

# Commercially important sea cucumbers on Geyser Bank (Scattered Islands – Gloriosos – Indian Ocean)

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## Abstract

A survey and abundance estimate of commercially important sea cucumbers were carried out on Geyser Bank in the waters of the Marine Park of the Gloriosos. A total of 32 stations were surveyed on its reef flats and inner and outer slopes. Some seven commercially important sea cucumber species were recorded, including three with high market values, i.e. *Holothuria nobilis*, *H. fuscogilva* and *Thelenota ananas*. A total of 11 specimens were recorded for all the stations, i.e. 32,000 m<sup>2</sup>. *T. ananas* was the most frequently observed species and represented 27% of the relative abundances. Commercially important sea cucumber population densities had been estimated at 6 ( $\pm$  3.2) specimens per hectare in 2006, while the estimate was 3.4 ( $\pm$  1.8) spec. ha<sup>-1</sup> in 2016. A great many observations have confirmed regular illegal fishing on this bank since the 2000s. The increasing scarcity of commercially important sea cucumbers along the coasts of Madagascar encourages fishers to widen their fishing grounds towards more distant sites that have been comparatively protected from fishing, including marine protected areas.

## Introduction

A survey and abundance estimate of commercially important sea cucumbers on Geyser Bank were carried out as part of the Epicure programme<sup>2</sup> under the supervision of IFREMER, the Mayotte university training and research centre (CUFR) and the French Southern and Antarctic Lands (TAAF). The first survey of sea cucumbers on this reef bank was carried out by Mulochau et al. (2007).

Geyser Bank is located in the western Indian Ocean, north of Mozambique Canal, between Mayotte and the Glorioso Islands, some 300 km west of the northern tip of Madagascar and 110 km north-east of Mayotte. This coral atoll, which is about 17.5 km in diameter, is built on shoals in the open ocean and only certain parts of Geyser Bank can be seen at the surface during low tide. Geyser Bank has a reef and lagoon surface area of some 257 km<sup>2</sup>, with three geomorphologic units: outlying sub-surface reefs, outlying submerged reefs and lagoon terraces (Mulochau et al. 2007; Andréfouët et al. 2009). It is part of the Glorioso Islands' marine nature park<sup>3</sup> and has been a marine protected area since 2012, covering an exclusive economic zone of some 43,000 km<sup>2</sup>. The Marine Nature Park of the Glorieuses was especially designed to create a strong marine biodiversity protection zone and become an area of

excellence in terms of sustainable fishing. Fishing is prohibited in territorial waters (Order no. 2010-151 dated 9 December 2010) and regulated in the exclusive economic zone (Order no. 2014-137 dated 21 October 2014), more specifically on Geyser Bank. In contrast to Grande Glorieuse, which is continually monitored by military contingents<sup>4</sup>, it remains difficult to monitor Geyser Bank due its isolation and lack of dry land.

The problems with managing commercially important sea cucumber populations in the south-western part of the Indian Ocean have already been emphasised (Conand and Muthiga 2007; Conand 2008; FAO 2013; Muthiga and Conand 2014; Conand 2017). Comparative studies on sea cucumber conservation and fisheries in the western Indian Ocean have demonstrated the value of implementing precautionary management approaches to protect stocks (Cariglia et al. 2013; Eriksson et al. 2015). Data on illegal fishing in Geyser Bank are sparse; it mainly involves fleets from Madagascar, beginning in the 2000s when commercially important sea cucumber resources had been overexploited in that country (Conand et al. 2015; Le Manach and Pauly 2015). These illegal harvests are difficult to estimate and such data are based on interventions by the French Government in the exclusive economic zone involved.<sup>5</sup>

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<sup>2</sup> [http://www.ifremer.fr/institut\\_es/Actualites-et-Agenda/Toutes-les-actualites/Xe-FED-regional-ocean-Indien](http://www.ifremer.fr/institut_es/Actualites-et-Agenda/Toutes-les-actualites/Xe-FED-regional-ocean-Indien)

<sup>3</sup> <http://www.aires-marines.fr/L-Agence/Organisation/Parcs-naturels-marins/Parc-naturel-marin-des-Glorieuses>

<sup>4</sup> <http://www.taaf.fr/Les-Glorieuses>

<sup>5</sup> <http://www.ecpad.fr/fazsoi-le-malin-intercepte-des-pecheurs-illegaux/>

