The status of the sea cucumber fishery in Batiki District, Lomaiviti, Fiji

Watisoni Lalavanua[1,], Ilisoni Tuinasavusavu[1] and Peni Seru[1]*

Abstract

The paper aims at assessing the status of sea cucumber stocks around Batiki District in eastern Fiji in order to provide communities with information about stock status and advice on whether to impose a ban on sea cucumber harvesting. In total, 99 specimens from 12 species were recorded during the assessment. The results of the survey indicate that the sea cucumber fishery in Batiki District is under stress or threat from overexploitation and requires effective management.

Introduction

Coastal communities in many Pacific Island countries and territories derive significant cash income from the harvesting of sea cucumbers and their transformation to the tradeable product beche-de-mer. Fiji is the third largest beche-de-mer producer in the Pacific Islands region although the real economic value of the region's sea cucumber fishery is likely to be underestimated (currently thought to be around USD 45 million), due to a lack of information.

The sea cucumber industry is an old trade in the Pacific, replacing the sandalwood trade in the early 1900s and later becoming Fiji's major export (FTIB 2009). It is also the Pacific's most valuable coastal fishery, second only to oceanic tuna fisheries. The number of sea cucumber species decreases from west to east across the Pacific, following the general trend of biodiversity in this region. Most Pacific Island countries and territories that live along the coast rely on this fishery as one of their major sources of incomes (Ram et al. 2008). Unfortunately, sea cucumber stocks have been overfished in many countries as a result of ever-increasing market demand, uncontrolled exploitation, inadequate fisheries management arrangements, and/or a lack of enforcement of regulations.

According to Conand (1989), of the 1,400 sea cucumber species known worldwide, 24–35 species are commercially exploited and 28 species are found in Fiji. The beche-der-mer industry in Fiji has undergone some major changes since 1813. From a small industry producing 20–30 tonnes of dried product a year, annual production rose dramatically in 1984, and in 1988 total production was about 665 tonnes. Unfortunately, this increase in production was accompanied by a sharp decrease of the final product value. For example Preston (1993) reports that 33 tonnes of dried sea cucumber sold in 1983 for FJD 394,800 (or FJD 11,963 per tonne), while the 1988 production of 665 tonnes sold for FJD 1,850,800 (or FJD 2,783 per tonne) (Preston 1990).

Sea cucumbers are generally collected by hand while free diving or reef gleaning at low tide. The use of underwater breathing apparatus (UBA) such as scuba and hookah gear has made the task of collecting deeper dwelling sea cucumbers much easier. The use of this type of equipment significantly increases the likelihood of localised overharvesting, while the uncontrolled introduction of hookah and scuba to village fishers puts villagers at considerable personal risk of the "bends" or death. According to Ward (1972), as early as 1834, sea cucumber populations were considered depleted on reefs of western, central and northern Vanua Levu and south-eastern Viti Levu.

Management measures have also undergone some major changes over the past three decades. In 1984, the Fiji Cabinet approved the recommendation that the Fiji Fisheries Department regulate the beche-de-mer fishery. Soon after, a "Beche-de-mer Exploitation Guideline" was produced, which outlined that the harvesting and processing of sea cucumber products should be restricted to Fijian nationals; the use of scuba gear for the collection of beche-de-mer be forbidden; and no size limits were necessary because prices varied with size and smaller individuals were neither collected nor commonly seen (Lewis 1985).

[1] Partners in Community Development Fiji
* Corresponding author: wlalavanua@pcdf.org.fj

According to Adams (1993), the banning of scuba in the guideline did not apply to hookah and this contributed to a new exploitation boom in 1991. The guideline was then revised in 1988 when the Cabinet legislated to prevent the export of any beche-de-mer less than 7.6 cm (3 in) in length in any form and also banned the export of all *dairo* (*Holothuria scabra*) in any form unless permission was granted from the Minister for Agriculture, Fisheries and Forestry. *Dairo*'s export was prohibited because it was a source of traditional food (Adams 1993). In Fiji, *dairo* and, to a lesser extent, *vula* (*Bohadschia vitiensis*) and *mudra* (*B. similis*) are the main sea cucumber species consumed by Fijians in large quantities, and can be important emergency food sources in time of hardship (Adams 1992). *Dairo* is eaten fresh, marinated in lemon juice and salt, or cooked in coconut milk.

