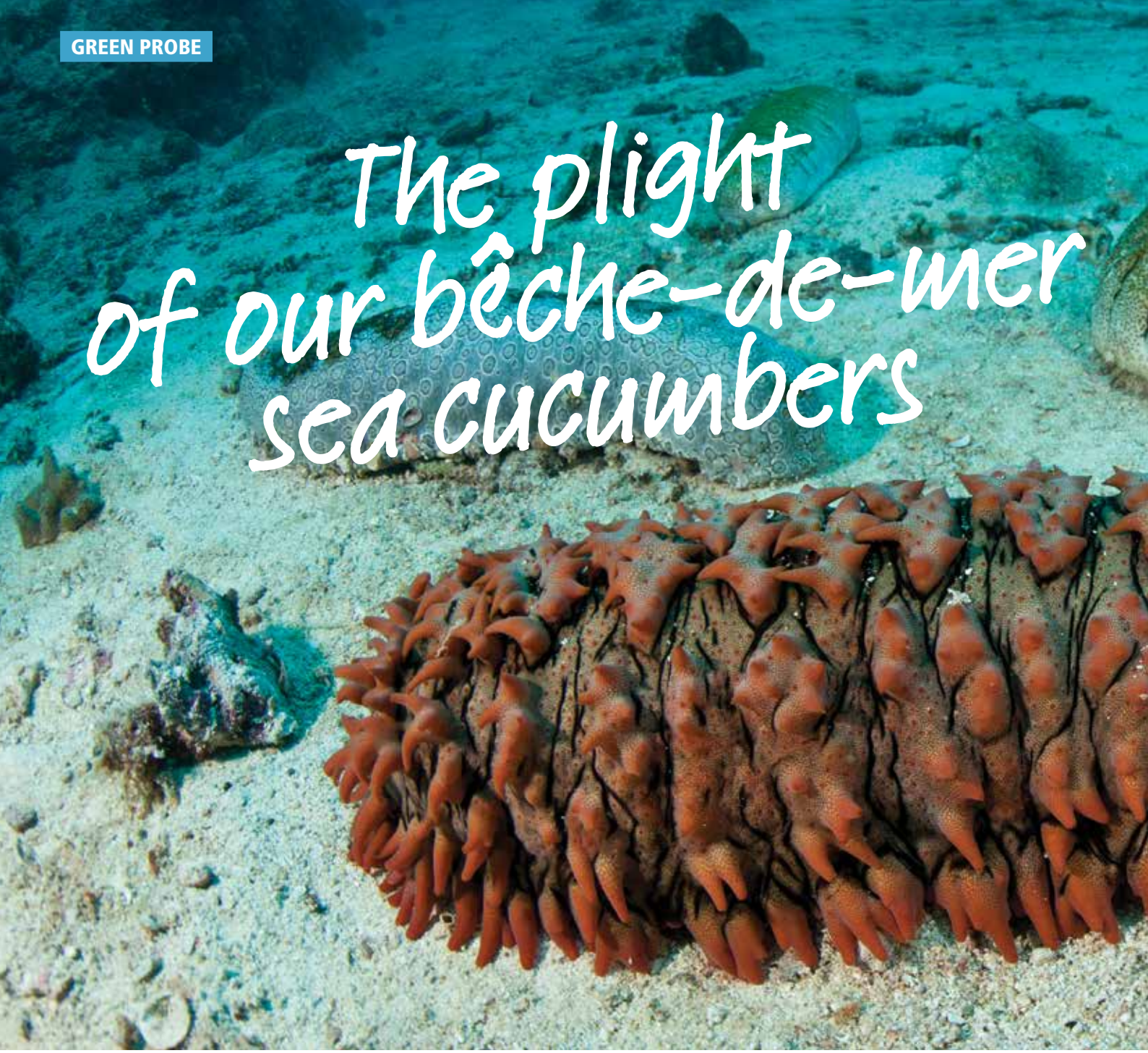
The plight of our bêche-de-mer sea cucumbers



They are highly valued in jars and poorly valued on reefs. Marine biologists **Kennedy Wolfe**, **Hampus Eriksson** and **Maria Byrne** report on lessons not learned in managing sea cucumber fisheries.

