishing and left on the reef to contribute to population replenishment. Mean densities are low, with several species not recorded at some sites. Sea cucumbers are relatively sedentary animals, with males and females needing to be in close proximity to one another for successful reproduction. Low density effectively reduces the chances of successful fertilisation of gametes, which leads to breeding failure.

A sea cucumber population that consists of primarily immature individuals and young adults will have a reduced recruitment potential than a population that consists of many large adults. Weakened breeding capacity of stocks leads to population declines and local extinctions. At this point, the sea cucumber stocks at the sites assessed across Solomon Islands are considered to be threatened and vulnerable to extinction. Under this scenario, the only best approach is to allow stocks to recover by enforcing a total ban on fishing and exporting beche-de-mer.

The total ban on sea cucumber fishing in 2005 was a timely move by MFMR to control the fishery. Zero exports of beche-de-mer in 2006 indicates effective compliance with the national ban. However, lifting the ban in 2007 for the Western Province created distrust by fishers from other provinces, which translated into a lack of compliance when the ban was reinstated in 2009. As revealed by the results of these surveys, sea cucumber stocks remain depleted and there are few indications to suggest that the existing ban has contributed to improvements in the abundance of certain species. Stock abundances for high-recovery species such as lollyfish should start to change within two years of a total ban, but continued harvesting activities has not allowed stocks time to repopulate.

Without effective management controls at this stage, the demand for beche-de-mer along with external market forces can easily drive the Solomon Islands sea cucumber fishery to collapse. This would be detrimental to coastal communities because it would take away an important income earning opportunity. To prevent this situation, and ensure that community fishers can continue to derive income from the sale of beche-de-mer in the future, there is an urgent need to develop and implement effective management systems.

The draft national sea cucumber fishery management plan for Solomon Islands provides the structure for improved management of the sea cucumber fishery in Solomon Islands by linking local communities, local authorities, provincial governments and the national government in a holistic approach of managing the country's sea cucumber fisheries. The plan outlines several management measures, including limiting access through export and processing licenses, quota allocations for licenses, and for catch and export quantities; restricting certain types of gear; imposing minimum harvest sizes and weight limits; limiting the number of species that can be harvested and exported; and implementing a monitoring mechanism of these measures, all of which are essential for restoring populations.

At the community level, a number of management tools exist that can be adopted by communities to manage sea cucumber fisheries, including rotational harvest closures, and limiting the number of species that can be harvested. A rotational harvest closure means shifting fishing effort in a systematic way after set periods of time among demarcated fishing grounds. This allows populations to recover for several years in some areas, while fishing is shifted to other areas. For example, the fishing ground adjacent to a community could be partitioned into a number of areas, with community fishers only being allowed to collect sea cucumbers of a certain size in one area each year. Fishing is then shifted to a different area the following year, and so on. An assumption is that the same areas will be fished again after some time or after reaching some certain state. Where populations can recover fairly quickly, it is possible to have rotating fishing effort over relatively short time intervals (e.g. two to three years).

In this way, rotational closures allow the sizes and abundance of sea cucumbers in closed areas to recover for two to three years before being fished again. Rotational closures can also be used to reduce costs of field surveys to estimate stock size because fishable areas for any given year are only a fraction of the whole fishery. With rotational closures, communities can also enforce a limited number of species that can be harvested, and alternate the species harvested in each of the partitioned areas or seasons. For example, white teatfish, brown sandfish and lollyfish of a certain size could be harvested in one year (or area) and sandfish, greenfish and curryfish harvested the following year (or area). Rotating the types of species that can be harvested each year or on a two-yearly basis should take into account the reproductive pattern and abundance of each species.

While there are opportunities for effective community management of sea cucumber fisheries in Solomon Islands, the present situation is not encouraging. Community leaders of Marau and Sandfly have raised concerns about the increase in poaching activities inside community marine protected areas. Communities are powerless to control poaching activities or to stop people from harvesting because they lack legal powers to enforce the current ban on the fishery or any fisheries regulations. It appears that the continuous buying of sea cucumbers by some traders has been the driver for fishing and poaching activities. Therefore, putting a halt to the buying of sea cucumbers is the best way to stop sea cucumber fishing activities. Once populations recover, the national sea cucumber fishery management plan for Solomon Islands should provide an improved strategy for harvesting and monitoring fishing activities. Community harvest strategies should be implemented with technical assistance and advice from MFMR and interested partners.

Local prices of sea cucumber products have varied by species, product stages and by buyers, and there has been little done to improve pricing. Traders are left to determine buying prices and realistic export values have been closely guarded information by exporters. As revealed in this assessment, sea cucumber and beche-de-mer prices have improved since 1991 and the recent 2013 export figures are the highest ever at over SBD 33 million. The sea cucumber trade is a lucrative industry that can contribute greatly to local community livelihoods and national and provincial revenue if effectively controlled. Measures must be developed now to control access to resources by limiting the number of exporters, introduce quota systems and measures to control these price fluctuations, and improve product quality.

Improving product quality means re-examining harvestable size limits by species (wet size) and exportable product form, and the associated weight loss conversion factors to facilitate valuation of both the resource and export products for transparent decision-making. The best prices are paid for beche-de-mer that are large and well processed. The sizes that produce high-grade product for each species can be determined and this size can be set as the minimum size for harvest, processing and export. This minimum size would need to be greater than the size at which sea cucumbers attain full maturity. This measure benefits both the stock and the fishers. By setting the minimum size greater than the size at full maturity, a proportion of the population will be approaching or be at full maturity, and protecting these individuals from harvest will allow them to contribute to stock replenishment. For fishers, implementation of such a measure means they will continue to derive a livelihood from the harvest of beche-de-mer over longer periods of time by receiving the best prices for large, high-grade product.

Aquaculture is of a growing interest in Solomon Islands as in other Pacific Islands. However, what needs to be known is that these studies have yet to produce profitable models for farming sea cucumbers in the Pacific Islands. While research is being conducted, it is critical that locally available stocks of certain species are preserved and kept in healthy condition for breeding research. At the same time, effort must be made to ensure interested investors in sea cucumber ranching are transparent and are genuine about what they do.

7. Recommendations for improved management

The following are some recommendations for the sustainable management of the Solomon Island sea cucumber fishery.

1. ***Total ban on sea cucumber fishing and exports.*** The implementation of the moratorium in 2005 was a timely action in the right direction. The decision to lift the ban in two provinces while the other provinces remained closed was not the best decision because this created a level of distrust of the national ban by fishers and buyers from across other provinces. This has resulted in the continued illegal harvesting, processing and stock piling of beche-de-mer after the ban was reinstated in April 2009. Therefore, lifting of a sea cucumber ban to allow fishing should be for the whole country and not part of the country, as has been experienced.
2. ***Effective enforcement of the existing ban.*** Effective enforcement of the existing ban has been weak. Efforts must be made to enforce the ban by eliminating sea cucumber buying and processing activities. Eliminating the market will, in turn, discourage fishing activities. Lifting the ban in the future should be based on resource assessment surveys, and improved harvesting strategies will ensure that effective monitoring is encouraged.
3. ***Community livelihood and resource management.*** Sustainable community livelihood and sustainable resources go hand in hand; therefore, if resources are depleted the community must accept the fact that by not taking action to control fishing or the harvesting of sea cucumbers, the possible subsequent collapse of the fishery will be devastating to the community.
4. ***Finalise the national sea cucumber fishery management plan.*** A draft national sea cucumber fishery management plan for Solomon Islands has been developed and provided to MFMR for consultation. The plan should be finalised and the necessary preparations be made for its implementation in future open seasons.
5. ***Develop sea cucumber regulations.*** Measures in the plan that needed to be regulated should be developed into regulations as a matter of priority. These measures include minimum harvest sizes and weight limits, closed seasons, restricted fishing gear, protected species, and training on compliance and enforcement should follow for effective implementation of the sea cucumber management plan.
6. ***Sea cucumber species identification issues.*** Sea cucumber species identification remains poor for fishers, buyers and exporters and within MFMR itself. The local Solomon Islands sea cucumber names are confusing and should be avoided. The use of standard common names must be enforced under the licensing condition for middlemen and export operators. Within MFMR, officers responsible for the sea cucumber fishery are encouraged to correct the product identification for wet and dried products, and standard species common names must be used. Production and distribution of identification cards to communities, middlemen and exporters must be undertaken as a matter of priority.
7. ***Collection and management of export data.*** Beche-de-mer export data must be recorded on a proper form provided within the management plan and broken down by species, quantity and prices; these data must be entered into a database, analysed and reported on in MFMR's annual report or a sea cucumber technical report.
8. ***Traceability of product quantity and value.*** Information on the origin of sea cucumber products within Solomon Islands is needed in order to improve the current understanding of productivity distribution and economic valuation of the resource to community livelihoods by areas, islands and provinces. Mandatory submission of catch quantities and prices must be recorded and submitted to MFMR in set forms as a condition of licenses. This information should be entered into a database and regularly analysed to monitor production quotas and this information should be made available to management.

