Population status, fisheries and trade of sea cucumbers in Asia

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The Philippines: a hotspot of sea cucumber fisheries in Asia

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Choo, P.S. 2008. Population status, fisheries and trade of sea cucumbers in Asia. In V. Toral-Granda, A. Lovatelli and M. Vasconcellos (eds). Sea cucumbers. A global review of fisheries and trade. *FAO Fisheries and Aquaculture Technical Paper*. No. 516. Rome, FAO. pp. 81-118.

SUMMARY

The regional review on the population status, fisheries and trade of commercially important sea cucumbers in Asia covers the east and southeast Asian regions including Indonesia, Malaysia, Thailand, Myanmar, Viet Nam, Philippines, Singapore, the Spratly Islands, Japan, Democratic People's Republic Korea, Republic of Korea, Far East Russian Federation, China Hong Kong Special Administrative Region (SAR) and Taiwan Province of China (PC). A total of 52 species are commercially exploited as food with most of them comprising tropical and sub-tropical species from the families Holothuriidae and Stichopodidae, including the genus *Holothuria*, *Actinopyga, Bohadschia* and *Stichopus*.

Fisheries in the Asian tropical and sub-tropical waters are multi-species, while the fishery in temperate waters is single species, comprising predominantly only one species, *Apostichopus japonicus.* Fishing and seafaring communities in Asia had been involved in sea cucumber fishing and processing since the sixteenth century. The fresh animals caught were processed into dried forms known as "trepang". Indonesia is the world's top producer of Holothuroidea from the capture fishery. Indonesia, together with the Philippines produced an annual average of 47 percent of the world's Holothuroidea landings, comprising an annual average of 2 572 tonnes (wet weight) between 2000 and 2005. The highest capture fishery producer of the temperate species, *A. japonicus* is Japan, with an average production of 8 101 tonnes per year between 2000 and 2005.

The sea cucumber capture statistics obtained from the Food and Agriculture Organisation (FAO) are recorded in wet weights; for landings in Southeast Asia the figures appear to be grossly underestimated, and the statistics need to be verified as to whether the data reported were actually dried and not wet weight. Except for China, where a substantial amount of sea cucumber production is from aquaculture (an estimated annual production of 10 000 tonnes dry weight), the production in the other Asian countries is derived predominantly, if not exclusively, from capture fisheries.

Apart from gleaning, the most common fishing methods for sea cucumbers include small bottom trawl nets in sandy bottoms, scallop-drag gear in nearshore rocky-bottom habitats, spears, hooks and scoop nets for reefs, and SCUBA and hookah for deeper reef and lagoons.

Overfishing is the main problem contributing to the depletion of sea cucumber resources. Except for Japan, other Asian countries are generally lacking in management measures to conserve and sustain their sea cucumber fisheries. The two most important

producing countries, Indonesia and the Philippines do not have management plans specific to sea cucumber conservation. Other threats to sustaining the sea cucumber resources include habitat loss, lack of accurate statistics, global warming and new uncontrolled uses (such as for pharmaceuticals and nutriceuticals) for sea cucumber resources.

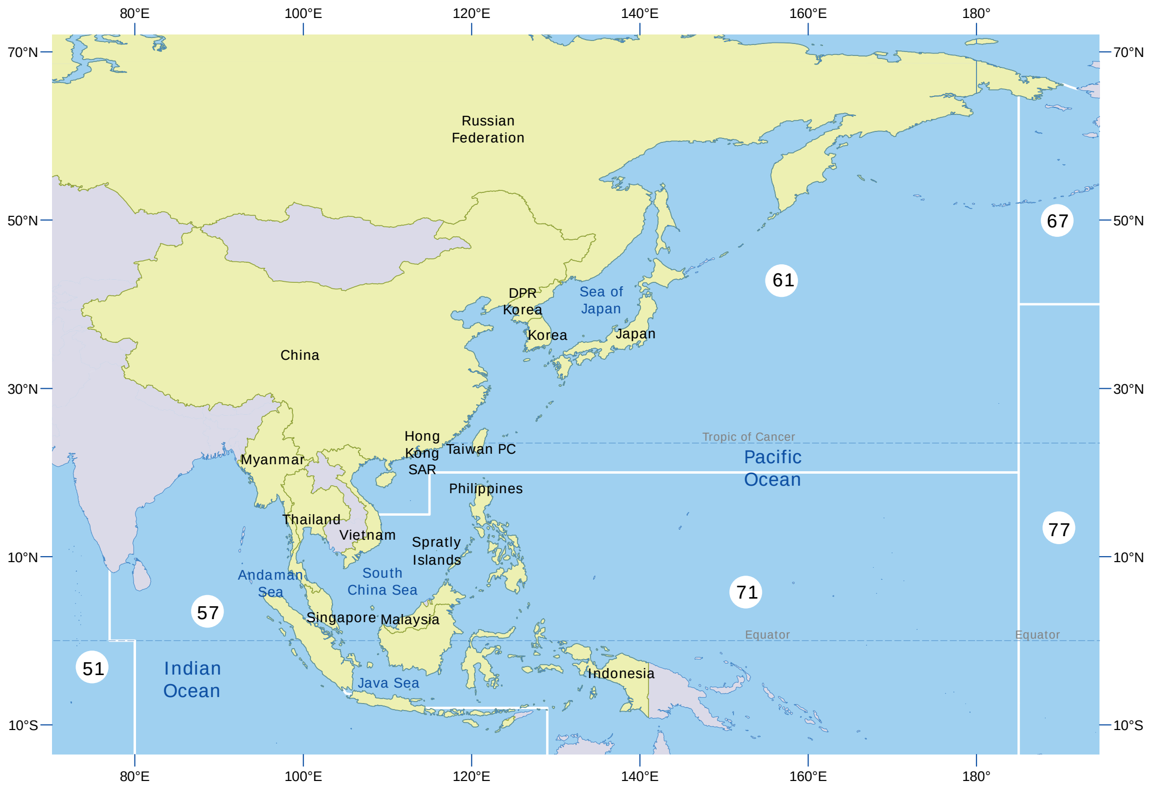
1. REGION UNDER STUDY

This paper covers the East and Southeast Asian regions (Figure 1) comprising Indonesia, Malaysia, Thailand, Myanmar, Viet Nam, Philippines, Singapore and the Spratly Islands (in tropical Southeast Asia); China, Japan, Democratic Peoples' Republic Korea, Republic of Korea and Far East Russian Federation (in temperate East Asia) and China Hong Kong Special Administrative Region (SAR) and Taiwan Province of China in the sub-temperate zone. The Spratly Islands are a group of reefs in the South China Sea with sovereign claims from China, Taiwan Province of China, Viet Nam, Brunei, Malaysia and the Philippines.

Generally, information on the biology, ecology, fisheries and trade on sea cucumbers in the Asian region is rather limited. Although China, China Hong Kong SAR and Singapore are important centres for sea cucumber trade, information published in English on trade from these countries were mainly written by researchers based outside the region. It is, however, unclear on how much information on this topic is available in other languages such as Chinese. There are a fair number of publications on sea cucumber from China, Japan, Indonesia, Philippines and Malaysia, but very little information is available from China Hong Kong SAR, Democratic People's Republic of Korea, Myanmar, Thailand, Singapore and Viet Nam, and no information at all (except for some FAO statistics on capture production) from the Republic of Korea.

FIGURE 1

Region under study and countries covered in this review (highlighted in yellow). The region partially encompasses the FAO Statistical Areas 57 (Eastern Indian Ocean), 71 (Western Central Pacific) and 61 (Northwest Pacific)



2. BIOLOGICAL AND POPULATION STATUS

2.1 Key taxonomic groups and commercial species

In Asia, sea cucumbers that are commonly fished are derived mainly from the Order Aspidochirotida under two families, Holothuriidae and Stichopodidae. Genuses that are frequently exploited for food include *Holothuria*, *Actinopyga* and *Bohadschia*. Altogether, a total of 125 sea cucumber species were recorded from various references (Chao, 1998; Jeng, 1998; Bussarawit and Thongtham, 1999; Forbes *et al*., 1999; Flint, 2002; Zaidnuddin, 2002; Tan, 2003; Chen, 2004; Choo, 2004; Mucharin and Putchakarn, 2005; Purwati, 2005; Tan, 2005a, b; Otero-Villanueva and Ut, 2007; Asmedi, undated), with 52 species documented as commercially important (Appendix I). Sven Uthicke (Australian Institute of Marine Science; personal communication) noted some confusion exists in the correct taxonomic names for the teatfish group; this report adheres to the results of a recent morphological and genetic study by Uthicke, O'Hara and Byrne (2004) which suggested that all black teatfish in the areas covered in this review are *Holothuria whitmaei*; it is presumed that *H. nobilis* does not exist in the Asian region covered in this review. Thus, references to *H. nobilis* given in several papers are referred to here as *H. whitmaei*. A country-by-country account on the sea cucumber distribution in the Asian region is given below.

