Evidence of rapid overfishing of sea cucumbers in the Sultanate of Oman

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Abstract

A small, artisanal sea cucumber export fishery developed in the Sultanate of Oman in 2004. The area covered by the fishery is limited to a single shallow embayment of 320 km^2 in Mahout Bay, and involves approximately 400 fishers, around 50% of whom are women. The fishing season (October to May) in 2005 was the first season to be officially recorded. However, anecdotal evidence suggests low levels of exploitation as early as the 1970s, although catch, effort and export data for this period are unavailable. The total biomass of the stock in 2005 was estimated at 1,500 tonnes (t) (fresh weight). In the following year, at least 14.5 t of processed *Holothuria scabra* were exported to the United Arab Emirates, corresponding to approximately 145 t, or around 10%, of the recorded biomass.

Interviews with fishermen and traders revealed that in 2005, about 100 sea cucumbers per fisher per fishing trip were collected, whereas by 2007, less than 20 sea cucumbers per fisher per fishing trip were collected, indicating that there had been significant pressure on the resource. Over the same timeframe, the value of an average sized *H. scabra* was 0.1 Omani rials (USD 0.25) in 2005, increasing to 1.5 Omani rials (USD 3.75) in 2007, and is still increasing. Concomitantly, fishers began targeting the less valuable *H. atra* in large numbers. This species commands a market price of 0.2 Omani rials (USD 0.5) per specimen. Also, an examination of processed specimens for sale showed a significant number of very small individuals (<6 cm processed, corresponding to around 12 cm live length).

These concurring evidences suggest a rapid decline of *H. scabra* populations in Mahout Bay, with a corresponding increase in pressure on other species such as *H. atra*. Accordingly, the Ministry of Fisheries Wealth of the Sultanate of Oman has initiated a number of projects aimed at monitoring the sea cucumber fishery with the ultimate objective of providing a regulatory framework to ensure the sustainability of the resource. Projects also include an evaluation of enhancement and ranching techniques.

Introduction

Although sea cucumbers (Holothuroidea) have been exploited for at least 1,000 years around India, Indonesia and the Philippines (Conand 2004), their exploitation in the Sultanate of Oman is relatively recent (Al-Rashdi et al. 2007a). Anecdotal reports from older fishermen indicate that a very small-scale *Holothuria scabra* fishery occurred as part of the traditional annual cycle of trade between Oman, India and East Africa, but that the recent increase in *H. scabra* landings only began in 2004 with the establishment of a truly commercial exploitation, involving 400 fishers and a handful of traders and exporters, for export to the United Arab Emirates (Al-Rashdi et al. 2007a). The fishery is restricted to a single embayment in Mahout Bay along the Arabian sea coast of the Sultanate of Oman (Al-Rashdi et al. 2007b). The body walls of sea cucumbers are locally processed and exported in dry form. Because this fishery is quite recent, there are currently no traditional or state-directed management strategies in place (i.e. it is a fully open access fishery) (Charles 2001). Following the report of this fishery, a short study carried out in 2005 to document the status of stocks and the fishery's structure (Al-Rashi et al 2007a,b), suggested that there were already some indications of overfishing in areas easily accessible to fishers.

This paper documents the status of sea cucumber stocks five years after the start of commercial exploitation.

Material and methods

The study area covered Mahout Bay (Ghubbat Hashish Bay; 20°27′ N 58°0′ E), the only known area where the sea cucumber fishery in the Sultanate of Oman takes place (Fig. 1). The semi-sheltered bay covers approximately 320 km^2 and forms the innermost part of the Gulf of Masirah (Fig. 1). It has a maximum depth of about 10 m in the southern part but most of the bay is less than 5 m deep. Tidal ranges

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are 1.8 m during spring tides and less than 1.0 m during neap tides. The bay remains relatively protected from severe storm waves that are generated by monsoonal winds during the summer. A large part of the bay's sandy bottom is covered with sparse to dense sea grass beds dominated by *Halodule uninervis* and *Halophila ovalis (*Al-Rashdi et al. 2007a,b).

Originally, we had planned to revisit all six fishing grounds described in Al-Rashdi et al (2007a,b), but the extremely low population density observed in 2008–2009 did not allow comparisons between sites. During each field survey, we interviewed fishermen about the length (duration) of their fishing trip, the number of fishers involved, and the method and location of the collection. We also recorded the number and species of sea cucumbers collected. On several occasions, we made informal visits to processing areas to document size and species distributions of sea cucumber landings.

Since 2007 and following our first survey, fisheries officers were requested to record all exports of processed sea cucumbers (beche-de-mer) at the main office of the Ministry of Fisheries Wealth in Mahout.

Results

Between March 2007 and June 2008, 15.5 t of dried, processed sea cucumbers were officially exported from Mahout Bay. Exports values followed a distinct yearly cycle, with a winter maximum and a summer minimum, ranging from 3.6 t per month in January 2008 to 0.0 t between July and October 2008 (Fig. 2). According to our interviews, prices varied with size and season, but overall, fishers received between 1.5 and 2.0 Omani rials (~USD 3.5–5.5) per sea cucumber in 2007–2008.