Partners in Community Development Fiji (PCDF) submitted an official request to the Secretariat of the Pacific Community (SPC) in May 2012 to improve PCDF's capacity in coastal invertebrate resource assessments and to assist with the development of Fiji's national sea cucumber management arrangements and governance structure for the effective management of the fishery. Following capacity building actions organised by SPC for PCDF and the Fiji Fisheries Department in the districts of Kubulau and Bua (August/September 2012) in Bua Province, PCDF conducted sea cucumber resource assessments in Batiki District using the assessment methods recommended by SPC. The present report is based on the assessment survey undertaken in Batiki District in October 2012. PCDF staff and the communities of Batiki District worked together to assess the status of sea cucumber stocks around Batiki in order to provide communities with information about stock status and advice about whether to impose a ban on sea cucumber harvests.

Batiki — The setting

Batiki Island is a district in the Lomaiviti archipelago in eastern Fiji, and is an administrative unit of Lomaiviti Province. Batiki has a total land area of 12 km^2 and consists of four villages, which include Mua as the chiefly residence of the "Toranibau", Yavu, Manuku and Naigani. Villagers' main source of income is from pandanus (*voivoi*), copra, fishing and small-scale farming. There is a primary school on the island that caters to approximately 50 students and 4 teachers, and also a nursing station administered by a registered nurse. Transportation out of the island is mainly by fibreglass boat or franchise cargo vessel.

Batiki has a large interior lagoon of brackish water flanked by mud flats. A broad barrier reef surrounds Batiki with a channel in Nakasava on the north side of the island. A small portion of the coastal area is covered by mangroves, mainly in Wainiketei Bay. The island's beche-de-mer fishery mainly involves male youths. Most of them transport their sea cucumbers to Suva on a weekly basis.

Materials and methods

The diversity and abundance of invertebrate species in Batiki District, including sea cucumbers, were determined with a broad-scale assessment (using a manta tow) and a fine-scale assessment of shallow water environments (using the reef benthos transect method, or RBt). The sea cucumber assessment team dived for approximately two weeks in Batiki and collated a wide-ranging series of data to determine sea cucumber distribution and density. The assessment was also designed to determine the effectiveness of the village marine protected area (MPA). In total, 2.04 ha were surveyed within the MPA and 3.12 ha were surveyed in non-MPA sites (Table 1). Because the total area surveyed in non-MPA sites was higher, the number of stations for manta tows was likewise higher in non-MPA sites (n = 8) than in MPA sites (n = 5). However, the same number of stations (n = 10) was used for the fine-scale assessment (RBt) of MPA and non-MPA sites.

Manta tow surveys were done to assess large sedentary invertebrates and habitats. A surveyor held onto a manta board that was towed behind a boat travelling at slow speeds of less than 2.5 km per hour. Manta tow stations were positioned

Table 1. Total area surveyed in the Batiki marine protected area (MPA) and non-marine protected area sites (non-MPA).

Sites	Survey type	No. of stations	No. of replicates	Area (m^2)	Area (ha)	Total area covered (ha)
MPA	Manta tow	5	30	18,000	1.80	2.04
	Reef benthos transect	10	60	2,400	0.24	
Non-MPA	Manta tow	8	48	28,800	2.88	3.12
	Reef benthos transect	10	60	2,400	0.24	
Total area covered (ha)						**5.16**

along the inner fringing reefs within the lagoon reefs and along back-reefs. Manta tow surveys were conducted in depths of 1 m to less than 10 m of water but mostly around 1.5–6.0 m, covering coral and sand substrates, and the edges of reefs. Each transect was 300 m long and 2 m wide along reef contours and habitats of interest on lagoon reefs. Transect length was calibrated using the odometer function within the "trip computer" option of a global positioning system (GPS) unit or equivalent. Waypoints were recorded at the start and end of each transect to an accuracy of within 10 m. The surveyor recorded the number of large sedentary invertebrates observed along the transect within a 2-m swath. Any invertebrates observed were recorded during the tow, and habitat records were made at the end of each tow. Hand counters were used to assist with enumerating commonly observed species.