9. ***Limit the number of exporters.*** The sea cucumber industry in Solomon Islands has been left open for many years. As a result, many companies have come in and out of the industry and the industry is dominated by Asian nationals, some of whom are local citizens while others are foreigners in joint venture arrangement with local interests. To ensure effective monitoring, a national beche-de-mer export license quota should be established, and the recommended number of licensed exporters should be less than five in the country per year or fishing season.

10. ***Improve product prices.*** For many years, sea cucumber buying prices have remained low and accurate export values underreported by exporters. Since the 1990s, the value of sea cucumbers overall have increased and the total value of 2013 exports — SBD 33 million — was the highest ever from the fishery. Recent beche-de-mer buying price estimates for 2012 in Melanesian + Tongacountries should be used as a benchmark for setting minimum product prices in the future. Appendix 5 provides local prices from Solomon Islands and the mean prices for MSG + Tonga countries for 2012. MSG + Tonga prices can be used as the basis for setting minimum buying prices for dried sea cucumbers in Solomon Islands if needed in future fishing seasons.

11. ***Restrictions on fishing gear.*** The only method for collecting sea cucumbers that should be allowed is by hand using a snorkel. The prohibition on the use of underwater breathing apparatus gear for fishing and/or collecting sea cucumbers should be enforced, and heavy penalties to offenders should be applied. The use of a bottom trawl to fish for sea cucumbers should be prohibited (or at the very least, restricted) and this prohibition should be enforced.

12. ***Harvestable size and weight limits.*** Minimum harvest and export sizes and weight limits should be imposed to protect juvenile sea cucumbers from being fished and give them a chance to grow, reach maturity and spawn for more than one season, thus contributing to population replenishment before being harvested. Minimum size limits must be set at sizes greater than the size when sea cucumbers reach sexual maturity. Larger specimens produce a greater number and larger more viable eggs than recently mature or small and/or young adult sea cucumbers. The size and age when sea cucumbers reach sexual maturity differ among species; therefore, minimum sizes should be species specific. Imposing conservative large minimum size limits to target high-grade products of a species is encouraged. If enforced and complied with, this measure will gradually improve stock replenishment capability and improve fishing communities' income over the long term. To minimise confusion among fishers, processors and exporters, and to simplify beche-de-mer inspection, a few minimum size limits (e.g. three to four size categories such as 100 mm, 150 mm and 200 mm of dried product) should be selected, and species that are similar in size at maturity or have similar biological characteristics can be grouped into these size limits. The elastic feature of many sea cucumber species makes enforcing size limits at the fisher and processing levels challenging. Applying and enforcing dry minimum size limits, however, is achievable if consignments are inspected and certified prior to the consignment being exported overseas.

13. ***Permissible list of species for harvest and exports.*** Prohibiting the export of species whose populations are critically low reduces fishing pressure so that these populations can recover. Placing the onus on export companies to not export certain sea cucumber species is simpler to enforce than inspecting fishers' catches at the provincial or country level. Providing an annual or biannual list of permissible export species provides managers and the industry with the option to add species that previously were prohibited to being exported when stocks recover, or to remove species from the list of permissible export species when their stock status are (or remain) uncertain. The nine species currently placed under the International Union for the Conservation of Nature Red List of endangered and threatened species are priority species to be excluded in the permissible export species list. This measure will require that consignments are inspected and certified prior to the consignment being exported overseas.

14. ***Protection of breeding stocks by communities.*** Community managed marine areas are important for protecting breeding stocks of sea cucumbers. Communities are encouraged to establish managed areas as no-take zones in order to preserve sea cucumber stocks in these areas as local sources of recruitment for re-populating harvested stocks.

15. ***Aggregation of broodstock.*** One option for increasing the chances of spawning and the successful fertilisation of gametes in severely fished stocks is through the aggregation of mature broodstocks. Practiced widely with giant clams, the idea has not been tested with sea cucumbers. With sustained fishing pressure, aggregations of sea cucumbers in an area will likely attract the attention of poachers, further exacerbating existing challenges. Any attempt to aggregate adult stocks must be undertaken in an established marine protected area with strong protection.

16. ***Monitoring, compliance and enforcement.*** Monitoring and compliance is a common weakness in sea cucumber fisheries throughout the Pacific Islands. Establishing a licensing and permitting system would enable MFMR to monitor the sea cucumber more effectively. Capacity building in coastal fisheries compliance and enforcement are needed for Solomon Islands and other Pacific Island countries, and MFMR should make this need known to relevant donor partners for assistance.

17. ***Healthy density references.*** Site-by-site species reference densities provide useful benchmarks for determining healthy abundances. Reference densities are best set for stocks that have fully recovered. Determining these species references points requires stocks to recover to healthy levels. Areas known to be very lightly fished or not fished at all should be assessed in order to provide information to help determine virgin or near virgin stock densities that MFMR can use this as a "yard stick" for comparing with densities of impacted sea cucumber populations. Collaboration with neighbouring countries (e.g. Papua New Guinea) is recommended.

18. ***Poaching in community managed areas.*** Community managed areas are struggling against sea cucumber poaching because buyers continue to purchase sea cucumbers from fishing communities. Shorter, better controlled open seasons (when stocks have recovered to healthy fishable levels) and effective enforcement of fishery closures are important control measures to prevent poaching in community managed areas.

19. ***Standardise sea cucumber resources assessment.*** Several resource assessment methods have been adopted in evaluating sea cucumber resources in Solomon Islands. To improve resource knowledge and develop local capacity in stock assessment in the long term, the resource assessment survey methods used in the current surveys should be maintained into the future in order to generate comparable resource information to inform fishery management. The processing of resource data to produce fishable stock estimates by area is greatly encouraged to assist with the marketing of high-value products at a sustainable harvest level.

8. References

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Appendix 1.

Sea cucumber densities from fine-scale assessments (2011/2012) (reef benthos and soft benthos transect surveys combined)

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Central Malaita	*Holothuria whitmaei*	3.5	3.5	12	41.7		1	8
Central Malaita	*Bohadschia vitiensis*	3.5	3.5	12	41.7		1	8
Central Malaita	*Bohadschia marmorata*	31.3	31.3	12	375.0		1	8
Central Malaita	*Actinopyga echinites*	31.3	27.7	12	187.5	145.8	2	17
Central Malaita	*Holothuria fuscopunctata*	3.5	3.5	12	41.7		1	8
Central Malaita	*Holothuria atra*	69.4	41.8	12	277.8	97.2	3	25
Central Malaita	*Holothuria scabra*	17.4	17.4	12	208.3		1	8
Central Malaita	*Holothuria coluber*	3.5	3.5	12	41.7		1	8
Central Malaita	*Actinopyga mauritiana*	3.5	3.5	12	41.7		1	8
Central Malaita	*Bohadschia argus*	10.4	10.4	12	125.0		1	8
Chubikobi	*Thelenota anax*	2.1	2.1	20	41.7		1	5
Chubikobi	*Bohadschia vitiensis*	10.4	6.7	20	69.4	27.8	3	15
Chubikobi	*Bohadschia marmorata*	4.2	4.2	20	83.3		1	5
Chubikobi	*Holothuria fuscopunctata*	2.1	2.1	20	41.7		1	5
Chubikobi	*Pearsonothuria graeffei*	27.1	15.2	20	108.3	46.8	5	25
Chubikobi	*Holothuria lessoni*	2.1	2.1	20	41.7		1	5
Chubikobi	*Actinopyga miliaris*	8.3	4.9	20	55.6	13.9	3	15
Chubikobi	*Holothuria atra*	456.3	364.3	20	1,303.6	1,008.2	7	35
Chubikobi	*Holothuria atra* (big)	6.3	6.3	20	125.0		1	5
Chubikobi	*Holothuria edulis*	12.5	12.5	20	250.0		1	5
Chubikobi	*Thelenota ananas*	2.1	2.1	20	41.7		1	5
Chubikobi	*Holothuria flavomaculata*	2.1	2.1	20	41.7		1	5
Chubikobi	*Bohadschia argus*	4.2	2.9	20	41.7	0.0	2	10
Chubikobi	*Holothuria fuscogilva*	8.3	6.5	20	83.3	41.7	2	10
Kia	*Thelenota anax*	24.4	24.4	29	708.3		1	3
Kia	*Holothuria whitmaei*	11.5	5.4	29	83.3	0.0	4	14
Kia	*Bohadschia vitiensis*	11.5	6.5	29	83.3	29.5	4	14
Kia	*Holothuria fuscopunctata*	11.5	10.1	29	166.7	125.0	2	7
Kia	*Pearsonothuria graeffei*	21.6	8.7	29	89.3	21.2	7	24
Kia	*Stichopus chloronotus*	137.9	137.9	29	4,000.0		1	3
Kia	*Actinopyga miliaris*	1.4	1.4	29	41.7		1	3
Kia	*Holothuria atra*	2,864.9	2,085.2	29	3,612.3	2,618.1	23	79
Kia	*Holothuria edulis*	24.4	20.2	29	236.1	174.0	3	10