Liao (1997, cited in Chen, 2004) reported that China has about 134 species of sea cucumbers with 28 of them considered edible or with medicinal properties (Zhang, 1954, 1958; Fan, 1979). Twenty seven of these commercial species are listed in Appendix I. Most of the commercial species from China are distributed in the tropical and subtropical regions; only a few species are found in temperate waters (Chen, 2004). *Apostichopus japonicus* is the most commercially important temperate species.

Jeng (1998) recorded a total of 13 species of sea cucumbers in Taiping Island which is one of the largest islands in the Spratly group of islands. Most species found here are also commonly found in the Indo-West Pacific coral reefs (Appendix I). Species like *Actinopyga lecanora*, *Stichopus chloronotus*, *Thelenota rubralineata* and *Synaptula lamperti* have been reported in Taiping Island but had not been recorded from waters off Taiwan Province of China. *A. lecanora* and *T. rubralineata* were rare species and only one specimen of each was found during the survey in Taiping Island.

Chao (1998) listed the presence of 30 species from three Orders and five Families in the shallow waters of Taiwan Province of China. There is no documentation from the FAO statistics that a sea cucumber capture fishery exists in Taiwan Province of China.

In the coastal waters of China, Hong Kong SAR, 14 Holothuroidea species including *H. scabra,* were documented in a paper published in the 1930s (Mortensen, 1934). Xing and Chia (1997) noted that *H. leucospilota* were found in the shallow waters of many areas in China Hong Kong SAR. The author could not find any commercial sea cucumber fishery records for China Hong Kong SAR; sea cucumber trade is dependent on imports from all over the world, a vast percentage of which are re-exported.

Fishing for sea cucumbers in Viet Nam takes place mainly in the waters around the Phu Quoc Archipelago in southern Viet Nam; 25 species of sea cucumbers have been documented here, of which 11 species are exploited for their commercial value (Otero-Villanueva and Ut, 2007).

The sea cucumber fishery in Indonesia is generally artisanal, and is scattered throughout the many Indonesian islands including Lampung, Java, Nusa Tenggara, Sulawesi, Maluku and Irian Jaya (Tuwo and Conand, 1992). There were at least 56 species in the Spermonde Archipelago in Southwest Sulawesi, Indonesia (Massin, 1999). In the Kaledupa Stakeholder Zone in the Wakatobi Marine National Park in Sulawesi, Flint (2002) recorded the presence of 32 species of holothurians of which 26 could be processed into trepang, with *H. hilla* and *H. pervicax* being used as fillers to top up weights during sale transaction.

Aryono (1987) noted the presence of nearly 25 000 sea cucumbers (including *Synapta* sp. and *H. atra*) in a hectare of seagrass meadows in the Seribu Islands. In the coastal waters of Sulawesi, there were probably 30 species of sea cucumber, the most common of which were *H. atra* which measured up to 60 cm in length, *S. chloronotus* (about 30 cm long) and *H. scabra* (Whitten, Mustafa and Henderson, 2002).

Information extracted from Bussarawit and Thongtham (1999) and Mucharin and Putchakarn (2005) indicated the presence of 71 species of sea cucumbers from the waters in Thailand out of which eight were described as commercially important (Appendix I).

A total of 62 species of sea cucumbers belonging to three Orders and five Families from the coral reef areas in Peninsular Malaysia and Sabah have been recorded (Forbes *et al.,* 1999; Zaidnuddin, 2002); out of these 20 were of commercial importance (Choo, 2004). Nineteen commercial species from Malaysia are listed in Appendix I. Commercial species identified only to the genus (*Bohadschia*) level ("lubuyoh tadik" and "mother tadik") are not included in Appendix I. The local names of trepang from Sabah are taken from Filipino migrants (Akamine, J., Nagoya City University, Japan, personal communication).

In the marine park in Pulau Payar, located in the northwest coast of Peninsular Malaysia, Zaidnuddin and Forbes (2000) noted that *H. atra* was the most abundant species, followed by *H. leucospilota*, *S. chloronotus* and *S. horrens.* Zaidnuddin (2002) documented the presence of seven species in Balik Pulau, Penang, which is located in the north–west coast of Peninsular Malaysia. He suggested that the low-value *Paracaudina* sp. found abundantly in the muddy habitats of Balik Pulau and eaten raw by the local population, be more widely promoted as a food source. Boss, Yasin and Tan (1999) completed a preliminary survey of sea cucumbers in Pulau Besar, Johore, located in the southeast coast of Peninsular Malaysia and reported the presence of seven species including five species of *Stichopus* (*S. herrmanni* and four other species which have not been identified), *A. lecanora* and *H. impatiens*. They suggested that the high number of *Stichopus* spp. in Pulau Besar may be due to the variable habitats found there, namely sea grass beds, different types of corals and rocky areas.

Species documented from Singapore waters included those popular in the aquarium trade such as the thorny sea cucumber, *Colochirus quadrangularis* and sea apple, *Pseudocolochirus violaceaus,* found in Pulau Ubin (Tan, 2003, 2005a). Other species recorded from Pulau Ubin included *H. scabra* and *Phyllophorus* sp., while the pink warty sea cucumber, *Cercodemas anceps*, was found in Changi and Pulau Sekudu (Tan, 2005b). However, the species of sea cucumbers stated above were not exploited for commercial purposes in Singapore.

2.2 Biology and ecology of sea cucumbers

Relatively little information is available on the biology and ecology of sea cucumbers in this region. Only a few species of the two orders Aspidochirotida and Apodida found in tropical waters have been studied (Chao, Chen and Alexander, 1995). Among the tropical species with a significant amount of information is the high value species *H. scabra,* and for the temperate species, *A. japonicus*, the latter being one of the best studied species.

Uehara (1991) noted that most benthic sea cucumbers in Asia exhibit two activity patterns: (i) feeding actively the whole day and resting irregularly (examples include *H. atra*, *A. mauritiana* and *H. edulis*); and (ii) demonstrating a cycle of active and inactive periods (examples include *H. scabra*, *B. argus* and *B. bivittata*) where they come out of the sand in the evening, move and feed actively at night and bury themselves under the sand in the morning. Commonly, juvenile sea cucumbers inhabit shallower areas than the adults, and they migrate to deeper areas at a later stage (Uehara, 1991). Most sub-tropical sea cucumber species from Japan reach sexual maturity in about three years and live for more than five years (Uehara, 1991).

TABLE 1
Sea cucumber species from the Balik Pulau District, Penang, Malaysia

Family/Species	Location	Bottom type	Habitat	Abundance
Holothuridae				
H. martensi	Balik Pulau	Muddy with shells	Northwestern area, 3–4 nautical miles from shore with water depth to 30–40 m	<10 Specimens from 1 hour trawl
H. atra	Pulau Kendi	Dead corals	Coral area, shoreward side of reef	<10 Specimens from 1 hour trawl
H. leucospilota	Pulau Kendi	Dead corals	Coral area, shoreward side of reef	<10 Specimens from 1 hour trawl
Stichopodidae				
S. chloronotus	Pulau Kendi	Dead corals	Coral area	1–2 specimen(s) from 1 hour trawl
S. horrens	Pulau Rimau	Mud mixed with shells	Eastern and southern side of Pulau Rimau	1–2 specimen(s) caught with grab
Molpadiidae				
Paracaudina sp.	Border with Perak	Muddy	South of Pulau Pinang, occupying muddy area <10 m deep	>500 specimens; >500 kg from 1hr trawl
Cucumariidae				
Pseudocolochirus spp.	Pulau Rimau	Muddy and rocky	Cage culture area	3 specimens found in discarded netting

Source: Zaidnuddin, 2002.

Zaidnuddin and Forbes (2000) noted that in the Malaysian reef areas, *H. atra* had a preference for soft, sandy bottoms; *S. chloronotus* preferred areas with some boulders mixed with live corals and *S. horrens* occupied areas scattered with boulders of the coral *Porites* spp. Shallow water species inhabiting depths up to 10 m included *S. horrens, H. leucospilota, H. hilla* and *H. pardalis*, while *B. marmorata* and *S. herrmanni* were found in deeper areas. Table 1 shows the substrate preference for seven species of sea cucumber found in the Balik Pulau District, Penang, Malaysia (Zaidnuddin, 2002).

Uehara (1991) noted that most holothurians in Asia are dioecious (having male and female reproductive organs in separate animals but not both together as in hermaphrodites, and sometimes described with the synonym "gonochoric") with external fertilisation. Some species, example *Synaptula hydriformis*, release their larvae through a rupture in the body wall, or more often through a perforation in the wall of the intestine after development in the coelom (Bakus, 1973). For the viviparous species such as *A. africana* and *Scoliodotella lindbergi*, the larvae are housed in the brood pouch (Uehara, 1991).