'One cannot help but lament over bêche-de-mer,' wrote EJ Banfield in the *Townsville Bulletin* in 1912. Sea cucumbers, the source of bêche-de-mer, were being exploited 'inconsiderately, almost wantonly', and the industry was on the brink of ruin. Banfield (famous for his book *Confessions of a Beachcomber*) blamed interfering politicians.

Sea cucumbers don't attract much admiration – Banfield described them as 'slothful slugs' and not at all loveable – but they have had an extraordinary influence on human affairs. The Chinese fancy for them as culinary delicacies, aphrodisiacs and medicines has for centuries lured men in pursuit. The establishment of international trade networks linked Australia and Asia long before Europeans arrived.

Sea cucumbers continue to cause lamentation. Their fisheries in many countries have crashed, and several species have recently been listed as threatened by the IUCN, including some exploited in Australian waters. Our recent analysis of catches in the Great Barrier Reef suggests that all is not well for sea cucumbers, even in a world heritage area.

Australia's oldest export industry

From the 1700s to the early 1900s, a fishing fleet would set out each December from the port city of Makassar, now Ujung Pandang in South Sulawesi, and sail 1600 kilometres on the monsoonal winds to Australia. Along the Arnhem Land and Kimberley coasts the fishers – numbering at their peak some 1000-2000 in 60 boats – would set up camps, collect sea cucumbers and cure them in smoke houses. In March or April they would return home and sell their catch to Chinese traders. The Makassan 'trepangers' traded other goods with Aboriginal communities and left a considerable cultural imprint – evident in the languages, art and spiritual practices of northern coastal groups. Overfishing and the introduction of license fees and duties brought an end to their Australian voyages in the first decade of the 1900s.

These sea cucumbers in the Great Barrier Reef Marine Park – prickly redfish (*Thelonota ananas*, front), leopard sea cucumber (*Bohadschia argus*, right) and sandfish (*Holothuria scabra*) – are some of the major species targeted globally for bêche-de-mer. *Photo: Jurgen Freund*

The patterns of exploitation in the marine park are typical of boom and bust practices in low-income countries.

Sea cucumbers as wildlife

Like their more glamorous relatives – the starfishes and sea urchins – sea cucumbers are members of the echinoderm phylum. They are widespread – found from the tropics to the Antarctic, from shallow intertidal areas down to deep abyssal plains. Sea pigs (or scotoplanes) reside at over 3000 metres depth, living in perpetual dark on falling detritus. The occasional whale carcass can attract hundreds to the feast. Many sea cucumbers are deposit feeders, ingesting and processing large quantities of sediment to digest algae and microorganisms in the sand.

Like other echinoderms, sea cucumbers move on hydraulically operated 'tube feet', which move when water is pumped in and out. Although lacking a brain, they exercise great control over this system. They have a net of nerves throughout their body, and sensory cells for touching, smelling and detecting light.

Sea cucumbers breathe through their anus, sucking up and passing water across their respiratory organs. Some animals put sea cucumber anuses to other uses – pearlfish often live inside the anus of the larger species. There, well protected from predators, they peer out on the world and duck in and out to feed. Their hosts seem to derive no benefit and in some cases they suffer harm when the pearlfish eat their gonads.

Some sea cucumbers have a unique method of self-defense – they eviscerate (vomit out) their internal organs to confuse the predator while they escape. Over several weeks to months, they then regenerate the discarded organs. Many echinoderms can regenerate body parts, as is well known for seastar arms.

As ecological benefactors

The contribution of sea cucumbers to marine ecosystems compares to that of earthworms on land. In extracting organic matter attached to sand, they break down and turn over large volumes of sediments, and redistribute nutrients, helping improve the productivity of seagrass and algae. Like earthworms, they 'fertilise their own gardens'.