Fine-scale RBt surveys were conducted on hard bottom habitats on back-reefs, reef flats and reef crest areas to capture invertebrates associated with those habitats. RBt assessments gave greater accuracy by assessing the range, abundance, size and condition of invertebrate species and their habitat at smaller spatial scales within fishing areas and areas of aggregated stocks. RBt assessments could also be conducted along the reef crest at low tide by walking and using the GPS odometer function to measure transect length. In this instance, transects were laid along the reef to assess species such as surf redfish, trochus and turbo shells. Surveys were conducted within six transects that were 40 m long and 1 m wide. Observations were made by snorkelling or by walking at low tide. Species and habitat data were recorded, and a single waypoint was logged for each station (to an accuracy of ≤ 10 m).

Data were entered into the Reef Fisheries Integrated Database (RFID) developed by the Secretariat of the Pacific Community. RFID has pre-set queries to extract summaries of information on species composition, density and population size structure. Densities were compared with regional reference densities determined by SPC. These densities are used for comparison because Fiji does not have sea cucumber reference densities. This comparison allows greater insight into the stock status for some sea cucumbers species at Batiki.

RFID can provide information to determine population size structure, which can be extrapolated to biomass if size and weight information are collected during in-water assessments. Population size structure provides an indication of the condition of stocks, which enables an understanding of the proportion of stocks at different life stages and what proportion may be fished.

Results

Species survey

In total, 93 specimens from 11 species were recorded during the assessment. *Bohadschia argus*, *Pearsonothuria graeffei*, *Holothuria atra* and *Stichopus chloronotus* were recorded in both MPA and non-MPA sites (Table 2). In comparison, during the marine resource inventory made by the Fiji Fisheries Department in 2010, 34 specimens from 5 species of sea cucumber had been recorded.

Stichopus chloronotus was the most recorded species followed by *Holothuria atra* (Table 3). Both were mainly found on back-reefs and reef flats. Most of the specimens recorded were found near the main channel in Nakasava.

One specimen of *Holothuria scabra* (sandfish, or *dairo*) was recorded during a search in Wainiketei Bay. This is the bay where the local community usually collects sandfish for subsistence use. The size of the sandfish found was 250 mm, and according to locals it was smaller than those they usually collect.

Table 2. Species recorded from Batiki marine protected area (MPA) sites and from non-MPA sites using different survey methods.

Site	Species	Manta tow	Reef benthos transect
MPA	*Actinopyga miliaris*		+
	Bohadschia argus		+
	Pearsonothuria graeffei	+	
	Bohadschia vitiensis		+
	Holothuria atra	+	+
	Holothuria whitmaei		+
	Stichopus chloronotus	+	+
Non-MPA	*Bohadschia argus*	+	
	Pearsonothuria graeffei		+
	Holothuria atra	+	+
	Holothuria edulis	+	+
	Holothuria fuscogilva	+	
	Holothuria fuscopunctata	+	
	Stichopus chloronotus	+	+
	Thelenota ananas	+	

Table 3. Number of specimens recorded.

Scientific name	Common name	Specimens recorded
Stichopus chloronotus	Greenfish	58
Holothuria atra	Lollyfish	18
Bohadschia argus	Tigerfish	6
Bohadschia vitiensis	Brown sandfish	4
Holothuria edulis	Pinkfish	4
Pearsonothuria graeffei	Flowerfish	2
Holothuria whitmaei	Black teatfish	2
Holothuria fuscogilva	White teatfish	1
Holothuria fuscopunctata	Elephant trunkfish	1
Actinopyga miliaris	Blackfish	1
Thelenota ananas	Prickly redfish	1
*Holothuria scabra**	Sandfish	1

* *Holothuria scabra* was not recorded from any transect but was found during searches at Wainiketei Bay.