Chao, Chen and Alexander (1995) conducted a study on the reproductive cycles (including reproductive type, gonad colour, spawning period and gonad morphology) of nine tropical species of sea cucumbers found in the reef flats of the southern tip of Taiwan Province of China. The results are summarised in Table 2.

Sea cucumbers from temperate regions have been found to undergo aestivation – a form of dormancy during the summer months in high temperatures or during the dry seasons. Yuan *et al.* (2007) noted that aestivation has ecological implications and acts as an energy-saving mechanism during the hot period. Aestivation of *A. japonicus* has been widely reported by Chinese researchers (Liu *et al.*, 1996; Sui and Liao, 1988; Yang *et al.*, 2005).

The biology and ecology of the two best studied species in the region (the tropical species *H. scabra* and the temperate species *A. japonicus*) are described in more detail below.

TABLE 2
Reproductive characters of nine species of holothurians from southern Taiwan Province of China. Species of commercial importance in Asia are written in bold letters. Month in parentheses indicates when oocyte diameter was measured

Species	Reproductive type	Oocyte diameter (µm)	Spawning period
A. africana	Gonochoric, fission	350 ± 50 (May)	Mar–Apr
A. echinites	Gonochoric	110 ± 5 (June)	Jun–Jul
H. leucospilota	Gonochoric	120 ± 5 (Jul)	Jun–Sep
H. cinerascens	Gonochoric	100 ± 10 (May)	Apr–Jun
H. difficilis	Gonochoric	75 ± 5 (Aug)	Aug–Sep
S. maculate	Gonochoric	70 ± 5 (Jun)	Jun–Jul
Opheodesma grisea	Gonochoric	100 ± 5 (Jul)	Jun–Jul
Patinapta taiwaniensis	Gonochoric	65 ± 10 (May)	Jun–Jul
Polycheira rufescens	Gonochoric	110 ± 10 (May)	Apr–Jun

Source: Chao, Chen and Alexander, 1995.

2.2.1 Tropical species: Holothuria scabra *(sandfish)*

Holothuria scabra, commonly known as sandfish, is widely distributed throughout the Indo–Pacific, being found roughly between latitudes 30 °N and 30 °S (Hamel *et al.*, 2001). Its range extends from the east coast of Africa and the Red Sea, eastward to the Caroline Islands and Fiji in the Pacific, and from the Amami Islands southward to the Torres Strait (Uehara, 1991). In Japan, the distribution of *H. scabra* is limited to several areas around Okinawa such as Haneji Inland Sea, Nakagusuku Bay, Kin Bay, and in Yakata-katabaru in Onna Village (Uehara, 1991). In Viet Nam, sandfish are found in sandy estuaries or lagoons at depths of 2–25 m or more, often in patches of high concentration (Pitt and Duy, 2003).

Rowe (1969, cited in Hamel *et al.*, 2001) noted the presence of nine species in the subgenus *H. scabra*, with all of them located in the Indo–west Pacific. Sandfish from Khan Hoa Province, Viet Nam, appears to be closer to *H. scabra* in terms of their small size and size at first maturity, with colours ranging from black through dark brown to light beige, often with transverse stripes, and less deeply ridged than those from Oceania (Pitt and Duy, 2003). The subspecies found in Tunku Abdul Rahman Park in Sabah, East Malaysia, was identified as *H. scabra* var. *versicolor* by Forbes *et al.* (1999); the animals which might grow to an estimated 30 cm were found in inner reef flats or near estuaries, and were often buried in sand or covered with leaves. Uehara (1991) noted that *H. scabra* could attain a maximum length of 37 cm and a weight of 600 g.

There is a high degree of polymorphism, which is observed throughout the *H. scabra* geographic range (Conand, 1990). Hamel *et al.* (2001) noted that there are two reasons for the high degree of polymorphism: identification errors and important morphological plasticity over the geographic range. However, Hamel *et al.* (2001) noted that the behaviour and reproductive patterns described for all the species of *H. scabra* in its geographic range differed considerably, suggesting that there might be taxonomic confusion and not all studies were conducted on *H. scabra*.

In countries situated near the Equator, sandfish spawn throughout the year (Agudo, 2006). Tuwo (1999) noted that *H. scabra* from Southwest Sulawesi, Indonesia, had two peak spawning periods, although spawning occured throughout the year; the two post–spawning periods were at the beginning of the dry season (March to July) and at the beginning of the rainy season (November to January). In the Philippines, gonad maturation occured from January to April and from July to October, with main spawning events occurring from May to June and from October to November (Ong Che and Gomez, 1985).

Sandfish, classified as commercially high value species, are easily overexploited since they are commonly found in shallow waters. With the great demand for trepang and the active harvesting from local fishers, there is severe fishing pressure on natural populations of *H. scabra* (Hamel *et al*., 2001). In Malaysia, Choo (2004) reported on signs of overfishing of the sandfish stock in Sabah, East Malaysia as evident by the decrease in landings and overall size of the animals landed. Otero-Villanueva and Ut (2007) noted that less than 100 kilograms (dry weight) per annum were currently landed from the Phu Quoc Archipelago in Viet Nam, and while conducting over 80 underwater surveys in the area up to a depth of 18 m, they had not encountered sandfish.

2.2.2 Temperate species: **Apostichopus japonicus** *(Japanese spiky sea cucumber)*

A. japonicus (formerly known as *Stichopus japonicus*), a species found along the Asian coast, has long been exploited as an important fishery resource in Far East Russian Federation, China, Japan, Republic of Korea and Democratic People's Republic of Korea (Sloan, 1984, cited in Yang *et al.,* 2005). This species has been successfully cultured on a large commercial scale in northern China. Chen (2004) reported that the total production of *A. japonicus* in China reached over 5 865 tonnes (dry weight) in 2002 against a capture fishery production of 470 tonnes (dry weight) in the same year.

A. japonicus ingests organic matter, bacteria, protozoa, diatoms as well as plant and animal detritus (Zhang, Sun and Wu, 1995, cited in Yang *et al.,* 2005) and reutilises residual food and faeces (Yang *et al*., 2001, cited in Yang *et al.,* 2005). It becomes inactive when water temperature exceeds 18 °C, and will aestivate at water temperatures about 20–24.5 °C (Sui and Liao, 1988; Liu *et al.,* 1996). Liu *et al.* (1996) noted that in some regions in China, aestivation can last up to four years. From laboratory experiments conducted under controlled conditions, Yang *et al*. (2005) found that large and medium animals (72.3–139.3 g) aestivated at a threshold temperature between 24.5 and 25.5 °C while for small animals, aestivation was observed when the temperature was between 25.5 and 30.5 °C. In general, *A. japonicus* from the more southern areas have a higher threshold temperature for aestivation (Yang *et al*., 2005).

In Japan, *A. japonicus* are red ("aka namako"), green ("ao namako") or black ("kuro namako") in colour; specimens with different colour morphs fetch different prices and have their own unique tastes (Kan-no and Kijima, 2003). "Aka" and "Ao namako" are the most important morphs for commercial fishing; the three colour morphs are distributed from the surface to a depth of 40 m, over a wide area of the north-eastern Pacific: from Sakhalin Island and Alaska to the Amami Islands (Japan) and the east coast of China (Arakawa, 1990). In Japan, the red type inhabits gravel bed offshore while the green and black types inhabit the sand–muddy bottom inshore (Choe, 1963). Based on their study, Kan-no and Kijima (2003) suggested that the microhabitat differentiation might have resulted in reproductive isolation; however, they noted that the clear genetic independence of the red types could not be explained by differences of microhabitat alone. In a later study using 11 microsatellite markers, Kanno *et al.* (2006) tested the genetic differentiation among the three sympatric colour morphs and showed the strong heterogeneity of the red morph, while no significant difference was observed between the green and black morphs. These results indicated the separate species status of the red morph and supported the population identity of the sympatric green and black morphs (Kanno *et al.*, 2006). A study conducted by Yao *et al.* (2007) on *A. japonicus* from Penglai in Changdao and Lingshandao in Qingdao (China) showed that the genetic diversity of the two stocks was still large but the genetic distance between them was close; a dendogram constructed for the 57 individuals from the two stocks indicated that the genetic structure was unitary for those from Penglai but complex for those from Lingshandao.

2.3 Background of sea cucumber fishery

Sea cucumbers have been fished and traded in the Indo–Pacific regions since the sixteenth century (Akamine, 2004). Akamine (2004) mentioned that Japan traded trepang with China for silk and medicine during the Edo period (1601–1867). About the same time Europeans brought trepang from tropical waters to China in exchange for tea, silk and porcelain (Akamine, 2004). Uehara (1991) reported that dried sea cucumbers were exported in considerable amount to Taiwan Province of China and China from Okinawa, Japan, until about 1940, and those from Haneji in Okinawa (known as "haneji-iriko", comprising *H. scabra*) were especially famous. Currently only small amounts are exported from Okinawa by several fisheries cooperatives. In Asia, sea cucumbers have been reported to be heavily exploited in China, Indonesia, Malaysia, Philippines, Thailand and Viet Nam (Bruckner, 2005).