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Kia	*Thelenota ananas*	7.2	3.6	29	52.1	10.4	4	14
Kia	*Actinopyga mauritiana*	2.9	2.0	29	41.7	0.0	2	7
Kia	*Bohadschia argus*	23.0	7.6	29	66.7	14.2	10	34
Kia	*Holothuria fuscogilva*	7.2	4.2	29	69.4	13.9	3	10
Marau_MPA	*Bohadschia vitiensis*	5.2	5.2	8	41.7		1	13
Marau_MPA	*Bohadschia marmorata*	26.0	26.0	8	208.3		1	13
Marau_MPA	*Stichopus herrmanni*	20.8	20.8	8	166.7		1	13
Marau_MPA	*Holothuria fuscopunctata*	5.2	5.2	8	41.7		1	13
Marau_MPA	*Pearsonothuria graeffei*	10.4	6.8	8	41.7	0.0	2	25
Marau_MPA	*Actinopyga miliaris*	5.2	5.2	8	41.7		1	13
Marau_MPA	*Holothuria atra*	78.1	78.1	8	625.0		1	13
Marau_MPA	*Holothuria edulis*	5.2	5.2	8	41.7		1	13
Marau_MPA	*Thelenota ananas*	5.2	5.2	8	41.7		1	13
Marau_MPA	*Holothuria scabra*	192.7	192.7	8	1541.7		1	13
Marau_MPA	*Holothuria coluber*	5.2	5.2	8	41.7		1	13
Marau_MPA	*Synapta maculata*	5.2	5.2	8	41.7		1	13
Marau_MPA	*Bohadschia argus*	36.5	36.5	8	291.7		1	13
Marau_MPA	*Holothuria fuscogilva*	26.0	26.0	8	208.3		1	13
Marau_Non_MPA	*Holothuria whitmaei*	1.7	1.3	35	29.2	12.5	2	6
Marau_Non_MPA	*Bohadschia vitiensis*	26.2	12.2	35	131.0	44.0	7	20
Marau_Non_MPA	*Bohadschia marmorata*	14.3	9.2	35	166.7	63.6	3	9
Marau_Non_MPA	*Holothuria fuscopunctata*	1.2	1.2	35	41.7		1	3
Marau_Non_MPA	*Pearsonothuria graeffei*	9.5	4.9	35	83.3	17.0	4	11
Marau_Non_MPA	*Holothuria lessoni*	1.2	1.2	35	41.7		1	3
Marau_Non_MPA	*Holothuria atra*	70.2	19.5	35	189.1	32.2	13	37
Marau_Non_MPA	*Holothuria edulis*	3.6	2.6	35	62.5	20.8	2	6
Marau_Non_MPA	*Thelenota ananas*	2.9	1.7	35	33.3	8.3	3	9
Marau_Non_MPA	*Holothuria scabra*	16.7	14.3	35	194.4	152.8	3	9
Marau_Non_MPA	*Holothuria coluber*	8.3	5.3	35	97.2	36.7	3	9
Marau_Non_MPA	*Bohadschia argus*	7.1	2.7	35	41.7	0.0	6	17
Marau_Non_MPA	*Holothuria fuscogilva*	8.6	3.4	35	50.0	6.8	6	17
Ngella_MPA	*Holothuria whitmaei*	6.9	6.9	6	41.7		1	17
Ngella_MPA	*Bohadschia vitiensis*	13.9	13.9	6	83.3		1	17
Ngella_MPA	*Pearsonothuria graeffei*	34.7	22.6	6	104.2	20.8	2	33
Ngella_MPA	*Stichopus chloronotus*	6.9	6.9	6	41.7		1	17

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Ngella_MPA	*Holothuria atra*	819.4	255.6	6	819.4	255.6	6	100
Ngella_MPA	*Thelenota ananas*	6.9	6.9	6	41.7		1	17
Ngella_MPA	*Actinopyga mauritiana*	6.9	6.9	6	41.7		1	17
Ngella_MPA	*Synapta maculata*	27.8	27.8	6	166.7		1	17
Ngella_MPA	*Bohadschia argus*	34.7	16.7	6	69.4	13.9	3	50
Ngella_MPA	*Holothuria fuscogilva*	6.9	6.9	6	41.7		1	17
Ngella_Non_MPA	*Holothuria whitmaei*	2.8	1.9	30	41.7	0.0	2	7
Ngella_Non_MPA	*Pearsonothuria graeffei*	5.6	4.3	30	83.3	41.7	2	7
Ngella_Non_MPA	*Actinopyga miliaris*	1.4	1.4	30	41.7		1	3
Ngella_Non_MPA	*Holothuria atra*	152.8	35.2	30	208.3	42.2	22	73
Ngella_Non_MPA	*Holothuria scabra*	13.9	13.9	30	416.7		1	3
Ngella_Non_MPA	*Actinopyga lecanora*	1.4	1.4	30	41.7		1	3
Ngella_Non_MPA	*Bohadschia argus*	16.7	6.8	30	83.3	15.2	6	20
Ngella_Non_MPA	*Holothuria fuscogilva*	5.6	3.3	30	55.6	13.9	3	10
Rarumana	*Stichopus vastus*	3.0	3.0	14	41.7		1	7
Rarumana	*Bohadschia vitiensis*	20.8	11.3	14	97.2	13.9	3	21
Rarumana	*Stichopus herrmanni*	3.0	3.0	14	41.7		1	7
Rarumana	*Pearsonothuria graeffei*	6.0	6.0	14	83.3		1	7
Rarumana	*Actinopyga miliaris*	8.9	6.4	14	62.5	20.8	2	14
Rarumana	*Holothuria atra*	77.4	41.9	14	154.8	74.8	7	50
Rarumana	*Holothuria edulis*	29.8	21.1	14	138.9	77.3	3	21
Rarumana	*Holothuria fuscogilva*	11.9	6.8	14	55.6	13.9	3	21
Reef Islands	*Holothuria whitmaei*	1.6	1.6	26	41.7		1	4
Reef Islands	*Stichopus vastus*	3.2	3.2	26	83.3		1	4
Reef Islands	*Bohadschia vitiensis*	89.7	55.3	26	291.7	164.4	8	31
Reef Islands	*Actinopyga palauensis*	20.8	19.2	26	270.8	229.2	2	8
Reef Islands	*Stichopus chloronotus*	4.8	4.8	26	125.0		1	4
Reef Islands	*Actinopyga miliaris*	1.6	1.6	26	41.7		1	4
Reef Islands	*Holothuria atra*	101.0	29.8	26	175.0	42.7	15	58
Reef Islands	*Holothuria scabra*	1.6	1.6	26	41.7		1	4
Reef Islands	*Bohadschia argus*	91.3	73.7	26	395.8	305.9	6	23
Reef Islands	*Holothuria fuscogilva*	3.2	2.2	26	41.7	0.0	2	8
Russell Islands_Non_MPA	*Holothuria whitmaei*	1.4	1.4	29	41.7		1	3
Russell Islands_Non_MPA	*Bohadschia vitiensis*	33.0	25.6	29	479.2	229.2	2	7
Russell Islands_Non_MPA	*Bohadschia marmorata*	1.4	1.4	29	41.7		1	3