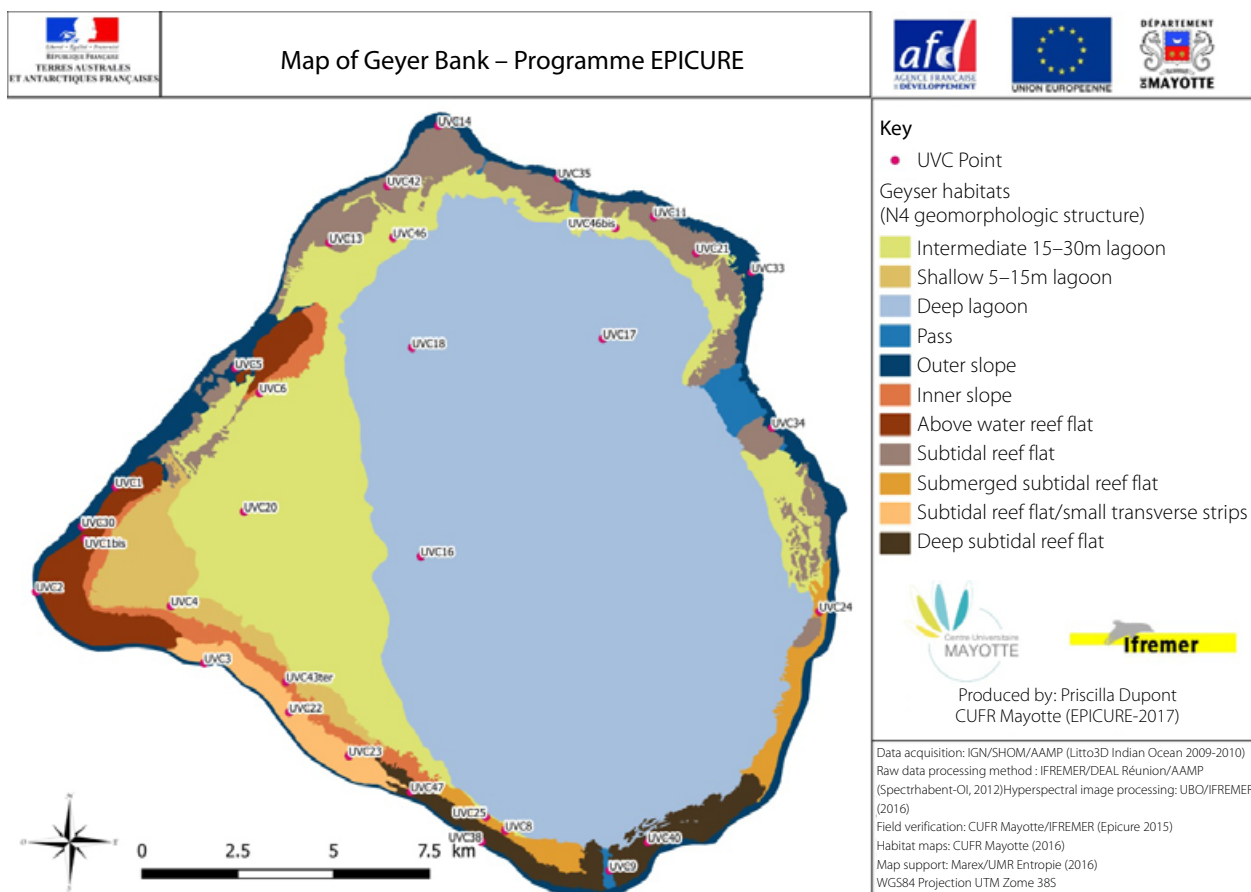
## Materials and methods

Sampling of commercial sea cucumber species on Geysers Bank took place from 16 October to 9 November 2016. The survey covered 32 stations spread out over the entire island group, including 13 reef flat

stations (emerged, intertidal and subtidal), 9 outer slope stations, 7 lagoon stations (shallow, intermediate and deep), 2 inner slope stations, and 1 pass station (Table 1 and Figure 1). Each station was uniform in terms of habitat and the various hydrodynamics parameters.

**Table 1.** Commercially important sea cucumber-population monitoring stations on Geysers Bank in October–November 2016: stations, longitudes (Long. pts.) and latitudes (Lat. pts.) in WGS84 (in decimal degrees), date, depth in metres (Depth), and geomorphology.