Sea cucumbers also perform a valuable service by excreting calcium carbonate sand, an essential component of the skeletons or shells of corals, molluscs, crustaceans and other animals. Their digestion is likely to become even more important in future as higher levels of atmospheric carbon dioxide

In the first phase (1991-99) of the modern sea cucumber fishery in the Great Barrier Reef Marine Park the high-value black teatfish (*Holothuria whitmaei*) was the main target. Catches peaked at 350 tonnes, and dropped to 100 tonnes in 1999, despite increasing effort. This species is now globally endangered, having declined by 60-90% in the majority of its range. Despite the fishery being closed in Australia, there is concern that some populations have not recovered. *Photo: Maria Byrne*

The second phase of the GBR fishery (1999-2004) focused mainly on the high-value white teatfish (*Holothuria fuscogilva*), now listed by the IUCN as vulnerable. Also targeted were several other species including the high-value prickly redfish (*Thelenota ananas*), shown here. This species is still fished. It has been listed by the IUCN as endangered. *Photo: Robin Jeffries*

The third phase (2004-11) of the GBR fishery saw the total catch increase from 270 to 387 tonnes. Mainly targeted were the medium-value burying blackfish (*Actinopyga spinea*) and medium to low-value curryfish (mostly *Stichopus hermanni*), shown here. The catch of this species has increased rapidly despite a lack of knowledge of what a sustainable harvest is. It has been listed by the IUCN as vulnerable. *Photo: Kennedy Wolfe*

acidify the oceans, reducing carbonate levels and undermining calcification of reefs and shells. A study at One Tree Reef (off the central Queensland coast), where sea cucumbers achieve densities of about one per square metre, found they probably contribute close to half the nightly release of calcium carbonate. The alkaline faeces of sea cucumbers may help buffer changes in seawater pH.

Grave public concerns are held about the loss of coral on the Great Barrier Reef due to bleaching, crown-of-thorns starfish and cyclones. Overexploitation of ecologically important animals such as sea cucumbers may also be contributing to the decline.

As products

Bêche-de-mer is the hard, largely tasteless, dry body wall of sea cucumbers – what is left after they have been gutted, salted, boiled, smoked and dried. It is typically rehydrated in a soup, salad or stir-fry, and takes on the taste of the stock or broth.

While the bêche-de-mer trade has operated for centuries, the recent 'to get rich is glorious' awakening in China is driving unprecedented demand for a food that often features in business and wedding banquets. Previously, only the social elites could afford it but an increasingly wealthy middle class has seen exploitation expand to many more countries and include many more species.

From 1996 to 2011, the countries supplying Hong Kong with bêche-de-mer increased from 35 to 83, an average of three new exporters a year. Now, over 90% of tropical coastlines lie within countries exporting bêche-de-mer.

The conservation of commercially valuable species is challenging. In many countries overfishing has occurred before management agencies have been able to react and develop fishing rules.

As vulnerable

Slow-moving, easy to collect, and generally reproducing only once a year, sea cucumbers are vulnerable to overfishing. Sven Uthicke and co-researchers found that removing just 5% each year of the biomass of black teatfish, a species now endangered, would over time deplete breeding stocks on the Great Barrier Reef.

A typical pattern with new sea cucumber fisheries is a catch that peaks within 5–8 years, followed by rapid decline. This prompts a shift to lower value species, which allows for continued opportunistic exploitation of the rarer overfished species, sending them towards extinction. These patterns are typical of the fisheries operating in developing countries and small island communities, which have limited management capacity and depend heavily on fisheries for income.

More than 70% of tropical sea cucumber fisheries worldwide are thought to be fully exploited, over-exploited or depleted. In recent years, fisheries have collapsed or been closed in 24 nations, including Costa Rica, Ecuador, India, Mexico, Papua New Guinea, Samoa, Tonga and Vanuatu. Sea cucumber populations have been entirely removed in some accessible areas.