Sea cucumber densities

The density of greenfish (*S. chloronotus*) from RBt assessments was the highest (45.83 ind. ha^{-1} ± 14.78 [SE]) of all sea cucumber species, and was found in 40% of all stations (Table 4). The density of *S. chloronotus* in Batiki, however, is far below the regional reference density of 3,500 ind. ha^{-1}. Lollyfish (*Holothuria atra*) and tigerfish (*Bohadschia argus*) were the second and third most commonly found species, with lollyfish found in densities of 12.50 ind. ha^{-1} ± 5.32, and in 25% of all stations, and tigerfish found in densities of 10.42 ind. ha^{-1} ± 7.33, and in 10% of all stations. The densities of both *H. atra* and *B. argus* were well below the regional reference densities of 5,600 ind. ha^{-1} and 120 ind. ha^{-1}, respectively.

Table 4. Overall density (ind. ha^{-1}) of species for manta tow and reef benthos transects (RBt) completed at Baitiki. Numbers in parentheses indicate standard error.

Species	Overall density		Regional reference density	
	Manta tow	RBt	Manta tow	RBt
Stichopus chloronotus	8.12 (4.56)	45.83 (14.78)	1,000	3,500
Holothuria atra	5.88 (2.77)	12.50 (5.32)	2,400	5,600
Pearsonothuria graeffei	0.64 (0.64)	2.08 (2.08)	50	100
Holothuria edulis	0.64 (0.46)	4.17 (4.17)	250	260
Bohadschia argus	0.53 (0.37)	10.42 (7.33)	50	120
Thelenota ananas	0.32 (0.32)	-	10	30
Holothuria fuscogilva	0.21 (0.21)	-	-	20
Holothuria fuscopunctata	0.21 (0.21)	-	10	10
Holothuria whitmaei	-	4.17 (2.87)	10	50
Actinopyga miliaris	-	2.08 (2.08)	-	150
Bohadschia vitiensis	-	2.08 (2.08)	160	100

Only two species were found in both MPA and non-MPA sites: *S. chloronotus* and *H. atra*, and their densities in each area did not differ significantly (Fig. 1). *B. argus*, *H. whitmaei*, *Actinopyga miliaris* and *B. vitiensis* were only found in MPA sites while *H. edulis* and *Pearsonothuria graeffei* were only found in non-MPA sites.

S. chloronotus was the species found in the highest densities from RBt assessments in both MPA (33.33 ind. ha^{-1} ± 16.24) and non-MPA (58.33 ind. ha^{-1} ± 20.03) sites. Some localised aggregations of *S. chloronotus* were found in densities of 400 ind. ha^{-1} ± 100 as seen in MPA sites and 350 ind. ha^{-1} ± 66.7 in non-MPA sites.

The next most dominant species in MPA and non-MPA sites from RBt assessments were *B. argus* (20.83 ind. ha^{-1} ± 10.78) and *H. atra* (12.50 ind. ha^{-1} ± 7.09). In terms of aggregation, *B. argus* density reached densities of 312.50 ind. ha^{-1} ± 62.50 and *H. atra* density can be 250 ind. ha^{-1}.

In total, 18 specimens of *H. atra* were measured in Batiki (recoded in both MPA and non-MPA sites) with a minimum size of 55 mm and a maximum size of 325 mm. Most specimens recorded were found in the MPA at Mua village. The mean size recorded was 159 mm. The recorded sizes indicate that the specimens recorded are below the regional common length of 230 mm and most of them are juveniles.