Stations	Long. pts.	Lat. pts.	Date	Depth	Geomorphology
UVC1	46.4461	-12.3300	16/10/2016	15	Outer slope/spread out rubble
UVC1bis	46.4389	-12.3426	16/10/2016	3	Above water reef flat
UVC2	46.4272	-12.3550	21/10/2016	19	Outer slope/spread out rubble
UVC3	46.4677	-12.3716	27/10/2016	12	Outer slope/spurs and grooves
UVC4	46.4596	-12.3582	21/10/2016	6	Shallow 5–15m lagoon/coral formations
UVC5	46.4749	-12.3024	18/10/2016	17	Outer slope/spurs and grooves
UVC6	46.4806	-12.3079	17/10/2016	7	Inner slope/coral colonies
UVC8	46.5401	-12.4107	26/10/2016	22	Submerged subtidal reef flat/coral heads
UVC9	46.5652	-12.4200	25/10/2016	24	Pass/Coral formations/extensive coral cover
UVC11	46.5750	-12.2658	20/10/2016	13	Subtidal reef flat/seagrass bed
UVC13	46.4972	-12.2724	11/09/2016	17	Subtidal reef flat/seagrass bed
UVC14	46.5231	-12.2447	20/10/2016	21	Outer slope/spread out rubble
UVC16	46.5194	-12.3462	11/08/2016	25	Deep lagoon/seaweed
UVC17	46.5629	-12.2946	28/10/2016	20	Deep lagoon/coral formations
UVC18	46.5172	-12.2970	11/05/2016	22	Deep lagoon/coral formations
UVC20	46.4771	-12.3359	19/10/2016	16	Intermediate 15–30 m lagoon/coral formations
UVC21	46.5852	-12.2742	22/10/2016	15	Subtidal reef flat
UVC22	46.4882	-12.3831	11/07/2016	5	Subtidal reef flat/small transverse strips and spread out rubble
UVC23	46.5025	-12.3933	11/07/2016	9	Subtidal reef flat/small transverse strips and spread out rubble
UVC24	46.6153	-12.3586	11/03/2016	25	Submerged subtidal reef flat/spread out rubble
UVC25	46.5355	-12.4075	29/10/2016	25	Submerged subtidal reef flat/spread out rubble
UVC30	46.4381	-12.3396	17/10/2016	14	Outer slope/spread out rubble
UVC33	46.5985	-12.2788	24/10/2016	25	Outer slope/coral formations
UVC34	46.6036	-12.3153	11/03/2016	12	Outer slope/spurs and grooves
UVC35	46.5519	-12.2567	22/10/2016	18	Outer slope/spurs and grooves
UVC38	46.5345	-12.4134	26/10/2016	20	Subtidal reef flat/small transverse strips/coral colonies
UVC40	46.5744	-12.4132	25/10/2016	14	Subtidal reef flat/dense coral colonies
UVC42	46.5110	-12.2589	20/10/2016	17	Subtidal reef flat/coral colonies
UVC43ter	46.4874	-12.3759	11/08/2016	7	Inner slopes/grooves and spurs
UVC46	46.5125	-12.2711	19/10/2016	18	Intermediate 15–30 m lagoon/coral formations
UVC46bis	46.5657	-12.2685	24/10/2016	26	Intermediate 15–30 m lagoon/coral heads



**Figure 1.** Locations of the 32 stations sampled on Geyser Bank in October and November 2016 in order to monitor commercially important sea cucumbers (Dupont et al. 2016).

Sampling was carried using underwater diving on beds at depths of between 3 to 25 m. Two 50 m measuring tapes were set up and two 5-m-wide zones located on either side of them were sampled, i.e. a total surface area of 1000 m<sup>2</sup> per station. Observers recorded all the commercially important sea cucumber species they encountered. These counts were done visually at the surface of the substrate and did not include cryptic species hidden under the rocks or inside the reef. Less sampling was done on the outer and inner reefs located in the south and southeast due to difficult weather conditions.

## Results

### *Species richness and abundance*

Seven commercially important sea cucumber species were recorded (Table 2): 3 high-market-value species, i.e. *Holothuria nobilis*, *H. fuscogilva* and *Thelenotia ananas*, and 4 low-to-medium market value species, i.e. *H. edulis*, *Actinopyga miliaris*, *Bohadschia subrubra*, *Pearsonothuria graeffei*. All of the species observed were sampled over 11 stations, while no commercially important sea cucumber species were observed in two-thirds of the stations (21 stations).