In the late seventeenth century, the fishing and seafaring communities of Sulawesi became actively involved in sea cucumber gathering which prompted the search for high quality sea cucumber throughout eastern Indonesia and beyond, with most of the trade centred on Makassar in South Sulawesi (Fox and Sen, 2002). In the mid 1880s, fishers from Makassar, Indonesia, were known to have gone as far as northern Australia to fish for sea cucumbers (Purwati, 2005). Exports of seafood products to Singapore from Indonesia have been traced back to the 1800s; in 1830, 180 boats owned by the Bugis were reported to have landed in Singapore bringing with them marine products from eastern Indonesia (Purwati, 2005). Direct trepang trade between China and Indonesia was documented to date back to the sixteenth and seventeenth century (Purwati, 2005).

Butcher (2004) also noted that trepang trade in Southeast Asian countries with China dates back to the 1700s. He reported that Papuan slaves were forced to dive for trepang by people from the Aru Islands. In the latter part of the eighteenth century, British traders began stopping in Jolo in the Philippines where they traded firearms, Indian cloth and opium for trepang which were later sold to the Chinese. At the height of the marine products trade in the 1830s, as many as 68 000 slaves were captured each year and handed to the sultans and chiefs of Jolo who forced the slaves to dive for pearl shell and trepang. During this period, about 600 tonnes of trepang were exported from Jolo each year. The harvesting of huge amounts of trepang in the mid 1800s saw a resurgence of heavy exploitation in the 1980s and 1990s to satisfy the demands from wealthy consumers from Taiwan Province of China, China Hong Kong SAR, southeastern China and the Chinese communities from Southeast Asia (Butcher, 2004).

However, not all countries in the Asian region have a long history of sea cucumber fishery. In Viet Nam, for example, the sea cucumber fishery in the vicinity of the Phu Quoc Archipelago, the mainstay of the country's sea cucumber resources, has only a recent documented history, dating back to the early 1980s (Otero-Villanueva and Ut, 2007). Within a short span of ten years, sea cucumber resources in this region have been over exploited, and sea cucumber fishers are turning to fishing for other organisms for a livelihood. Otero–Villanueva and Ut (2007) reported that in 2004, the average monthly income for a sea cucumber diver in Viet Nam was estimated to be USD 130–194. The sea cucumber fishery in Thailand also has a relatively young history which dates back to the late 1960s (Bussarawit and Thongtham, 1999).

2.4 Species in trade

Based on historical records, the Chinese are probably the first to utilise sea cucumbers as food because of its nutritional and medicinal properties. Chen (2003) noted that eating trepang is a Chinese custom that can be traced back to the Ming Dynasty (1368–1644 BC), and traditionally, they were eaten more for their tonic value than for their taste. Some communities in the Philippines are known to consume sea cucumbers (Trinidad-Roa, 1987; Heinen, 2001) whilst Conand and Byrne (1993) also

TABLE 3
Categorization of sea cucumber species in the international food market according to their commercial value. Common names in parentheses

High value	Medium value	Lower medium value	Low value
H. scabra (sandfish)	*A. lecanora* (stonefish)	*A. echinites* (deep water redfish)	*B. marmorata/ vitiensis* (brown sandfish)
H. fuscogilva (white teatfish)	*A. mauritiana* (good quality surf redfish)	*A. miliaris* (blackfish)	*H. atra* (lollyfish)
H. whitmaei (black teatfish)	*S. chloronotus* (good quality greenfish)	*S. chloronotus* (greenfish)	*H. edulis* (pinkfish)
T. ananas (prickly redfish)	*S. herrmanni* (curryfish)		*H. fuscopunctata* (elephant trunkfish)
			T. anax (amberfish)
			B. argus (tigerfish)

report traditional consumption in Papua New Guinea, Samoa and Fiji. Some species (*S. horrens* and *S. herrmanni*) are utilised commercially for the preparation of medicinal products but less commonly used as food items. In Malaysia, for example, both these species are used in the preparation of traditional medicinal products. Species utilised by humans generally include members of the families, Holothuroidea and Stichopodidae. Fishing down the high value species and the replacement of these species with lower value species is commonly documented in the Southeast Asian region in Malaysia, Thailand, Viet Nam and the Philippines (Bussarawit and Thongtham, 1999; Forbes and Ilias, 1999; Bruckner, Johnson and Field, 2003; Choo, 2004; Gamboa, Gomez and Nievales, 2004; Otero-Villanueva and Ut, 2007). In recent years, commercially less-valuable species like the "worm" species *Synaptula* spp. belonging to the family Synaptidae have been exploited.

Sea cucumbers fished from the tropics are classified into four categories in the international food market according to their commercial values (Ferdouse, 2004). Some species categorized under the four groups are shown in Table 3.

Sea cucumbers are also exploited for the aquarium trade. The most common genera utilised for the aquarium trade are *Euapta, Synapta, Synaptula* or *Opheodesoma* (Toonen, 2002); other species include the thorny sea cucumber (*Colochirus quadrangularis*), yellow sea cucumber (*Colochirus robustus*) and sea apple (*Pseudocolochirus violaceaus*) belonging to the Family Cucumariidae. *T. ananas*, more commonly harvested for food, is sometimes harvested also for the aquarium trade.

The commercial exploitation and trade in sea cucumbers in some countries in Asia are described below.

2.4.1 China

Most of the 27 species of commercially exploited sea cucumbers in China belong to the Order Aspidochirotida, with a few species belonging to the Order Dendrochirotida and the Order Moldavia (Appendix I). Wild fishery catches from China are not recorded in the FAO yearbook on fishery statistics capture production.

2.4.2 Japan

Ohshima (1934, cited in Uehara, 1991) listed 18 species of edible sea cucumbers from the Ryukyu Islands in Japan, among which were: *H. scabra*, *H. atra*, *H. edulis*, *B. argus*, *B. bivittata*, *A. mauritiana* and *T. ananas*. Anon (1989) noted that in Japan, the commercial sub-tropical species, *T. ananas* (locally known as "baika") is the country's largest sea cucumber (maximum length of 70–80 cm) and are found in the waters from Okinawa, Japan, stretching to Micronesia; the temperate species, *Cucumaria frondosa japonica* (locally known as "kinko") is found in cold waters along the coast of the Sea of Japan and north of Ibaraki Prefecture to Hokkaido. *A. japonicus* (called "manamako") is the most common species and is found in shallow waters surrounding Japan.

Parastichopus nigripunctatus (called "oki-namako") grows up to 40 cm, is found along the western coast of Japan at depths up to 160 m. Currently, only small quantities of *P. nigripunctatus* and *C. japonicus* are harvested and processed (Akamine, 2004). There are demands from the Republic of Korea and the United States of America markets for dried *P. nigripunctatus* and its production in Japan has been increasing since 2005 (Akamine, J., Nagoya City University, personal communication).

2.4.3 Democratic People's Republic of Korea

Little information is available on the sea cucumber fishery in Democratic People's Republic of Korea. There is no information on the total number of species exploited; the species commonly exploited for food from the capture fishery is *A. japonicus* which has been reported to be severely exploited (Anon., undated). Attempts to hatchery-reproduce sea cucumber juveniles for restocking programmes and mariculture activities have started in 2001 with the construction of small hatcheries operated by fishing cooperatives (Lovatelli, A., FAO, personal communication)

2.4.4 Indonesia

Thirty-five species of sea cucumber under the order Aspidochirotida and Dendrochirotida are commercially exploited in Indonesia (Appendix I). Commercial species are usually given local names by the fishers, and sometimes, different trepang species are given the same local name, adding to the taxonomic confusion (Purwati, 2005). Statistics on trepang exported are not separated into individual species, and therefore details on production status and landing trends on individual species are not available.

2.4.5 Thailand

Sea cucumbers were initially harvested for local consumption. The export fishery was developed in the beginning of the late 1970s, targeting *H. scabra* and *H. atra* (Bruckner, 2005). Tebchalerm (1984, cited in Bussarawit and Thongtham, 1999) reported that they were harvested commercially in a number of Thai provinces along the Andaman Sea. According to Bussarawit and Thongtham (1999), *H. scabra, H. leucospilota, H. edulis, B. marmorata, T. ananas, S. chloronotus* and *S. herrmanni* were collected commercially by fishermen in Rayong and Chon Buri in eastern Thailand.

2.4.6 Viet Nam

In Viet Nam, sea cucumbers are heavily exploited and processed as trepang which is exported to markets in China, China Hong Kong SAR, Japan, Singapore and Taiwan Province of China (Otero-Villanueva and Ut, 2007). Eleven species of sea cucumbers were harvested commercially in Phu Quoc as shown in Table 4.