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Russell Islands_Non_MPA	*Actinopyga echinites*	24.4	16.6	29	177.1	98.3	4	14
Russell Islands_Non_MPA	*Pearsonothuria graeffei*	1.4	1.4	29	41.7		1	3
Russell Islands_Non_MPA	*Stichopus chloronotus*	2.9	2.9	29	83.3		1	3
Russell Islands_Non_MPA	*Holothuria atra*	232.8	96.4	29	397.1	153.8	17	59
Russell Islands_Non_MPA	*Actinopyga mauritiana*	1.4	1.4	29	41.7		1	3
Russell Islands_Non_MPA	*Synapta maculata*	56.0	33.7	29	270.8	138.5	6	21
Russell Islands_Non_MPA	*Bohadschia argus*	21.6	5.7	29	56.8	6.3	11	38
Russell Islands_Non_MPA	*Holothuria leucospilota*	2.9	2.9	29	83.3		1	3
Russell Islands_Non_MPA	*Holothuria fuscogilva*	11.5	4.6	29	55.6	8.8	6	21
Santa Cruz	*Stichopus vastus*	6.9	6.9	6	41.7		1	17
Santa Cruz	*Bohadschia vitiensis*	347.2	266.3	6	1,041.7	583.3	2	33
Santa Cruz	*Actinopyga palauensis*	13.9	13.9	6	83.3		1	17
Santa Cruz	*Holothuria fuscopunctata*	41.7	41.7	6	250.0		1	17
Santa Cruz	*Pearsonothuria graeffei*	6.9	6.9	6	41.7		1	17
Santa Cruz	*Holothuria lessoni*	6.9	6.9	6	41.7		1	17
Santa Cruz	*Holothuria atra*	3,250.0	2,060.0	6	6,500.0	3,264.2	3	50
Santa Cruz	*Holothuria edulis*	13.9	13.9	6	83.3		1	17
Santa Cruz	*Holothuria coluber*	48.6	31.2	6	145.8	20.8	2	33
Santa Cruz	*Bohadschia argus*	69.4	53.4	6	138.9	97.2	3	50
Santa Cruz	*Holothuria fuscogilva*	6.9	6.9	6	41.7		1	17
Star Harbour	*Bohadschia vitiensis*	79.2	32.5	10	131.9	42.2	6	60
Star Harbour	*Bohadschia marmorata*	4.2	4.2	10	41.7		1	10
Star Harbour	*Stichopus herrmanni*	33.3	33.3	10	333.3		1	10
Star Harbour	*Actinopyga echinites*	725.0	720.4	10	3,625.0	3,583.3	2	20
Star Harbour	*Stichopus horrens*	8.3	8.3	10	83.3		1	10
Star Harbour	*Pearsonothuria graeffei*	8.3	8.3	10	83.3		1	10
Star Harbour	*Holothuria lessoni*	333.3	251.6	10	1,666.7	791.7	2	20
Star Harbour	*Actinopyga miliaris*	25.0	16.7	10	83.3	41.7	3	30
Star Harbour	*Holothuria atra*	1,766.7	1,080.1	10	1,963.0	1,187.4	9	90
Star Harbour	*Holothuria edulis*	4.2	4.2	10	41.7		1	10
Star Harbour	*Holothuria scabra*	3,666.7	1,976.3	10	9,166.7	3,533.8	4	40
Star Harbour	*Actinopyga mauritiana*	8.3	8.3	10	83.3		1	10
Star Harbour	*Bohadschia argus*	1,166.7	1,166.7	10	11,666.7		1	10
Tapazaka	*Holothuria whitmaei*	15.6	11.0	8	62.5	20.8	2	25
Tapazaka	*Bohadschia vitiensis*	500.0	465.3	8	2,000.0	1,750.0	2	25

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Tapazaka	*Holothuria lessoni*	5.2	5.2	8	41.7		1	13
Tapazaka	*Holothuria atra*	302.1	104.7	8	402.8	111.1	6	75
Tapazaka	*Holothuria scabra*	99.0	82.6	8	395.8	270.8	2	25
Tapazaka	*Actinopyga mauritiana*	166.7	166.7	8	1,333.3		1	13
Tapazaka	*Bohadschia argus*	166.7	133.4	8	444.4	323.0	3	38
Tapazaka	*Holothuria fuscogilva*	5.2	5.2	8	41.7		1	13
Taro	*Holothuria whitmaei*	3.2	3.2	13	41.7		1	8
Taro	*Bohadschia vitiensis*	70.5	32.8	13	152.8	55.6	6	46
Taro	*Stichopus herrmanni*	12.8	8.7	13	83.3	0.0	2	15
Taro	*Pearsonothuria graeffei*	9.6	5.1	13	41.7	0.0	3	23
Taro	*Holothuria lessoni*	22.4	22.4	13	291.7		1	8
Taro	*Actinopyga miliaris*	3.2	3.2	13	41.7		1	8
Taro	*Holothuria atra*	35.3	13.2	13	76.4	16.7	6	46
Taro	*Thelenota ananas*	3.2	3.2	13	41.7		1	8
Taro	*Holothuria scabra*	16.0	16.0	13	208.3		1	8
Taro	*Bohadschia argus*	51.3	21.2	13	111.1	31.7	6	46
Taro	*Holothuria fuscogilva*	22.4	16.8	13	145.8	62.5	2	15
Tatamba	*Holothuria whitmaei*	4.6	4.6	18	83.3		1	6
Tatamba	*Bohadschia vitiensis*	23.1	13.6	18	138.9	36.7	3	17
Tatamba	*Thelenota rubralineata*	39.4	37.0	18	354.2	312.5	2	11
Tatamba	*Stichopus herrmanni*	9.3	7.2	18	83.3	41.7	2	11
Tatamba	*Holothuria fuscopunctata*	2.3	2.3	18	41.7		1	6
Tatamba	*Actinopyga miliaris*	2.3	2.3	18	41.7		1	6
Tatamba	*Holothuria atra*	592.6	390.9	18	820.5	533.1	13	72
Tatamba	*Thelenota ananas*	11.6	9.4	18	104.2	62.5	2	11
Tatamba	*Actinopyga lecanora*	2.3	2.3	18	41.7		1	6
Tatamba	*Bohadschia argus*	16.2	9.6	18	72.9	31.3	4	22
Tatamba	*Holothuria fuscogilva*	23.1	18.8	18	208.3	125.0	2	11
Ugi	*Bohadschia vitiensis*	125.0	114.9	5	312.5	270.8	2	40
Ugi	*Stichopus herrmanni*	8.3	8.3	5	41.7		1	20
Ugi	*Holothuria fuscopunctata*	16.7	16.7	5	83.3		1	20
Ugi	*Pearsonothuria graeffei*	8.3	8.3	5	41.7		1	20
Ugi	*Holothuria atra*	275.0	89.9	5	275.0	89.9	5	100
Ugi	*Holothuria edulis*	8.3	8.3	5	41.7		1	20
Ugi	*Actinopyga lecanora*	25.0	25.0	5	125.0		1	20

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Ugi	*Bohadschia argus*	50.0	15.6	5	62.5	12.0	4	80
Ugi	*Holothuria fuscogilva*	8.3	8.3	5	41.7		1	20
W. Guadalcanal_MPA	*Bohadschia vitiensis*	8.3	8.3	5	41.7		1	20
W. Guadalcanal_MPA	*Bohadschia marmorata*	83.3	83.3	5	416.7		1	20
W. Guadalcanal_MPA	*Holothuria atra*	300.0	142.2	5	375.0	155.9	4	80
W. Guadalcanal_MPA	*Holothuria scabra*	16.7	16.7	5	83.3		1	20
W. Guadalcanal_MPA	*Actinopyga mauritiana*	8.3	8.3	5	41.7		1	20
W. Guadalcanal_MPA	*Bohadschia argus*	8.3	8.3	5	41.7		1	20
W. Guadalcanal_Non_MPA	*Bohadschia vitiensis*	4.9	3.4	17	41.7	0.0	2	12
W. Guadalcanal_Non_MPA	*Holothuria lessoni*	2.5	2.5	17	41.7		1	6
W. Guadalcanal_Non_MPA	*Stichopus chloronotus*	4.9	4.9	17	83.3		1	6
W. Guadalcanal_Non_MPA	*Holothuria atra*	345.6	202.7	17	534.1	302.5	11	65
W. Guadalcanal_Non_MPA	*Thelenota ananas*	19.6	11.4	17	111.1	27.8	3	18
W. Guadalcanal_Non_MPA	*Holothuria scabra*	4.9	4.9	17	83.3		1	6
W. Guadalcanal_Non_MPA	*Holothuria coluber*	7.4	7.4	17	125.0		1	6
W. Guadalcanal_Non_MPA	*Synapta maculata*	14.7	8.7	17	83.3	24.1	3	18
W. Guadalcanal_Non_MPA	*Bohadschia argus*	61.3	19.3	17	115.7	24.8	9	53
W. Guadalcanal_Non_MPA	*Holothuria fuscogilva*	2.5	2.5	17	41.7		1	6

Mean = overall mean density (numbers per hectare); Mean_P = mean density of stations where species is present; n = number of stations; SE = standard error; n_P = number of stations where species is present; %_P = percentage of stations when a record is present; MPA = marine protected area.