We observed a definite decline in sea cucumber abundance. In 2008,

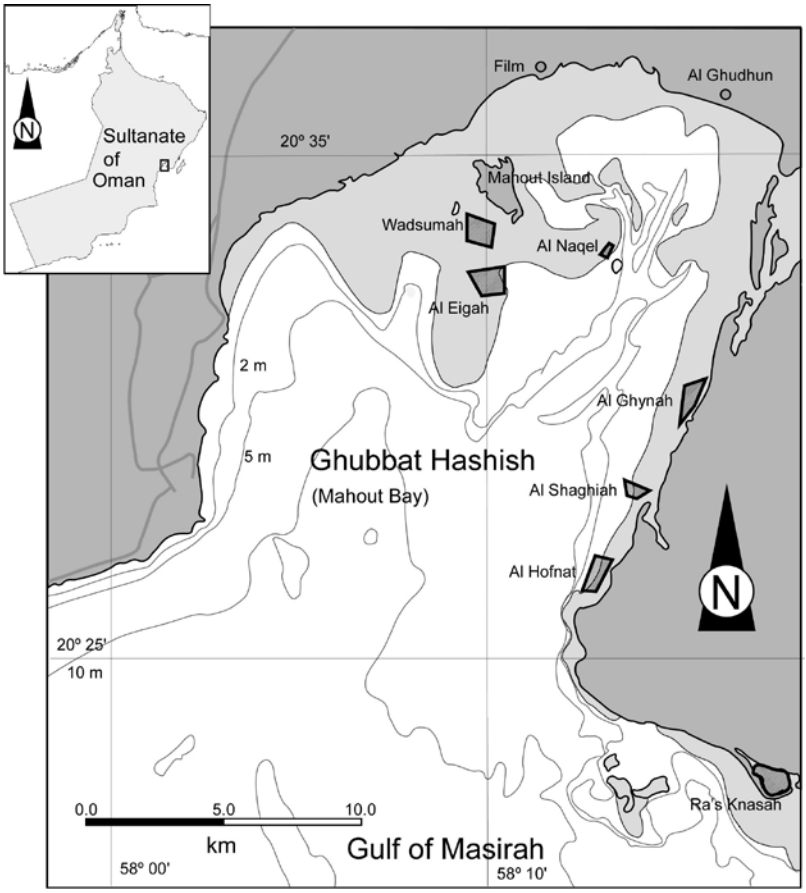

Figure 1. Mahout Bay (Ghubbat Hashish: "bay of grass") in the Sultanate of Oman and the major fishing areas for *Holothuria scabra*.

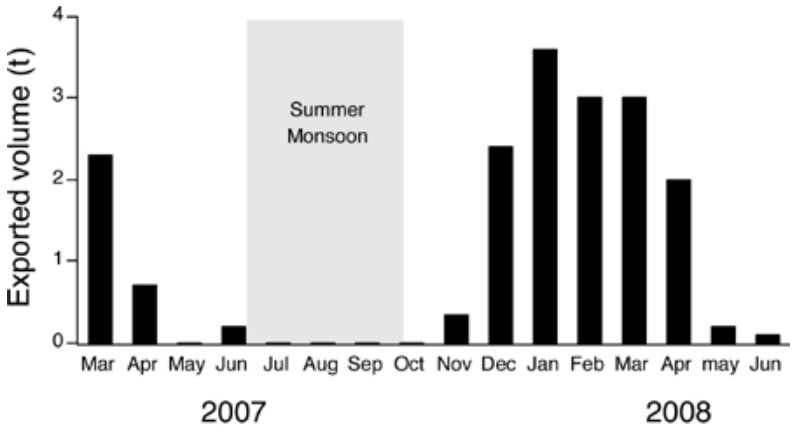

Figure 2. Volume of dried *Holothuria scabra* exported from Oman to Dubai in 2007–2008. The grey area covering June-September corresponds to the period of the southwest monsoon (Khareef), during which most fishermen leave the area.

on all exploratory dives at the six fishing grounds used in the 2004–2005 survey (Fig.1) (Al-Rashdi et al. 2007a), only one or two sea cucumbers were observed during the 30-minute dives, precluding any use of quantitative population density or biomass estimates. Similarly, shallow water quadrats in the same locations as that of the previous survey (Al-Naqel, Wadsumah, Al-Eigah, Al-Shagnhiah, Al-Hofnat and Ra's-Knasah) showed that abundances were very much reduced: in Ra's-Knasah, we collected 3 individuals per 200 m^2 and only one individual in Al-Naqel. In the other four sites, no sea cucumbers were recorded. In terms of catch per unit of effort, fishers and traders reported that in 2005, about 100 sea cucumbers per fisher were collected during a single fishing trip (3–4 hours of wading at low tide), whereas in 2007, less than 20 sea cucumbers per fisher were collected (Table 1). We also observed a shift in fishing methods used by fishermen. In 2005 (Al-Rashdi et al. 2007b), all fishing took place at spring low tide on foot, but in 2007–2008, 30% of fishermen reported using snorkeling and skin-diving gear to collect their catch. Furthermore, in 2005, about 50% of the fishers were women and children; this ratio dropped to less than 10% in 2007–2008 (Table 1).