TABLE 4
Sea cucumbers harvested commercially in Phu Quoc, Viet Nam

Scientific name	English name	Local name	Average value (VND/kg dry weight) (1USD=15 000 VND)
H. scabra	Sandfish	Đột trắng	500 000–700 000
H. atra	Lollyfish	Đĩa đen, đĩa máu	40 000
H. leucospilota	–	Đĩa mũ	20 000
H. edulis	Pinkfish	Sâu gai	50 000
H. fuscopunctata	Elephant trunkfish	Đột đá, đột da trăn	80 000
S. chloronotus	Greenfish	Sâu biển, đột bê ơ	250 000–300 000
S. herrmanni	Curryfish	Đột ngận đá, đột ngận trường	>300 000
T. ananas	Prickly redfish	Đột điều	800 000
B. marmorata	Brown sandfish	Đột mủ	100 000
B. argus	Tigerfish	Đột da trăn, Sâm vàng	300 000
Pentacta quadragulis		Đột gai đổ	130 000

Source: Otero-Villanueva and Ut, 2007.

Otero-Villanueva and Ut (2007) noted that trepang were traded mainly in Ho Chi Minh City; initially the species traded was *H. scabra* but later the species exploited commercially include also *H. leucospilota, H. edulis, H. atra* and *A. echinites*. With the decline in sea cucumber stocks in the late 1990s, most grocery shops have ceased selling sea cucumbers (Otero-Villanueva and Ut, 2007).

2.5 Population status

Butcher (2004) reported that many Southeast Asian countries had collected trepang for trade with China for many centuries, and during the late 1900s populations of sea cucumbers collapsed in many places because many more fishers were fishing for sea cucumbers and new technology enabled them to harvest far more efficiently.

According to a report by the National Oceanic and Atmospheric Administration (NOAA) (undated), tropical and sub-tropical species that are heavily exploited globally (including Asia) and whose populations are seriously depleted include: *Holothuria fuscogilva*, *H. whitmaei*, *H. scabra* and *T. ananas*, and species that are heavily fished in certain countries including those in Asia are: *A. echinites*, *H. scabra versicolor*, *A. lecanora*, *A. miliaris*, *A. mauritiana*, *S. herrmanni*, *S. horrens* and *S. chloronotus*. Species that may be under potential fishing threats are *B. argus* and *H. fuscopunctata*. The temperate species of sea cucumbers, including *A. japonicus* has also been reported to be depleted in Democratic Peoples's Republic of Korea and Russian Federation (Anon., undated; Konstantinova, 2004).

Sea cucumber population status in some of the countries in this region is reported below.

2.5.1 Indonesia

At Pulau Hoga in Sulawesi, a survey by the Operation Wallacea project indicated that the total holothurian density was about 5 ind./100 m^2 in the reef-crest zone (Anon, 2001), but figures before this study were not available to assess whether the resources have declined. Hoeksema (2004) noted that around the islands of Makassar in South Sulawesi, large sea cucumbers were commonly observed during reef surveys conducted from 1984–1986 in reef slopes deeper than 20 m. Ten years later, after the introduction of hookah diving in this area, the commercially important species have almost disappeared, and the non–commercial species were either absent, rare or only represented by a few small specimens. Fox (2002) noted that in the late 1980s and early 1990s, the Bajaus in Mola, on the island of Wanci in the Tukang Besi Islands shifted to shark fishing in response to the diminishing supply of trepang and the increasing price of sharkfin.

Throughout much of the nineteenth century, the Bajaus, a nomadic fishing community, used to regularly sail to the northern Australian territorial waters to gather trepang without much intervention from the Australian government until the 1960s. In 1974, to prevent unsustainable fishing in Australian waters, the Australian government concluded a Memorandum of Understanding (MOU) with Indonesia (which came into effect on 1 February 1975) that identified five small points (Ashmore Reef, Cartier Islet, Scott Reef, Seringapatam Reef and Browse Islet) on the northwest Australian continental shelf at which traditional Indonesian fishermen were given access to harvest trepang, trochus, abalone, green snail, sponges and all molluscs on the seabed adjacent to these areas (Fox, 2005). A series of sovereignity claims by Australia culminated in a 200 nautical mile Australian Fishing Zone in 1979, which encroached on the traditional fishing grounds of a number of Indonesian fishing communities (Stacey, 2000).

Sea cucumber landings by Indonesian fishers in the area of the MOU (known as the “MOU Box”) from 1998 onwards indicated very low catches (maximum recorded catches were 1 000 kilograms dried weight/vessel with median catches around 100 kg dried weight/vessel) even during traditional peak period; a 1999 Commonwealth

Scientific and Research Organization (CSIRO) reeftop survey noted that high value trepang stocks were overexploited in the MOU Box except on Ashmore Reef (Fox and Sen, 2002).

Species heavily exploited in Indonesia include: *A. echinites, A. mauritiana, A. miliaris, B. argus, B. vitiensis, H. atra, H. edulis, H. fuscogilva, H. fuscopunctata, H. whitmaei, H. scabra, H. scabra* var. *versicolor, H. coluber, S. chloronotus, S. herrmanni, T. ananas* and *T. anax* (Tuwo, 2004). Erdmann (1995) showed that the most valuable trepang group, *Actinopyga* spp. are now virtually extinct in the Spermonde Archipelago in southwest Sulawesi, where it was heavily fished by 200–300 households per km of coastline as human population burgeoned and destructive fishing techniques proliferated. *H. scabra* had been overfished in Sulawesi, and in some locations it was regarded as a rare species (Massin, 1999). Massin noted that only few and small specimens were observed during a field trip to Bali and Lombok in 1998. In the Spermonde Archipelago, *S. herrmanni* caught were generally small in size; in a thousand specimens, 36.0 percent were about 16.5 cm in length, 24.5 percent were 27.3 cm, 19.9 percent were 33.8 cm and 10.0 percent were 40 cm (Basri, 1997 cited in Tuwo, 2004). The minimum size for exploitation in Queensland for *S. herrmanni* is 35 cm (Anon, 2004) meaning that only about 10 percent of the Spermonde population is of fishable size based on the Queensland's management measure.

Exploitation of sea cucumbers in Indonesia has increased rapidly during the last decade. Currently, most of the capture sea cucumbers are landed by small- and medium-sized fishing boats of <10 gross tonnage (Tuwo, 2004). These fishing boats increased from 4 to almost 50 boats in 2003 in Barrang Lompo Island, and the catch per unit effort (CPUE) for medium–sized fishing boats in Indonesian waters was low with monthly trips recording about 1 000 specimens versus 2 500 specimens during a five-day trip in Australian waters in 1997 (Tuwo, 2004). Ten years ago, small trawls caught 10–20 specimens per night or 3–7 specimens of *H. scabra* per trawl versus the current catch of 1–2 specimens per night or 0.33–0.66 per trawl (Tuwo, 2004). Trepang fishery in West Nusa Tenggara have suddenly collapsed, dropping from 17.7 tonnes in 1993 to 6.3 tonnes of low quality trepang in 1994 (Fox, 2005).

Tuwo (2004) estimated that the exploitation rate of sea cucumbers in Indonesian waters is more than 0.5, (meaning that 50 percent of the biomass of the stock is harvested annually), which is considered to be the maximum limit for sustainable exploitation. Eyrika (1999) noted that the exploitation rate of *H. scabra* in Saugi island waters was 0.62 in 1999, while in 1997 the exploitation rate of *S. herrmanni* was 0.69 (Tuwo, 2004).

2.5.2 Malaysia

A sea cucumber survey carried out in Sabah, East Malaysia, from July 1996 to December 1998 by Forbes and Ilias (1999) showed that many of the high value species, such as *H. scabra*, were now rare, resulting in increased pressure on the stocks of middle-range and low-value species such as *T. anax, T. ananas* and *Stichopus* spp. Local information also suggested the population and average size of individuals of *T. anax* have decreased.

On the west coast of Peninsular Malaysia, reports from Langkawi Island by Baine and Choo (1999) indicated that there is historical evidence that a fishery once existed for *Stichopus* spp. (local name "gamat") but nowadays, any sea cucumber fishing undertaken is at best part-time and occasional. In 1994, in Pangkor Island located in the west coast of Peninsular Malaysia, in an hour of diving it was possible to collect a large bucket of gamat, however, nowadays, it is difficult to get even three big sea cucumbers (Pankor, 2004).

Studies in marine parks along the east coast of Peninsular Malaysia, where illegal fishing is uncommon, showed healthy populations of sea cucumbers. The density (ind./100 m^2 ± s.d. in brackets) was 4.7 (4.2), 2.8 (2.6) and 11.9 (17.8) in Redang Island, Tioman Island and Tinggi Island, respectively, suggesting low fishing pressure (Harborne *et al.*, 2000). A survey conducted by Coral Cay Conservation (CCC) in the Redang Island Marine Park during March–September 2004 using the CCC baseline transect technique showed that sea cucumbers had the highest overall invertebrate abundance of 0.41 using the semi-quantitative DAFOR[1] ordinal scale (Comley *et al.*, 2004). The survey conducted by CCC indicated that the extraction pressure of sea cucumbers was low in the Redang Island Marine Park (Comley *et al.*, 2004). One of the leading sea cucumber wholesalers in Singapore noted that sea cucumbers were plentiful along the east coast of Peninsular Malaysia because few Malaysians were financially desperate enough to want to collect them (Butcher, 2004).