Appendix 2.

Sea cucumber densities from broad-scale manta tow assessments (2011/2012)

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Chubikobi	*Holothuria atra*	17.9	5.4	14	17.9	5.4	14	100
Chubikobi	*Bohadschia vitiensis*	2.8	1.4	14	7.8	3.0	5	36
Chubikobi	*Actinopyga miliaris*	1.0	0.6	14	4.6	1.9	3	21
Chubikobi	*Synapta maculata*	1.6	1.0	14	7.4	2.4	3	21
Chubikobi	*Bohadschia argus*	0.6	0.4	14	4.2	1.4	2	14
Chubikobi	*Holothuria fuscopunctata*	0.4	0.3	14	2.8	0.0	2	14
Chubikobi	*Stichopus vastus*	0.2	0.2	14	2.8		1	7
Kia	*Holothuria atra*	12.1	4.6	20	18.6	6.4	13	65
Kia	*Bohadschia argus*	1.3	0.5	20	4.2	0.9	6	30
Kia	*Pearsonothuria graeffei*	1.4	0.6	20	5.6	1.2	5	25
Kia	*Bohadschia vitiensis*	0.6	0.3	20	2.8	0.0	4	20
Kia	*Holothuria edulis*	0.8	0.5	20	5.6	1.6	3	15
Kia	*Thelenota ananas*	1.0	0.6	20	6.5	2.4	3	15
Kia	*Thelenota anax*	0.4	0.2	20	2.8	0.0	3	15
Kia	*Holothuria fuscogilva*	0.3	0.2	20	2.8	0.0	2	10
Kia	*Holothuria fuscopunctata*	0.1	0.1	20	2.8		1	5
Kia	*Stichopus chloronotus*	5.7	5.7	20	113.9		1	5
Kia	*Stichopus herrmanni*	1.0	1.0	20	19.4		1	5
Kia	*Stichopus vastus*	0.1	0.1	20	2.8		1	5
Marau_MPA	*Bohadschia argus*	7.2	2.9	5	9.0	2.9	4	80
Marau_MPA	*Thelenota ananas*	8.9	3.4	5	11.1	3.4	4	80
Marau_MPA	*Holothuria fuscogilva*	5.6	3.2	5	9.3	4.0	3	60
Marau_MPA	*Holothuria fuscopunctata*	10.0	6.7	5	25.0	8.3	2	40
Marau_MPA	*Stichopus herrmanni*	10.0	6.7	5	25.0	8.3	2	40
Marau_MPA	*Holothuria atra*	1.7	1.7	5	8.3		1	20
Marau_MPA	*Thelenota anax*	0.6	0.6	5	2.8		1	20
Maurau_Non_MPA	*Bohadschia argus*	2.9	0.8	19	5.6	0.7	10	53
Maurau_Non_MPA	*Holothuria atra*	6.2	2.8	19	11.8	4.8	10	53
Maurau_Non_MPA	*Thelenota ananas*	1.9	0.9	19	6.1	2.2	6	32
Maurau_Non_MPA	*Thelenota anax*	0.9	0.4	19	4.2	0.8	4	21
Maurau_Non_MPA	*Bohadschia vitiensis*	0.4	0.2	19	2.8	0.0	3	16
Maurau_Non_MPA	*Holothuria edulis*	0.4	0.2	19	2.8	0.0	3	16
Maurau_Non_MPA	*Holothuria fuscopunctata*	0.8	0.4	19	5.1	0.5	3	16

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Maurau_Non_MPA	*Pearsonothuria graeffei*	0.3	0.3	19	5.6		1	5
Maurau_Non_MPA	*Bohadschia herrmanni*	0.1	0.1	19	2.8		1	5
Maurau_Non_MPA	*Holothuria fuscogilva*	0.1	0.1	19	2.8		1	5
Maurau_Non_MPA	*Stichopus herrmanni*	0.3	0.3	19	5.6		1	5
Ngella_MPA	*Bohadschia argus*	7.4	0.9	3	7.4	0.9	3	100
Ngella_MPA	*Holothuria atra*	41.7	29.2	3	41.7	29.2	3	100
Ngella_MPA	*Thelenota anax*	2.8	1.6	3	4.2	1.4	2	67
Ngella_MPA	*Pearsonothuria graeffei*	1.9	1.9	3	5.6		1	33
Ngella_MPA	*Holothuria fuscogilva*	0.9	0.9	3	2.8		1	33
Ngella_Non_MPA	*Holothuria atra*	10.9	3.4	13	14.2	3.9	10	77
Ngella_Non_MPA	*Thelenota ananas*	1.3	0.7	13	4.3	1.5	4	31
Ngella_Non_MPA	*Bohadschia argus*	1.3	0.8	13	5.7	1.8	3	23
Ngella_Non_MPA	*Pearsonothuria graeffei*	0.4	0.3	13	2.8	0.0	2	15
Ngella_Non_MPA	*Holothuria fuscogilva*	0.4	0.3	13	2.8	0.0	2	15
Ngella_Non_MPA	*Actinopyga mauritiana*	0.2	0.2	13	2.8		1	8
Ngella_Non_MPA	*Bohadschia vitiensis*	0.2	0.2	13	2.8		1	8
Ngella_Non_MPA	*Holothuria edulis*	0.2	0.2	13	2.8		1	8
Ngella_Non_MPA	*Holothuria fuscopunctata*	0.6	0.6	13	8.3		1	8
Ngella_Non_MPA	*Stichopus herrmanni*	0.4	0.4	13	5.6		1	8
Rarumana	*Holothuria atra*	11.8	7.9	12	17.7	11.5	8	67
Rarumana	*Bohadschia argus*	1.2	0.5	12	3.5	0.7	4	33
Rarumana	*Bohadschia vitiensis*	1.2	0.6	12	4.6	0.9	3	25
Rarumana	*Holothuria edulis*	0.5	0.3	12	2.8	0.0	2	17
Rarumana	*Holothuria fuscogilva*	0.5	0.3	12	2.8	0.0	2	17
Rarumana	*Holothuria fuscopunctata*	0.7	0.5	12	4.2	1.4	2	17
Rarumana	*Actinopyga miliaris*	0.2	0.2	12	2.8		1	8
Rarumana	*Pearsonothuria graeffei*	0.2	0.2	12	2.8		1	8
Reef Islands	*Holothuria atra*	3.5	1.3	16	6.9	1.8	8	50
Reef Islands	*Bohadschia argus*	2.1	1.0	16	6.7	2.1	5	31
Reef Islands	*Bohadschia vitiensis*	0.3	0.2	16	2.8	0.0	2	13
Reef Islands	*Holothuria edulis*	0.7	0.7	16	11.1		1	6
Reef Islands	*Pearsonothuria graeffei*	0.3	0.3	16	5.6		1	6
Russell Islands_Non_MPA	*Holothuria atra*	10.0	6.8	13	26.1	15.9	5	38
Russell Islands_Non_MPA	*Bohadschia argus*	0.6	0.3	13	2.8	0.0	3	23