Sea cucumbers are likely to recover slowly from overfishing, or not at all, because they are broadcast spawners, and need the density of individuals to allow the sperm to find eggs.

In 2013 the IUCN listed 16 sea cucumber species as threatened. Thirteen of these are exploited, making up about a fifth of the 61 commercially important species. The main driver of extinction risk is high market value. Some of the species are harvested in Australian waters, and nine are found on the Great Barrier Reef.

Overfishing in a world heritage area

Overfishing is not just a problem in poor developing countries. The same patterns of exploitation are evident in Australia – and in a world heritage area no less – as two of us (Hampus and Maria) found last year when we assessed 20 years of catch data

Sea cucumbers are known as the 'vacuum cleaners' of coral reefs. Here, contributing an ecological service, a curryfish is excreting clean sand after digesting the organic material. *Photo: Kennedy Wolfe*

The contribution of sea cucumbers to marine ecosystems compares to that of earthworms on land.

Prices of bêche-de-mer vary depending on species, quality and time of year. In Sydney's Chinatown imported Japanese sea cucumbers, which are favoured in Beijing cuisine, can sell for several thousand dollars a kilogram ahead of Chinese New Year. The bigger species preferred in Cantonese cuisines sell for $100-400 a kilogram for medium to high value product. Here is bêche-de-mer for sale in Hong Kong. *Photo: Cam Lewis*

from the Queensland East Coast bêche-de-mer fishery. Despite just a few licensed sea cucumber fisheries to manage, serial exploitation of species has occurred just as it has in other parts of the world where fisheries have been proved unsustainable.

Some 350-400 tonnes of processed sea cucumber, worth around $5.5 million, are currently extracted each year from the Great Barrier Reef Marine Park. Although tropical Australia waters were a major source of bêche-de-mer in the 1700s and 1800s, the modern fishery is relatively new, starting in the mid-1980s and concentrated in the marine park.

Our study of catch data from 1991 to 2011 showed that in just 20 years this fishery has progressed through three waves.

The initial target was the high-value black teatfish. Catches rose in the 1990s then rapidly declined (by 70%) despite increasing fishing effort. A study found that densities on fished reefs were only a quarter of those on unfished reefs. That fishery was closed in 1999, and remains closed today.

The next target was another high-value species, the deeper water (20–30 metres) white teatfish. Despite the experience with black teatfish, this fishery developed without any information about abundance. In this second wave from 1999 to 2004, several other species, including the high value prickly redfish, were also taken.

During the third wave, from 2004 to 2011, the total catch increased by more than a third to 387 tonnes, mainly due to two new target species – the burying blackfish and the curryfish. These are lower value species, and now make up about 80% of the catch in the GBR. From 2007 to 2011 catches of curryfish doubled each year, without baseline studies or abundance estimates. At such rates, catches typically peak within a decade.

The black teatfish and prickly redfish have been listed by the IUCN as endangered and the white teatfish and curryfish as vulnerable.

The patterns of exploitation in the marine park are typical of boom and bust practices in low-income countries. Also typical is a lack of published scientific research, with no baseline studies to determine a sustainable harvest and no understanding of their ecology. Australia requires reporting of catch data but this is confidential so cannot be independently assessed.

The need is drastic for more research on sea cucumbers – on their taxonomy, abundance, life history and the impacts of fishing – and for more conservative fisheries practices. Otherwise, the lamenting reported by Banfield a century ago will go on, and Australia's reputation as the manager of the Great Barrier Reef will suffer. ■

READING: Eriksson H, Byrne M. 2015. The sea cucumber fishery in Australia's Great Barrier Reef Marine Park follows global patterns of serial exploitation. *Fish and Fisheries* 16: 329–41

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MARIA BYRNE is Professor of Marine Biology at the University of Sydney. She researches the biology and ecology of marine invertebrates and has a particular interest in echinoderms. In recent years her research has focused on the impacts of climate change on echinoderms from the tropics to the poles and on the biology of tropical sea cucumbers.

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