2.5.3 Thailand

Bussarawit and Thongtham (1999) reported on the overexploitation of sea cucumbers in the Gulf of Thailand and the Andaman Sea. According to the authors, when landings of *H. scabra* had become depleted, less valuable species like *H. atra* and *H. leucospilota* constituted the largest share of trepang produced in Thailand.

2.5.4 Viet Nam

Pitt and Duy (2004) reported that in the Khanh Hoa coastline in Central Viet Nam, small-scale commercial sandfish fisheries still existed in Van Phong and Nha Trang. Fishers in Khan Hoa reported that sandfish population which was once abundant is now depleted (Pitt and Duy, 2003). With the depleting wild resources, some farmers have been trying to rear small sandfish collected from the wild to larger sizes in pond (Pitt and Duy, 2004). In Phu Quoc Island, a sharp decrease in sea cucumber stock during the last five years was reported; *H. scabra* and *S. herrmanni*, once listed as highly abundant are believed to be approaching local extinction (Otero-Villanueva and Ut, 2007).

2.5.5 Russian Federation

Konstantinova (2004) noted that the sea cucumber (species not identified in the article, but likely to be *A. japonicus*) resources in Primorsky Krai, located in the extreme south–eastern region of the Russian Federation, have decreased to 16–20 percent of the stock that existed in the 1960s. The majority of the current stock comprises of specimens of around 40–60 g which were below the marketable size (Konstantinova, 2004).

2.6 Catches

As opposed to the single species sea cucumber fisheries in temperate waters, the fisheries in the Asian tropical and sub-tropical waters are multi-species. In terms of volume, sea cucumber fisheries mostly constitute only a minor portion (<0.2 percent) of the total marine fisheries landings in many of the countries that exploited them (Table 5). The sea cucumber capture landings obtained from FAO are recorded in wet weights; for some landings in Southeast Asia (e.g. Philippines) the figures appear to be grossly underestimated, and the statistics need to be verified as to whether the data reported were actually dried and not wet weight.

Except for China, where a substantial amount of sea cucumber production is from aquaculture, the production in the other Asian countries is derived predominantly, if not exclusively, from capture fisheries. Many tropical areas in the Indo-Pacific region

[1] In the DAFOR abundance rating, 0 number of individuals has a rating of 0; 1–5 individuals rating of 1; 6–20 individuals rating of 2; 21–50 individuals rating of 3; 51–250 individuals rating of 4; and >250 individuals a rating of 5 (Comley *et al.*, 2004).

TABLE 5
Sea cucumber landings in comparison to total landings of fish, crustacean, mollusc in some Southeast Asian and East Asian countries (unless specified, all values are wet weight)

Country/Species	Year	Sea cucumber (tonnes)	Marine fisheries (tonnes)	Sea cucumber landings (%)
Indonesia[1]	1990	1 722	2 285 450	0.075
(Southeast Asia)	2000	3 041	3 811 375	0.080
Holothuroidea	2001	3 517	3 963 422	0.089
(see Appendix I for	2002	3 057	4 038 767	0.076
commercial species)	2003	3 014	4 349 860	0.069
	2004	6 930	4 501 070	0.154
	2005	6 240	3 993 990	0.156
Philippines[1]	1990	4 023	1 623 057	0.248
(Southeast Asia)	2000	730	1 741 079	0.042
Holothuroidea	2001	791	1 813 188	0.044
(see Appendix I for	2002	801	1 899 661	0.042
commercial species)	2003	979	2 036 580	0.048
	2004	1 006	2 071 123	0.049
	2005	762	2 167 889	0.035
Malaysia[2]	1990	1 200	587 875	0.204
(Southeast Asia)	2000	159	1 285 696	0.012
Holothuroidea	2001	165	1 231 287	0.013
(see Appendix I for	2002	139	1 272 105	0.011
commercial species)	2003	100	1 283 256	0.008
	2004	122	1 331 645	0.009
	2005	139	1 209 601	0.011
Republic of Korea[1]	1990	2 491	2 717 000	0.092
(East Asia)	2000	1 419	1 817 854	0.078
Apostichopus japonicus	2001	900	1 984 751	0.045
	2002	833	1 665 730	0.050
	2003	1 281	1 635 366	0.078
	2004	1 154	1 565 035	0.074
	2005	1 135	1 622 462	0.070
Japan[1]	1990	6 426	10 145 435	0.063
(East Asia)	2000	6 975	4 918 742	0.141
Apostichopus japonicus	2001	7 229	4 651 452	0.155
	2002	7 259	4 302 774	0.169
	2003	8 517	4 610 570	0.185
	2004	9 268	4 341 326	0.213
	2005	9 373	4 742 574	0.215
China[3]	2001	358.44 (dry weight)	14 379 457	–
(East Asia)	2002	470.23 (dry weight)	14 305 218	–
Holothuroidea and	2003	–	14 293 783	–
Apostichopus japonicus	2004	–	14 473 187	–
	2005	–	14 792 598	–

Sources: [1] FAO; [2] Choo, 2004 (for 1990, Sabah landed 400 tonnes which included also sea urchins while Peninsular Malaysia landed 800 tonnes. Sea cucumber landings from 2000 onwards comprised landings solely from Sabah and extracted from the Annual Fisheries Statistics, Sabah (Anon. 2000 to 2005); 3. Chen, 2004 (sea cucumber landings in dry weight).

are heavily overfished for holothurians with *H. scabra* the main overfished species (Uthicke and Conand, 2005). Gleaning for sea cucumbers in shallow coastal waters is commonly carried out. Apart from this, the most common fishing methods for sea cucumbers include small bottom trawl nets in sandy bottoms, scallop-drag gear in nearshore rocky-bottom habitats, spears, hooks and scoop nets for reefs, and SCUBA and hookah for deeper reef and lagoon environments (Bruckner, Johnson and Field, 2003).

Because of the very small global landings of sea cucumbers compared to that of other marine species, records on catches are usually not given much attention by the individual governments and therefore may not be accurately documented. Catches are usually not separated by species and sometimes aggregated with other groups of invertebrates or echinoderms. In China, prior to 2001, capture sea cucumber production was classified under the "other" category in the Chinese Fisheries Annual

Statistics (Chen, 2004). The Malaysian sea cucumber catches ceased to be recorded in the FAO fishery statistics yearbook and the Malaysian Annual Fisheries Statistics yearbook after 1993.

Statistics from FAO indicated that Indonesia produced the highest Holothuroidea capture landings in the 2000s, followed by the Philippines. Together, these two countries produced an annual average of 47 percent of the world's Holothuroidea landings between 2000 and 2005 (Table 5). The highest capture fishery producer of the temperate species, *A. japonicus,* is Japan; between 2000 and 2005, an average of 8 101 tonnes per year were produced.

Information on sea cucumber harvesting methods and their landings, and the prices obtained for their harvests from individual countries in the Asian region are described below:

2.6.1 Indonesia

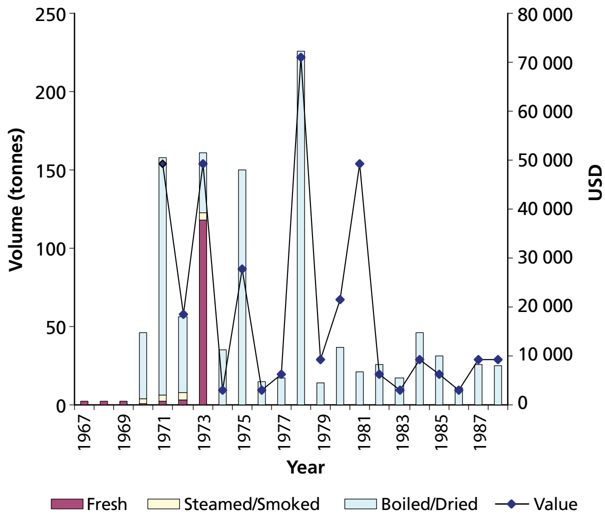
In the nineteenth century, in Sulawesi, fishers used their feet to locate sea cucumbers in shallow waters, while they dived to harvest those found in deeper waters (Butcher, 2004). Fishers from Buton, Salayar and other islands off the south coast of Sulawesi journeyed far out to sea to collect trepang. In the earlier days, fishers free-dived to collect trepang and other invertebrates; since the 1980s, they used compressors to collect their catch (Adhuri and Visser, 2007).