*T. ananas* (9.4%) was the most frequently observed species over the 32 stations in this study (Table 3). In terms of abundances (Table 3), 11 species were recorded over the 32 stations, i.e. 32,000 m<sup>2</sup>. The most abundant species was *T. ananas* at 27% of the relative abundances and three specimens observed over all the stations.

As a whole the species recorded during this study had an average of  $0.34 \pm 0.09$  specimens observed by station, which means an average of 3.4 sea cucumbers per hectare for the stations sampled with the method use. No station had an abundance of more than one specimen.

## Discussion

Commercially important sea cucumber-species diversity was low on Geyser Bank: seven species were observed over the 32 stations surveyed during this study, which supplements preceding surveys (Table 2) (Mulochau et al. 2007; Pareto and Arvam 2015) bringing the total to 11 species recorded on Geyser Bank since 2006. Three species had never been recorded on this reef bank before, i.e. *H. fuscogilva*, species listed as 'Endangered'

**Table 2.** Commercially important species (Purcell et al. 2012 and 2013) observed on Geysier Bank in 2007 (Mulochau et al.), 2015 (Pareto and Arvam) and 2016 ('This study'), market value and status on the International Union for Conservation of Nature's red list (Conand et al. 2014 ; IUCN 2016). x = observed.

	2007	2015	This study	Market value	IUCN status
<i>Actinopyga mauritiana</i>	x			Medium	Vulnerable
<i>Actinopyga miliaris</i>		x	x	Medium	Vulnerable
<i>Actinopyga obesa</i>	x			Medium	Data Deficient
<i>Bohadschia subrubra</i>	x		x	Medium	Data Deficient
<i>Holothuria atra</i>		x		Low	Least concern
<i>Holothuria edulis</i>		x	x	Low	Least Concern
<i>Holothuria fuscogilva</i>			x	High	Vulnerable
<i>Holothuria fuscopunctata</i>			x	Medium	Least concern
<i>Holothuria nobilis</i>	x			High	Endangered
<i>Pearsonothuria graeffei</i>			x	Low	Least Concern
<i>Thelenota ananas</i>	x	x	x	High	Endangered
Total	5	4	7		

**Table 3.** Observation frequencies for commercially important sea cucumber species (% of the number of stations where the species was observed in comparison to the total number of stations [32]) and relative abundances of the various commercially important sea cucumber species (in % of the number for a single species out of the total number of sea cucumbers [11]) in Geysier Bank for the 32 stations monitored.

	Observation frequency (%)	Relative abundances (%)
<i>Thelenota ananas</i>	9.4	27
<i>Actinopyga miliaris</i>	6.3	18
<i>Pearsonothuria graeffei</i>	6.3	18
<i>Bohadschia subrubra</i>	3.1	9
<i>Holothuria fuscogilva</i>	3.1	9
<i>Holothuria fuscopunctata</i>	3.1	9
<i>Holothuria edulis</i>	3.1	9

by the IUCN (2016), *H. fuscopunctata* and *P. graeffei*. These three species are found in the zone, particularly in Mayotte (Eriksson et al. 2012) and in the Gloriosos Islands (Mulochau and Guigou 2017). Some of the species observed in 2006 were not found during this study, i.e. *H. nobilis*, species listed as 'Endangered' by the IUCN (2016), *A. mauritiana*, listed as 'Vulnerable' and *A. obesa*. *Holothuria atra*, observed for the first time in 2015, was not found in 2016, either. *Bohadschia atra*, a recently described species (Massin et al. 1999), was not observed on this bank although this species is found in the zone and is frequently observed in Mayotte (Eriksson 2012; Mulochau 2018) and in the Gloriosos where it is abundant, especially on inner slopes (Conand et al. 2013; Mulochau and Guigou 2017). These data do not cover species considered to have no market value.