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Russell Islands_Non_MPA	*Bohadschia vitiensis*	0.4	0.3	13	2.8	0.0	2	15
Russell Islands_Non_MPA	*Thelenota anax*	0.4	0.3	13	2.8	0.0	2	15
Russell Islands_Non_MPA	*Actinopyga echinites*	0.2	0.2	13	2.8		1	8
Santa Cruz	*Holothuria atra*	13.2	7.2	8	21.1	10.2	5	63
Santa Cruz	*Bohadschia argus*	9.0	7.2	8	24.1	17.3	3	38
Santa Cruz	*Bohadschia vitiensis*	2.1	1.7	8	8.3	5.6	2	25
Santa Cruz	*Holothuria edulis*	2.8	2.4	8	11.1	8.3	2	25
Santa Cruz	*Actinopyga mauritiana*	0.3	0.3	8	2.8		1	13
Santa Cruz	*Actinopyga palauensis*	0.3	0.3	8	2.8		1	13
Santa Cruz	*Holothuria fuscogilva*	0.7	0.7	8	5.6		1	13
Santa Cruz	*Holothuria fuscopunctata*	2.8	2.8	8	22.2		1	13
Santa Cruz	*Holothuria whitmaei*	0.3	0.3	8	2.8		1	13
Santa Cruz	*Pearsonothuria graeffei*	0.3	0.3	8	2.8		1	13
Santa Cruz	*Thelenota anax*	0.3	0.3	8	2.8		1	13
Star Harbour	*Holothuria atra*	55.1	30.9	6	55.1	30.9	6	100
Star Harbour	*Holothuria edulis*	7.4	6.9	6	22.2	19.4	2	33
Star Harbour	*Thelenota ananas*	0.9	0.6	6	2.8	0.0	2	33
Star Harbour	*Bohadschia argus*	2.3	2.3	6	13.9		1	17
Star Harbour	*Bohadschia vitiensis*	0.5	0.5	6	2.8		1	17
Star Harbour	*Holothuria fuscopunctata*	0.5	0.5	6	2.8		1	17
Tapazaka	*Holothuria atra*	100.9	20.2	6	100.9	20.2	6	100
Tapazaka	*Bohadschia argus*	3.2	1.7	6	4.9	2.1	4	67
Tapazaka	*Bohadschia vitiensis*	2.8	2.8	6	16.7		1	17
Tapazaka	*Holothuria fuscopunctata*	0.5	0.5	6	2.8		1	17
Taro	*Holothuria atra*	20.2	4.3	11	22.2	4.2	10	91
Taro	*Bohadschia argus*	4.0	1.1	11	6.3	1.0	7	64
Taro	*Thelenota ananas*	2.0	0.7	11	3.7	0.6	6	55
Taro	*Thelenota anax*	1.8	1.0	11	4.9	2.1	4	36
Taro	*Bohadschia vitiensis*	4.5	2.9	11	16.7	7.0	3	27
Taro	*Holothuria whitmaei*	0.8	0.4	11	2.8	0.0	3	27
Taro	*Holothuria fuscogilva*	0.5	0.3	11	2.8	0.0	2	18
Taro	*Pearsonothuria graeffei*	0.5	0.3	11	2.8	0.0	2	18
Taro	*Holothuria lessoni*	0.5	0.5	11	5.6		1	9
Taro	*Stichopus herrmanni*	0.3	0.3	11	2.8		1	9

Site	Species	Mean	SE	n	Mean_P	SE_P	n_P	%_P
Tatamba	*Holothuria atra*	31.0	12.6	6	37.2	13.4	5	83
Tatamba	*Holothuria fuscogilva*	4.2	3.6	6	12.5	9.7	2	33
Tatamba	*Bohadschia argus*	0.5	0.5	6	2.8		1	17
Ugi	*Holothuria atra*	6.0	2.2	6	7.2	2.3	5	83
Ugi	*Bohadschia argus*	1.4	0.6	6	2.8	0.0	3	50
Ugi	*Holothuria edulis*	1.9	0.9	6	3.7	0.9	3	50
Ugi	*Holothuria fuscopunctata*	0.5	0.5	6	2.8		1	17
Ugi	*Holothuria whitmaei*	0.5	0.5	6	2.8		1	17
Ugi	*Thelenota ananas*	4.2	4.2	6	25.0		1	17
W. Guadalcanal_MPA	*Bohadschia argus*	1.4	1.4	2	2.8		1	50
W. Guadalcanal_MPA	*Holothuria atra*	2.8	2.8	2	5.6		1	50
W. Guadalcanal_Non_MPA	*Holothuria atra*	10.7	6.6	7	12.5	7.5	6	86
W. Guadalcanal_Non_MPA	*Holothuria fuscopunctata*	2.4	1.5	7	5.6	2.8	3	43
W. Guadalcanal_Non_MPA	*Bohadschia argus*	0.8	0.5	7	2.8	0.0	2	29
W. Guadalcanal_Non_MPA	*Bohadschia vitiensis*	1.6	1.6	7	11.1		1	14
W. Guadalcanal_Non_MPA	*Thelenota ananas*	0.8	0.8	7	5.6		1	14
W. Guadalcanal_Non_MPA	*Thelenota anax*	0.8	0.8	7	5.6		1	14

Mean = overall mean density (numbers per hectare); Mean_P = mean density of stations where species is present; n = number of stations; SE = standard error; n_P = number of stations where species is present; %_P = percentage of stations when a record is present; MPA = marine protected area.

Appendix 3.

Mean size (length in mm) of sea cucumbers from all sites surveyed in Solomon Islands sites and regional common size (2011/2012)

Common name	Mean size (mm)	SE	n	Regional common size (mm)
Black teatfish	207	19.1	15	340
Brown sandfish	237	3.2	335	310
Chalkfish	165	8.5	30	220
Curryfish	260	18.9	23	390
Deepwater blackfish	147	11.5	15	300
Deepwater redfish	174	10.6	46	150
Elephant trunkfish	362	24.2	21	480
Flowerfish	284	9.0	35	380
Golden sandfish	231	13.1	35	200
Greenfish	252	18.9	13	230
Hairy blackfish	184	11.4	16	230
Lollyfish	207	2.5	1,133	240
Pinkfish	236	10.0	37	240
Prickly redfish	373	24.6	22	550
Sandfish	159	3.4	229	240
Snakefish	263	32.0	7	400
Surf redfish	175	6.8	36	240
Tigerfish	272	4.8	129	370
White teatfish	237	8.6	64	410

SE = standard error; n = number of specimens.

Appendix 4.

Mean size (length in mm) for sea cucumbers by sites in Solomon Islands (2011/2012)

Site	Species	Mean_L (mm)	SE	n
Central Malaita	*Actinopyga echinites*	141	9.0	9
Central Malaita	*Actinopyga mauritiana*	150		1
Central Malaita	*Bohadschia argus*	323	14.5	3
Central Malaita	*Bohadschia marmorata*	142	12.4	9
Central Malaita	*Bohadschia vitiensis*	220		1
Central Malaita	*Holothuria atra*	232	16.9	20
Central Malaita	*Holothuria coluber*	200		1
Central Malaita	*Holothuria fuscopunctata*	290		1
Central Malaita	*Holothuria whitmaei*	230		1
Central Malaita	*Holothuria scabra*	184	6.8	5
Chubikobi	*Actinopyga miliaris*	180		1
Chubikobi	*Bohadschia argus*	285	35.0	2
Chubikobi	*Bohadschia marmorata*	245	25.0	2
Chubikobi	*Bohadschia vitiensis*	226	18.1	5
Chubikobi	*Holothuria atra*	216	13.0	37
Chubikobi	*Holothuria atra* (big)	257	29.6	3
Chubikobi	*Holothuria edulis*	244	32.8	5
Chubikobi	*Holothuria flavomaculata*	20		1
Chubikobi	*Holothuria fuscogilva*	247	32.0	4
Chubikobi	*Holothuria fuscopunctata*	410		1
Chubikobi	*Holothuria lessoni*	150		1
Chubikobi	*Pearsonothuria graeffei*	253	15.1	13
Chubikobi	*Thelenota ananas*	260		1
Chubikobi	*Thelenota anax*	540		1
Kia	*Actinopyga mauritiana*	190	10.0	2
Kia	*Actinopyga miliaris*	270		1
Kia	*Bohadschia argus*	252	25.6	16
Kia	*Bohadschia vitiensis*	222	36.8	8
Kia	*Holothuria atra*	178	6.0	181
Kia	*Holothuria edulis*	231	14.1	17
Kia	*Holothuria fuscogilva*	324	47.0	5
Kia	*Holothuria fuscopunctata*	336	17.0	8
Kia	*Holothuria whitmaei*	213	34.1	8
Kia	*Pearsonothuria graeffei*	296	9.4	14