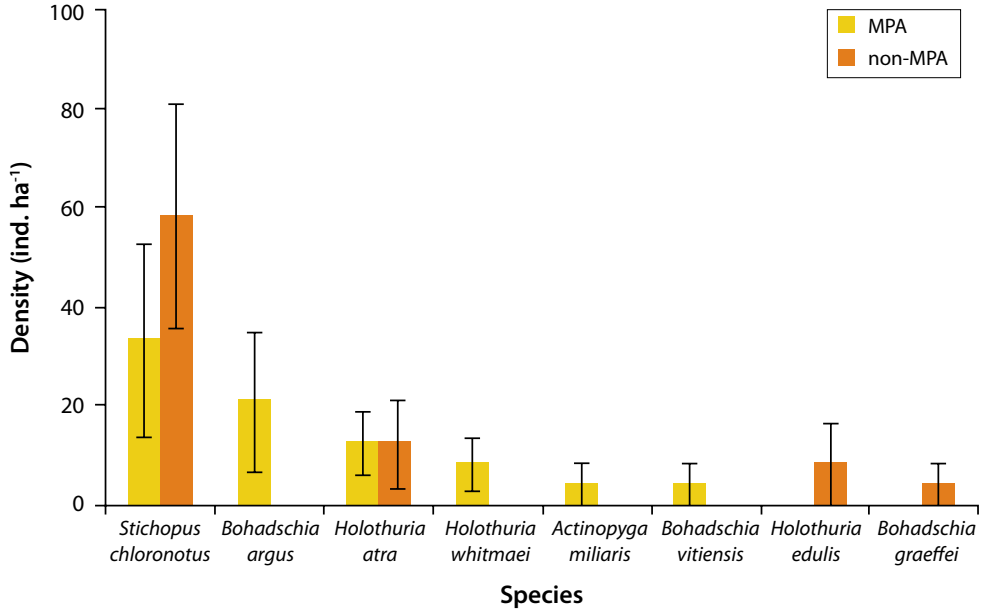

Figure 1. Sea cucumber densities in marine protected area (MPA) and non-MPA sites.

Discussion and conclusion

The results of the survey indicate that the sea cucumber fishery in Batiki is under stress or threat from overexploitation and requires effective management. The density of species present is low in comparison to regional reference densities. The two dominant species, *S. chloronotus* and *H. atra*, are medium- and low-value species, indicating that the fishing pressure applied to high-value species has probably resulted in their very low density. The presence of high-value sea cucumber species (in the reef system and seagrass beds) such as *H. whitmaei* and *H. scabra* indicates that they are still present but their numbers are so low that it will require a long closure of the fishery to allow these species' stocks to recover. If there is no closure, fishers might come across the last large high-value species specimens and harvest them while also harvesting medium- and low-value species.

The population structure also indicates that most specimens are in juvenile stages, which is another reason to recommend a permanent closure of the fishery in Batiki.

According to the survey, there was little difference in sea cucumber stock density between MPA and non-MPA sites. We therefore suspect that fishing activity is occurring in the MPA. During the presentation of preliminary assessment results to communities of Batiki, community members confirmed that poaching was occurring in their respective village MPA. One of the factors limiting the work of the fish wardens in Batiki in policing their whole *qoliqoli*[2], and especially their MPA, is that they do not have the equipment — boat, engine and fuel — needed to monitor and control fishing inside the MPA. In addition, past experience of fish wardens shows that their work is difficult and risky because poachers are better equipped than they are, and are sometimes very aggressive. Since fish wardens are volunteers with no compensation at all, this affects their interest in carrying out their duty.

Based on the results of the assessment, the following measures are recommended.

- The sea cucumber fishery in Batiki be closed for a period of five years. After five years of permanent closure, another assessment should be conducted to determine the status of the fishery. If it is healthy, then it should be re-opened using a quota or total allowable catch system.
- The use of underwater breathing apparatus (UBA) to collect sea cucumbers should be prohibited in Batiki. UBA has had serious negative impacts on the health of divers and the fishery itself. Because sea cucumbers are sedentary and 80% of species are found between 0 m and 20 m depths, there is no need to use UBA.
- Night fishing should not be practiced at any time. This is to safeguard against overexploitation of nocturnal species.

[2] A *qoliqoli* is a customary fishing rights area.

- Wainiketei Bay should be closed to fishing and established as a dedicated sea cucumber marine protected area because this is the only site in Batiki where high-value species of *H. scabra* can be found. In future assessments, a dedicated survey of *H. scabra* should be made in Wainiketei Bay to better understand its status.

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