In the Kangean Islands in the Java Sea, women hand-picked sea cucumbers on reef flats during low tide, while men collected them from boats in deeper waters by lowering a weighted, three pronged spear by rope to a point just above a sea cucumber and then releasing the rope to let the weight impale the animal (Butcher, 2004). Whitten, Mustaffa and Henderson (2002) suggested that the inefficient collecting methods have contributed to sustaining the sea cucumber fisheries by preventing overfishing. However, in recent times, with the advent of destructive reef fishing methods (such as blast and cyanide fishing, coupled with the use of hookah and SCUBA gears) invertebrate reef resources in Indonesia have greatly been depleted (Erdmann, 1995). In the Asia-Pacific area, the presence of an estimated 50 000–80 000 indigenous divers, mainly from Indonesia and the Philippines has been reported (Best, 2003).

2.6.2 Malaysia

The sea cucumber fishery in Peninsular Malaysia and in Sabah is artisanal. In Peninsular Malaysia, sea cucumber fishing is very small-scale and is limited to only a few localities, for example in Telok Nipah in Pangkor in the west coast of Peninsular Malaysia where sea cucumbers are harvested for use in traditional medicinal products. The harvesting of *S. horrens* from Pangkor is mainly by hand-picking during low spring tides, and is limited to about 20 days in a month. In Sabah, statistics collected from the mid-1990s onwards showed that 70–80 percent of the total landings are hand–picked (or diving without SCUBA) with the rest landed from trawling. Statistics collected before the mid-1990s indicated that more than 90 percent of the sea cucumber catches were landed by trawl as bycatch (Annual Fisheries Statistics, Sabah, years 1991–2004). Most of the sea cucumbers harvested by trawl gear are collected by trawlers of 10–24.9 and 25–39.9 gross tonnage fishing in waters within 30 nautical miles of the coast (Choo, 2004). Sea cucumbers in Sabah are landed in Semporna, Sandakan, Kudat, Kota Marudu, Kota Belud and Kota Kinabalu; from the mid-1990s there were no landings from Kota Marudu and Kota Belud, indicating that the waters from the surrounding waters from these two areas may have been depleted. The actual volume of sea cucumbers harvested by hand-picking are difficult to capture in official fisheries statistics since gleaners need not report their catches to a central authority; hence sea cucumber landings recorded in the Annual Fisheries Statistics, Sabah, are very likely underestimated and represented predominantly the bycatch from trawling. Statistics available from FAO and also

FIGURE 2
Sea cucumber utilisation in Thailand from 1967–1988



Source: Bussarawit and Thongtham, 1999.

from the Department of Fisheries, Sabah (Table 5) show that sea cucumber landings declined almost ten fold from the 1990s to the 2000s, from an average of around 1 000 tonnes (wet weight) in the 1990s to about 100 tonnes (wet weight) in 2000s .

2.6.3 Thailand

Bussarawit and Thongtham (1999) noted that Thailand supports a very small sea cucumber capture production, and that after 1988 there has been no fishery and trade statistics from the Fisheries Record of Thailand. From 1974 onwards sea cucumbers are processed into the boiled and dried category (Figure 2).

In Thailand, when sea cucumbers were first harvested more than 20 years ago, the most common fishing method was by hand-picking during low tide, but as resources declined, snorkelling to depths of 5–10 m became popular (Bussarawit and Thongtham, 1999). They noted that spears were commonly used by sea gypsies in the Andaman Sea to collect high value species such as *T. ananas*, *A. echinites* and *H. nobilis*. Sea gypsies often made trips to offshore islands lasting 1–7 days; sea cucumbers caught were gutted and brought back to shore for further processing. SCUBA fishing for sea cucumbers is not practised and fishers prefer to collect them from shallow bays during low tide.

2.6.4 Viet Nam

Otero–Villanueva and Ut (2007) reported overexploitation of the sea cucumber resources in Viet Nam. After the boom in the sea cucumber catches in the late 1980s, the average catch per diver in the 1990s dropped to 20 kg (dry weight) per day for species such as *H. leucospilota*, *S. herrmanni* and *B. argus* (Otero-Villanueva and Ut, 2007). Due to the sharp decline in stocks since the late 1990s (Table 6), fishers only dive occasionally around Phu Quoc Archipelago to collect sea cucumbers; however, Cambodian stocks in this Archipelago are still abundant and there have been reports of illegal fishing from Vietnamese fishers in Koh Sdach in Koh Kong province and Koh Rong in Sihanouk province (Otero-Villanueva and Ut, 2007). There is a small sea cucumber fishery in Kep and Sihanouk Province, Cambodia, where a wet weight of 470 tonnes and 210 tonnes respectively were landed in 2001 (Gillett, 2004).

Otero-Villanueva and Ut (2007) reported that sea cucumbers were initially caught in shallow waters using large poles operated from boats, but as the shallow water sea cucumber populations decreased, hookah divers replaced pole fishing activity. Sea

TABLE 6
Sea cucumber catches in Phu Quoc Archipelago before and after 1997

Species	Harvests before 1997 (dry weight unless mentioned otherwise)	Harvests after 1997 (dry weight unless mentioned otherwise)
H. scabra	200–500 kg/year	Less than 100 kg/year
H. atra	Many tonnes/year	Less than 1 tonne/year
H. leucospilota	Many tonnes/year	100 kg/year
S. herrmanni	1 tonne/day (fresh weight)	10 kg /day (fresh weight)
Total amount	**5 tonnes/year**	**500 kg/year**

Source: Otero-Villanueva and Ut, 2007.

cucumbers are less cryptic at night and because of stock depletion, hookah divers now collect at night using torches in waters as deep as 30–40 m (Otero-Villanueva and Ut, 2007).

2.6.5 Myanmar

The Burmese sea gypsies (Mokens) spend most of their lives on wooden boats, collecting sea cucumbers and other aquatic organisms from the reefs of the Mergui Archipelago in the Andaman Sea (Project Maje, 2004). Women often dive for shellfish, crabs, shrimp and sea cucumbers (Piprell, 2000). The Mokens do not use modern SCUBA gear and dive with only a mask, fins and a hosepipe acting as a super long snorkel (Northam, 2002). Smoked or dried sea cucumbers are traded with visiting dealers from Mergui town in Myanmar or with those from Ranong in Phuket, Thailand (Piprell, 2000). The amount of sea cucumbers collected by the sea gypsies whose population is estimated to be 2 000–3 000 is not known (Piprell, 2000).

2.6.6 China

Chen (2004) noted that the sea cucumber capture fisheries in Hainan and Guangdong in China comprised tropical and subtropical species such as *T. ananas*, *H. whitmaei*, *H. scabra, A. mauritiana*, *B. argus*, *S. herrmanni* and *S. chlononotus*, while in the temperate region of Liaoning and Shandong provinces only *A. japonicus* were exploited while in Zhejiang and Fujian provinces, species like *Acaudina leucoprocta* and *Mensamaria intercedens* were also fished. The wild capture fisheries of *A. japonicus* have declined significantly in the Shandong and Liaoning Provinces from 130–140 tonnes and 130 tonnes (dry weight) in the 1950s to 30–40 tonnes and 26 tonnes, respectively in the 1970s; current landings of wild-caught *A. japonicus* are close to zero (Chen, 2004). Chen (2004) noted that recovery plans for *A. japonicus* are in place together with the establishment of many conservation zones.

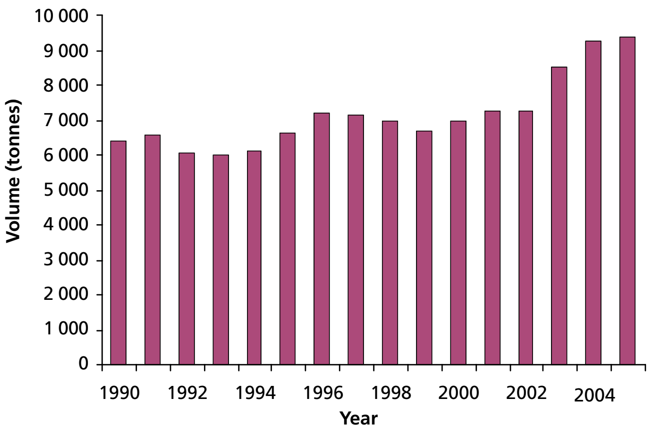
Harvesting methods vary from area to area, generally ranging from the use of simple to heavy diving equipment. According to Li (2004) historical records showed that sea cucumber harvesting in the Chinese Islands of Xisha, Zongsha and Nansha in the tropical South China Sea had gone uninterrupted from generation to generation since 1681. In the earlier days, harvesting was by free diving and hand collection, and therefore was restricted to shallower waters up to a depth of 20 m. However, in the 1920s, a tool known as the sea cucumber fork was developed allowing fishers to harvest sea cucumbers from deeper areas. The boats used in sea cucumber fishing are generally 50–80 gross tonnage fitted with a 120–250 hp engine with 12–16 fishers onboard. Each of these vessels are accompanied by three to four smaller boats (15–25 hp; 3–5 gross tonnage) to enable fishers to move easily around the reefs. Each of the smaller boats carries a crew of three, with one crew in charge of steering the boat while the other two are engaged in fishing with the fork equipment. Due to the turbidity of the water, fishing activity is restricted to a depth of 60 m. Each one of the small boats is able to catch up to 2 000 kilograms of sea cucumbers a year. In the northern part of China, temperate species of sea cucumbers are collected using adequate diving equipment (Chen, 2004).