Site	Species	Mean_L (mm)	SE	n
Kia	*Stichopus chloronotus*	218	15.8	6
Kia	*Thelenota ananas*	350	13.4	5
Marau_MPA	*Actinopyga miliaris*	130		1
Marau_MPA	*Bohadschia argus*	257	30.5	7
Marau_MPA	*Pearsonothuria graeffei*	290	30.0	2
Marau_MPA	*Bohadschia marmorata*	120	3.2	5
Marau_MPA	*Bohadschia vitiensis*	210		1
Marau_MPA	*Holothuria atra*	353	37.0	6
Marau_MPA	*Holothuria edulis*	260		1
Marau_MPA	*Holothuria fuscogilva*	235	18.2	5
Marau_MPA	*Holothuria fuscopunctata*	570		1
Marau_MPA	*Holothuria scabra*	132	4.8	37
Marau_MPA	*Stichopus herrmanni*	182	39.0	4
Marau_MPA	*Thelenota ananas*	750		1
Maurau_Non_MPA	*Bohadschia argus*	241	32.5	7
Maurau_Non_MPA	*Pearsonothuria graeffei*	250	30.1	11
Maurau_Non_MPA	*Bohadschia marmorata*	197	9.9	12
Maurau_Non_MPA	*Bohadschia vitiensis*	212	11.9	20
Maurau_Non_MPA	*Holothuria atra*	210	9.4	59
Maurau_Non_MPA	*Holothuria edulis*	283	31.8	3
Maurau_Non_MPA	*Holothuria fuscogilva*	209	14.2	8
Maurau_Non_MPA	*Holothuria fuscopunctata*	350		1
Maurau_Non_MPA	*Holothuria lessoni*	175		1
Maurau_Non_MPA	*Holothuria whitmaei*	270	30.0	2
Maurau_Non_MPA	*Holothuria scabra*	230	15.0	14
Maurau_Non_MPA	*Stichopus horrens*	230		1
Maurau_Non_MPA	*Thelenota ananas*	360	20.8	3
Ngella_MPA	*Actinopyga mauritiana*	250		1
Ngella_MPA	*Bohadschia argus*	282	46.4	4
Ngella_MPA	*Pearsonothuria graeffei*	265	35.0	2
Ngella_MPA	*Bohadschia vitiensis*	235	35.0	2
Ngella_MPA	*Holothuria atra*	219	7.3	92
Ngella_MPA	*Holothuria fuscogilva*	320		1
Ngella_MPA	*Holothuria whitmaei*	230		1
Ngella_MPA	*Stichopus chloronotus*	210		1

Site	Species	Mean_L (mm)	SE	n
Ngella_MPA	*Thelenota ananas*	450		1
Ngella_Non_MPA	*Actinopyga lecanora*	150		1
Ngella_Non_MPA	*Actinopyga mauritiana*	270		1
Ngella_Non_MPA	*Actinopyga miliaris*	180		1
Ngella_Non_MPA	*Bohadschia argus*	312	24.7	12
Ngella_Non_MPA	*Pearsonothuria graeffei*	287	25.0	4
Ngella_Non_MPA	*Holothuria atra*	229	8.1	79
Ngella_Non_MPA	*Holothuria fuscogilva*	217	25.0	6
Ngella_Non_MPA	*Holothuria whitmaei*	240	40.0	2
Ngella_Non_MPA	*Holothuria scabra*	134	7.9	10
Ngella_Non_MPA	*Stichopus herrmanni*	240	30.0	2
Ngella_Non_MPA	*Thelenota ananas*	580		1
Rarumana	*Actinopyga miliaris*	235	65.0	2
Rarumana	*Bohadschia vitiensis*	263	26.0	7
Rarumana	*Holothuria atra*	174	10.9	26
Rarumana	*Holothuria edulis*	234	20.1	10
Rarumana	*Holothuria fuscogilva*	258	36.4	5
Rarumana	*Holothuria scabra*	95	5.0	2
Rarumana	*Pearsonothuria graeffei*	290	10.0	2
Rarumana	*Stichopus herrmanni*	500		1
Rarumana	*Stichopus vastus*	420		1
Reef Islands	*Actinopyga miliaris*	210		1
Reef Islands	*Actinopyga palauensis*	148	13.3	13
Reef Islands	*Bohadschia argus*	294	8.5	57
Reef Islands	*Bohadschia vitiensis*	234	7.5	53
Reef Islands	*Holothuria atra*	184	10.1	63
Reef Islands	*Holothuria fuscogilva*	240	60.0	2
Reef Islands	*Holothuria scabra*	300		1
Reef Islands	*Holothuria whitmaei*	170		1
Reef Islands	*Stichopus chloronotus*	263	69.4	3
Reef Islands	*Stichopus vastus*	230	70.0	2
Russell Islands_Non_MPA	*Actinopyga echinites*	193	16.7	17
Russell Islands_Non_MPA	*Actinopyga mauritiana*	240		1
Russell Islands_Non_MPA	*Bohadschia argus*	287	22.2	15
Russell Islands_Non_MPA	*Bohadschia marmorata*	210		1

Site	Species	Mean_L (mm)	SE	n
Russell Islands_Non_MPA	*Bohadschia vitiensis*	196	9.6	23
Russell Islands_Non_MPA	*Holothuria atra*	180	4.8	121
Russell Islands_Non_MPA	*Holothuria fuscogilva*	179	15.6	8
Russell Islands_Non_MPA	*Holothuria whitmaei*	160		1
Russell Islands_Non_MPA	*Stichopus chloronotus*	310	10.0	2
Russell Islands_Non_MPA	*Thelenota anax*	500		1
Santa Cruz	*Actinopyga palauensis*	145	5.0	2
Santa Cruz	*Bohadschia argus*	312	15.8	10
Santa Cruz	*Bohadschia vitiensis*	252	6.3	50
Santa Cruz	*Holothuria atra*	194	8.1	68
Santa Cruz	*Holothuria coluber*	277	30.5	7
Santa Cruz	*Holothuria edulis*	265	15.0	2
Santa Cruz	*Holothuria fuscogilva*	190		1
Santa Cruz	*Holothuria fuscopunctata*	408	53.0	6
Santa Cruz	*Holothuria lessoni*	270		1
Santa Cruz	*Pearsonothuria graeffei*	300		1
Santa Cruz	*Stichopus vastus*	280		1
Star Harbour	*Actinopyga echinites*	171	15.6	24
Star Harbour	*Actinopyga mauritiana*	185	5.0	2
Star Harbour	*Actinopyga miliaris*	172	9.1	6
Star Harbour	*Bohadschia marmorata*	150		1
Star Harbour	*Bohadschia vitiensis*	266	9.2	19
Star Harbour	*Holothuria atra*	215	10.5	89
Star Harbour	*Holothuria edulis*	260		1
Star Harbour	*Holothuria lessoni*	192	11.0	28
Star Harbour	*Holothuria scabra*	150	3.4	112
Star Harbour	*Pearsonothuria graeffei*	370	80.0	2
Star Harbour	*Stichopus herrmanni*	241	25.7	8
Star Harbour	*Stichopus horrens*	165	35.0	2
Tapazaka	*Actinopyga mauritiana*	163	6.1	32
Tapazaka	*Bohadschia argus*	231	6.5	32
Tapazaka	*Bohadschia vitiensis*	238	3.1	96
Tapazaka	*Holothuria atra*	223	10.8	58
Tapazaka	*Holothuria fuscogilva*	160		1
Tapazaka	*Holothuria lessoni*	250		1