The shift in collection methods also allowed fishers to access deeper fishing sites. One additional fishing ground was exploited in 2007–2008 in Mahout Bay (Al-Ghynah: Fig. 1), and fishermen reported that some populations of *H. scabra* near Masirah Strait were also newly exploited.

Our observations at the processing sites revealed that in addition to *H. scabra* (*feik al-bahar*, literally "sea jaw", probably in relation to the U-shape this species tends to adopt in collection buckets), a significant proportion of processed sea cucumbers were *H. atra* (*abu ar-Reyf*, "father of Reyf") and *H. leucospilota* (*abu ar-Reyf naqly*, "fake *abu ar-Reyf*"). We also witnessed large numbers of very small *H. scabra* (<12 cm fresh, <6 cm processed) being processed (Fig 3).

Discussion

The rapid decline in population densities observed between 2005 and 2008 in Mahout Bay is not exceptional. Most exploited sea cucumber populations around the world experience similar declines at the onset of commercial exploitation (Conand 1997; Uthicke and Conand 2005). The abundance of *H. scabra* observed originally in 2005 was similar to

Figure 3. Small, processed juvenile *Holothuria scabra* on Mahout Island, October 2008. The 50 baisa coin is 23 mm in diameter.

Table 1. Changes in sea cucumber fishery indicators between 2004–2005 and 2007–2008 in Mahout Bay, Sultanate of Oman.

Indicator	2004–2005	2007–2008
Holothuria scabra population density	1000 ind. ha^{-1}	<1 ind. ha^{-1}
Targeted size	> 20 cm	All sizes (including <15 cm)
CPUE (ind. h^{-1})*	25 ind. h^{-1}	<5 ind. h^{-1}
Price to fishers (Omani rials)	0.1–1.0	1.5–2.0
Targeted species	*H. scabra*	*H. scabra* *H. atra* *H. leucospilota*
Fishing grounds	6 recorded grounds in Mahout Bay	7 recorded grounds in Mahout Bay + 2 in Masirah Strait
Fishers involved in the fishery	450	150
% of women and children	50%	15
Fishing methods	Low tide collection by hand	Low tide collection by hand (70%) Skin-diving (30%)

* Based on a four-hour fishing trip at low tide.

that of unexploited stocks of the same species in the Red Sea (Hasan 2005), and is likely the result of a highly productive ecosystem and a nearly unexploited sea cucumber population. The decrease in targeted size classes observed between 2005 and 2008 is an indicator of stressed (or overexploited) populations. Fishermen now collect almost any size of animal, including individuals well below the size at first maturity estimated for this species (i.e. 160–180 mm) (Conand 1989; Hasan 2005; Kithakeni and Ndaro 2002). This strategy was developed by fishermen to maintain a constant income from the fishery. However, because smaller size individuals fetch a much lower price than larger ones, more sea cucumbers needed to be caught. This in turn led to the collection of immature individuals (Richmond 1996). The recent addition of low-value species (*H. atra* and *H. leucospilota*) to catches indicates the poor status of the fishery in Mahout Bay (Friedman et al. 2008). Overall, all six indicators listed by Friedman et al. (2008) suggested that the *H. scabra* fishery was in poor "health" and that an annual exploitation of >10% of the stock was unsustainable (although export and landing data are likely to be strongly underestimated).

Following these observations, the Ministry of Fisheries Wealth gathered a team of experts to develop a management strategy for the Oman's sea cucumber fishery. Future regulation will include a minimum size at capture of 20 cm, as well as a seasonal closure (February–August). Despite these soon-to-be implemented regulations, several closure experiments in the Indo-Pacific have shown that overfished sea cucumber stocks were slow to recover (D'Silva 2001). This is partially because holothurians are broadcast spawners, whose fertilization rate drops rapidly at low population densities.

Modelling experiments indicate that individuals separated by only a few meters do not contribute practically to larval production because of the dilution of sperm in the water column (Claereboudt 1999). The reduction in population density due to fishing may render the remaining individuals nearly incapable of successful reproduction (Allee effect). In addition, the population in Mahout Bay appears to be nearly isolated from other populations of the same species, and most likely self-recruits, further increasing the likelihood of recruitment failure in the future.

In addition to these fisheries management efforts, the Ministry of Fisheries Wealth has also invested in sea cucumber aquaculture research to replace or supplement the income of fishermen involved in the sea cucumber fishery near Mahout, as well as to develop a large-scale sustainable production of beche-de-mer.

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