The abundances of commercially important sea cucumbers during this survey on Geysier Bank were low compared to other nearby sites such as Mayotte (Eriksson 2012; Mulochau 2018) or the Gloriosos (Conand et al. 2013; Mulochau and

Guigou 2017). These low abundances had already been highlighted by Mulochau et al. (2007). The large number of stations covered provided a robust estimate of the abundances of commercially important sea cucumbers on Geysier Bank and to compare that estimate to the 2006 survey. During that study (Mulochau et al. 2007), densities were estimated at 6 ( $\pm$  3.2) specimens/hectare, which seems to indicate that sea cucumber population abundances have decreased, since in 2016 the estimate was 3.4 ( $\pm$  1.8) spec. ha<sup>-1</sup>. Table 3 gives the observation frequencies and abundances for the two most frequently observed and most abundant species in 2006, recorded again in 2016. *T. ananas* and *B. subrubra* are the only species sampled during both studies and while they were found on half of the stations in 2006, they were found on less than 10% of the stations in 2016. Relative abundances for those two species were also down; while *T. ananas* remained the most abundant species as had been the case during the 2006 study. *B. subrubra* is a species that covers itself with coral debris or sand and can be difficult to sample as opposed to *T. ananas*, a species that is easily seen and recorded.

**Table 4.** Comparison of observation frequencies in % of the total (ratio of the number of stations where the species was observed to the total number of stations), relative abundances in % (ratio of the number of specimens of a species to the total number of sea cucumbers) and the average number of specimens between 2006 and 2016 for *T. ananas* and *B. subrubra*.

	Observation frequency (%)		Relative abundances (%)		Number of specimens per hectare	
	2006	2016	2006	2016	2006	2016
<i>Thelenota ananas</i>	54.5	9.4	39	27	2.3 (± 1.6)	0.9 (± 1.0)
<i>Bohadschia subrubra</i>	46.0	3.1	33	9	1.7 (± 1.6)	0.3 (± 0.6)

The Manta Tow technique (Friedmann et al. 2008) appears to be more appropriate for estimating sea cucumber populations particularly in shallow zones, over large surface areas with diversified habitats and with relatively low sea cucumber abundances as is the case with Geysers Bank. Study stations have to be set up for commercially important sea cucumber populations in order to understand changes in such populations and the impacts they are subjected to. The abundances observed during this study are tendencies; monitoring the stations over time and repeating this approach would provide a more reliable analysis of the situation so as to understand changes in commercially important sea cucumber populations on Geysers Bank.

Fishing is regulated on Geysers Bank and only authorised for fishing vessels registered in Mayotte that are under 15 m in length<sup>6</sup>. No commercial French fish vessels currently meet the requirements for developing such activities on Geysers Bank. So fishing impact is mainly linked to the presence of fishing vessels from neighbouring countries. As their coastal sea cucumber-fisheries resources have become scarce, these fishers prospect ever wider zones in order to support themselves. The many observations and a few interventions by the French military (local press;<sup>7</sup> Conand et al. 2015; pers. obs.) confirm regular fishing on the bank, particularly by ships from Madagascar equipped with diving equipment. Impact on sea cucumber populations may be continually since the 2000s when commercially important sea cucumber resources were overexploited in northern Madagascar (Conand et al. 2015; Le Manach and Pauly, 2015). As this bank is remote and isolated, control efforts are rare. The increasing scarcity of commercially important sea cucumbers on Geysers Bank has probably encourage fishers to move to fishing grounds further north towards the Gloriosos Islands, particularly to Lys Island where the lack of surveillance allows mooring and fishing (local press;<sup>8</sup> Mulochau and Guigou 2017) as well as to other protected areas such as Mayotte or Juan de

Nova, which are remarkable for reef biodiversity studies (Chabanet et al. 2016; Conand et al. 2016; Quetel et al. 2016). Nevertheless, sea cucumber harvests seem to continue on Geysers Bank as it is a passage zone than can be prospected before moving on to other sites in Mozambique Canal.

Given sea cucumbers' critical role in reef ecosystems (Purcell et al. 2016) and the threats that weigh on several species due to overfishing, it seems that urgent action must be taken by all the necessary means to put a halt to the illegal harvest of sea cucumbers on Geysers Bank in order to allow populations to recover.

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<sup>6</sup> [http://www.taaf.fr/IMG/pdf/a-2014-137\\_derogation\\_de\\_peche\\_au\\_geyser.pdf](http://www.taaf.fr/IMG/pdf/a-2014-137_derogation_de_peche_au_geyser.pdf)

<sup>7</sup> [http://www.zinfos974.com/TAAF-Un-navire-pris-en-flagrant-delit-de-peche-illicite\\_a64490.html](http://www.zinfos974.com/TAAF-Un-navire-pris-en-flagrant-delit-de-peche-illicite_a64490.html) and <http://www.ecpad.fr/fazsoi-le-malin-intercepte-des-pecheurs-illegaux-2/>

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