Site	Species	Mean_L (mm)	SE	n
Tapazaka	*Holothuria scabra*	148	6.3	19
Tapazaka	*Holothuria whitmaei*	210	34.6	3
Taro	*Actinopyga miliaris*	180		1
Taro	*Bohadschia argus*	260	10.2	16
Taro	*Bohadschia vitiensis*	256	13.7	22
Taro	*Holothuria atra*	351	26.0	11
Taro	*Holothuria fuscogilva*	300	23.5	7
Taro	*Holothuria lessoni*	341	17.4	7
Taro	*Holothuria scabra*	202	14.6	5
Taro	*Holothuria whitmaei*	240		1
Taro	*Pearsonothuria graeffei*	300	15.3	3
Taro	*Stichopus herrmanni*	260	19.1	4
Taro	*Thelenota ananas*	500		1
Tatamba	*Actinopyga lecanora*	140		1
Tatamba	*Actinopyga miliaris*	130		1
Tatamba	*Bohadschia argus*	207	12.3	7
Tatamba	*Bohadschia vitiensis*	259	9.4	10
Tatamba	*Holothuria atra*	236	8.1	84
Tatamba	*Holothuria fuscogilva*	219	8.0	10
Tatamba	*Holothuria fuscopunctata*	290		1
Tatamba	*Holothuria whitmaei*	180	0.0	2
Tatamba	*Stichopus herrmanni*	277	16.5	4
Tatamba	*Thelenota ananas*	240		1
Ugi	*Actinopyga lecanora*	227	6.7	3
Ugi	*Bohadschia argus*	295	6.2	6
Ugi	*Bohadschia vitiensis*	261	6.9	15
Ugi	*Holothuria atra*	238	12.9	33
Ugi	*Holothuria edulis*	120		1
Ugi	*Holothuria fuscogilva*	290		1
Ugi	*Holothuria fuscopunctata*	280	170.0	2
Ugi	*Pearsonothuria graeffei*	310		1
Ugi	*Stichopus herrmanni*	430		1
W. Guadalcanal_MPA	*Actinopyga mauritiana*	180		1
W. Guadalcanal_MPA	*Bohadschia argus*	260		1
W. Guadalcanal_MPA	*Bohadschia marmorata*	139	4.8	10

Site	Species	Mean_L (mm)	SE	n
W. Guadalcanal_MPA	Bohadschia vitiensis	130		1
W. Guadalcanal_MPA	*Holothuria atra*	164	9.0	36
W. Guadalcanal_MPA	*Holothuria scabra*	160	20.0	2
W. Guadalcanal_Non_MPA	*Bohadschia argus*	270	9.3	25
W. Guadalcanal_Non_MPA	*Bohadschia vitiensis*	200	40.0	2
W. Guadalcanal_Non_MPA	*Holothuria atra*	178	9.7	88
W. Guadalcanal_Non_MPA	*Holothuria fuscogilva*	150		1
W. Guadalcanal_Non_MPA	*Holothuria scabra*	235	5.0	2
W. Guadalcanal_Non_MPA	*Holothuria lessoni*	210		1
W. Guadalcanal_Non_MPA	*Stichopus chloronotus*	295	5.0	2
W. Guadalcanal_Non_MPA	*Thelenota ananas*	326	16.2	8

Note: For many species, sample sizes were low. Mean_L = mean length in mm; SE = standard error; n = number of specimens measured.

Appendix 5.

Beche-de-mer buying prices in Solomon Islands and average price for MSG + Tonga for high grade beche-de-mer

Local names	1991 (SBD)	2004 Honiara (SBD)	2004 Isabel Province (SBD)	2009 Western Province (SBD)	2010 Ontong Java (SBD)	2012 MSG + Tonga (SBD)	2012 MSG + Tonga (USD)
Amberfish	2.70	45	40	17	50	101.01	14
Black teatfish (l)	10.00	150	120	200	53	382.40	53
Black teatfish (sm)		100	45				
Hairy blackfish	8.00	180	160	250	200	144.30	20
Brown sandfish	3.30	70	57	100	100		
Brown sandfish (l)		35	35			101.01	14
Brown sandfish (sm)		20					
Chalkfish	6.00	30	27		300	101.01	14
Curryfish	9.00	185	158	250	200	144.30	20
Deepwater blackfish						324.68	45
Deepwater redfish						324.68	45
Elephant trunkfish	2.70	35	29	70		79.37	11
Golden sandfish						432.90	60
Greenfish	10.00	200	173	250		360.75	50
Hairy lollyfsh		25					
Hong pai / House pigfish		25	24				
Lemonfish		25					
Lollyfish (l)	1.60	30	23	50	35	79.37	11
Lollyfish (sm)		20	17				
Peanutfish (l)		185	158	250	250	101.01	14
Peanutfish (sm)		90	77				
Pinkfish	1.60			50		43.29	6
Prickly redfish (l)	13.00	185	155			324.68	45
Prickly redfish (sm)		90		320			
Red lollyfish		20	25				
Red snakefish		30	39				
Flowerfish / Ripple	1.60	30	19			101.01	14
Sandfish (l)	12.00	200	145			649.35	90
Sandfish (sm)		100	78				
Snakefish	1.60	40	35	50		115.44	16
Stonefish (l)	6.00	185	158	250		144.30	20
Stonefish (sm)		90					

Local names	1991 (SBD)	2004 Honiara (SBD)	2004 Isabel Province (SBD)	2009 Western Province (SBD)	2010 Ontong Java (SBD)	2012 MSG + Tonga (SBD)	2012 MSG + Tonga (USD)
Surf redfish (l)	7.50	170	159	200		281.39	39
Surf redfish (sm)		80	80				
Tigerfish	5.00		58	100	50	144.30	20
White teatfish (A)	30.00	270	230		300	606.06	84
White teatfish (B)		230	179		250		
White teatfish (C)		150	148		120		
White teatfish (D)		110	70		70		

Notes: Local names are trade names used in Solomon Islands. l = large; sm = small; A = A grade; B = B grade; C = C grade; D = D grade; SBD = Solomon Islands dollars; USD = United States dollars.

Appendix 6.

Procedure for estimating harvestable sea cucumber stocks

Step 1. Estimate density from section 3.3. If densities are above the regional reference for most species, progress to step 2, if densities are below the regional references, stock abundance is not healthy to recommend fishing, and fishing should not be allowed.

Step 2. Calculate the reef or habitat area of interest in hectares with the use of GIS mapping software.

Step 3. Calculate the standing stock by multiplying species density by reef habitat area (estimated number of individuals). Caution needs to be exercised here; it is of paramount importance that the variance of density estimates be taken into consideration. A more conservative way to derive standing stocks estimates for harvest recommendations is to apply the lower 95% confidence levels to any extrapolation of mean density.

Step 4. To estimate fishable stocks, a proportion of stocks above the minimum species harvest sizes (or size at maturity) is calculated. Multiply this by the total standing stock in step 3 to come up with the total estimated fishable stock.

Step 5. The recommended fishable stock estimates are worked out based on conservative estimates. Here it is recommended that harvest estimates be 30% or less of the total fishable stock. Note that this is to be worked out by site or fishing ground, which can vary from island to island and between specific village reef areas.

Step 6. Final fishable stock is then converted to biomass in wet weight and to dry weight, using standard conversion ratios (% weight loss) derived from other geographical locations in the Pacific. A table of sea cucumber conversion ratios is provided in Appendix 7. However, conversion ratio studies for the desired local products should be developed for Solomon Islands.

Step 7. The recommended harvest quota is presented to decision-makers in a report or advisory sheet, detailing the process followed to arrive at the final estimates.

Appendix 7.

Standard conversion ratio for processed sea cucumber products

Common name	Unprocessed weight 1 piece (g)	Semi-processed weight (gutted / salted)	Dried weight (beche-de-mer)
Amberfish	3,500	0.5	0.05
Black teatfish	2,400	0.5	0.10
Blackfish	500	0.5	0.10
Brown curryfish	650	0.5	0.04
Brown sandfish	1,000	0.5	0.04
Chalkfish	750	0.5	0.06
Curryfish	2,100	0.5	0.04
Deepwater blackfish	400	0.5	0.12
Elephant trunkfish	2,000	0.5	0.13
Flowerfish	1,000	0.5	0.04
Golden sandfish	1,400	0.5	0.08
Greenfish	300	0.5	0.03
Lollyfish	300	0.5	0.05
Peanutfish	100	0.5	0.04
Pinkfish	300	0.5	0.04
Prickly redfish	3,500	0.5	0.07
Red snakefish	300	0.5	0.04
Sandfish	750	0.5	0.05
Snakefish	300	0.5	0.04
Stonefish	650	0.5	0.05
Surf redfish	850	0.5	0.06
Tigerfish	1,000	0.5	0.04
White teatfish	2,500	0.5	0.09

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