In China, the soaring price of *A. japonicus* has stimulated the development of aquaculture including sea ranching activities. Chen (2004) noted that the output from these two sectors would reach 6 750 tonnes (dry weight) or an equivalent wet weight of 135 000 to 202 500 tonnes. According to FAO statistics the average annual global wild-capture harvest for the same species from Japan and Republic of Korea between 2000 and 2005 was 9 221 tonnes.

2.6.7 Japan

A. japonicus landings from Japan from 1990 to 2005 are shown in Figure 3. Japan's sea cucumber landings were sustained at an average of 8 101 tonnes from 2000

FIGURE 3
***A. japonicus* landings from Japan in years 1990 to 2005**



Source: FAO.

to 2005, while the average production between 1990 and 1999 was 6 579 tonnes. Akamine (2004) attributed the steady landings to the several resource management practices by local fisheries cooperative associations including size limits, gear restrictions, closed seasons and stock enhancement.

A. japonicus is harvested by using a dredge net (also known as a beam trawl, according to Kiso, K., Ishigaki Tropical Station, personal communication), hook, clip and twist, spear or dart, or by diving (Akamine, 2004). In the Semposhi Fisheries Cooperative Association (SFCA) in northern Hokkaido, more than 98 percent of the catch is from net dredging which operates mainly in waters that are 40–50 m deep; as of July 2003, there were 11 dredge net operations permitted (Akamine, 2004).

There is a small *S. chloronotus* fishery in Okinawa where a single fisher hand picks and processes the sea cucumbers and sells them in the dried form to Chinese restaurants in Japan (Akamine, J., Nagoya City University, personal communication). The dried *S. chloronotus* are sold between USD 85–90/kg.

2.6.8 Democratic People's Republic of Korea

In the Democratic People's Republic of Korea, the sea urchin and sea cucumber landings had declined from an annual catch of 7 200 tonnes during 1970 to 1975 to about one-third this amount during 1985–1990 (Anon, undated).

2.6.9 Republic of Korea

Capture production of *A. japonicus* from the Republic of Korea (obtained from FAO yearbook on capture fisheries production) showed an average production of about 1 902 tonnes from 1990 to 1999; the average capture production from 2000 to 2005 was 1 120 tonnes.

2.7 Management measures

Except for Japan, countries in the Asian region are generally lacking in management measures to conserve and sustain their sea cucumber fisheries. The two most important producing countries, Indonesia and the Philippines do not have management plans specific to sea cucumber conservation (Bruckner, Johnson and Field, 2003).

The information below describes some of the management measures or proposals for the protection of sea cucumber fisheries.

2.7.1 Japan

In Asia, Japan has the longest history of managing their sea cucumber resources. Mitsukuri (1903) noted that for hundreds of years, the people of Oki Island used to put up loose stone piles in the shallow seas to provide adult *A. japonicus* a place to aestivate and to provide a place for metamorphosing larvae and young juveniles to aggregate. Japan has enforced regulations setting aside certain localities as breeding reserves where stone piles have been constructed, and in these places, sea cucumber fishing was strictly forbidden (Mitsukuri, 1903). The construction of stone piles is still practised in some areas.

The Fisheries Law in Japan, established in 1949, manages fisheries resources with either the "fishery rights" system for stationary fisheries, or the "fishery permit" system for mobile fisheries (Akamine, 2004). The holothurian fishery is regulated by the "fishery rights" system. This "fishery right" is granted by the Sea-area Fishery Adjustment Commission (SFAC). Akamine (2004) noted that no one can freely collect holothurians unless he/she has a "fishery right" and can do so only with hooks, clips and twists or by diving. Fisheries Cooperative Associations in fishing communities are also given the power to regulate fisheries practices: for example, in the Rishiri district located at the northern tip of Hokkaido, the Semposhi Fisheries Cooperative Association (SFCA) does not permit the fishing of *A. japonicus* during the spawning season from May 1 to June 15; with more comprehensive scientific data, the SFCA has proposed to change the closed season from July 20 to the end of September (Akamine, 2004). Further regulations imposed by the SFCA include a minimum catch size of 130 g (wet weight) and an annual catch of not more than 50 tonnes from the Rishiri area.

Japan's aquatic resource recovery plans include the recovery of sea cucumbers in the Ohmura Bay, located in western Kyushu in western Japan where sea cucumbers are caught among other methods by small trawl fishery (Anon., 2005). The Ohmura Bay is a closed bay, and sea cucumber fishery has been carried out for a long time, with *A. japonicus* (red, blue and black varieties) being the target species (Kiso, K., Ishigaki Tropical Station, personal communication). Management measures (effective as of 30 August 2005), established by the Fisheries Policy Planning Department, Fisheries Agency, include closed seasons, minimum harvesting size, mesh size restriction and no–fishing areas (Anon., 2005). Fishing season was reduced to two months (from December to January) from the previous season of five months (November to March), and harvesting sea cucumbers of less than 100 g weight was not permitted (Mitsunaga *et al.*, 2006). Mitsunaga *et al.* (2006) showed that the sea cucumber recovery plan in Ohmura Bay has positive impacts on the sea cucumber fishery: the total resources of *ao* (green) and *aka* (red) *namako* increased to 177 tonnes in 2005 from 150 tonnes in 2004; the density m^{-2} of *ao* (green) and *aka* (red) *namako* in 2005 was 0.24 tonnes versus 0.20 tonnes in 2004, resulting in an increase of 18 percent in 2005.

2.7.2 Democratic People's Republic of Korea

The Oruji Nature Reserve which has an area of 750 hectares and located in Ryongyon and Jangyon counties in the S. Hwanghae Province was established in 1996 mainly for the conservation of sea cucumbers (Anon, undated). Problems facing the management of nature reserves in Democratic People's Republic of Korea include the following (Anon., undated):

- Inadequate and poor enforcement of regulations: currently, most of the newly established nature reserves do not have adequate regulations and do not enforce the Law on Environment Protection which was established in 1986; moreover, there is a lack of coordination among relevant agencies and difficulty in establishing consensus among agencies.
- Poor management capacity: currently, reserves are managed by those who lack the knowledge and expertise. There is no budget allocated for nature reserve management and there are no awareness programmes to educate the local people.
- Weak central agency and the lack of coordination between central agency and local authorities: there is an urgent need to enhance the function and effectiveness of the Ministry of Land Environment Protection and the coordination with local authorities.
- Lack of international connection: some of the reserves are of regional and international importance to a number of countries; the lack of collaboration among these countries is therefore a setback.

2.7.3 Malaysia

In Malaysia, the Establishment of Marine Parks Malaysia Order 1994 acts as a protection against the illegal collection of marine organisms in marine parks. There are no quota system and minimum legal size to protect sea cucumbers from overfishing in non-marine park areas. Waters off Pulau Singa Besar in Langkawi Island off the northwestern coast of Peninsular Malaysia have been earmarked for the establishment of a two-hectare sanctuary in view of the indiscriminate harvesting of sea cucumbers in Langkawi waters (Starmetro Newspaper, 10 January 2007).

2.7.4 Viet Nam

Presently, there are no fishing regulations in placed for the sea cucumber fisheries in Viet Nam (Otero-Villanueva, M., Yancheng Forestry Bureau, Jiangsu Province, personal communication). Viet Nam, including their most important fishing area, the Phu Quoc Archipelago, lacks a management plan for the sea cucumber fishery. Otero-Villanueva and Ut (2007) proposed the following measures for the Phu Quoc Archipelago:

- More detailed studies on the sea cucumber fisheries activities in Phu Quoc Archipelago and the neighbouring Cambodian islands in order to understand the interaction between the CPUE and the yield of commercial sea cucumbers;
- Regulation of all commercial sea cucumber species to prevent overfishing;
- Co–management of the sea cucumber resources; and
- Awareness campaigns to avoid overexploitation of the sea cucumber stocks.

2.7.5 MOU Box: Ashmore Reef

In 1983, the Australian Government declared Ashmore Reef a National Nature Reserve prohibiting the removal of all fauna and flora to a depth of 50 m (Fox, 2002). Fox noted that at the time of this ban, trepang stocks were already depleted near all the reefs and islets in the MOU Box. A survey conducted by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) 15 years after the ban showed that it had resulted in a partial recovery of sea cucumber population (Fox, 2002). Smith *et al.,* (undated) reported that no specimens of *Holothuria timana* were located during a survey in Ashmore Reef in 2000 but this high value species was reported to be in significant numbers in 1988, comprising 11 percent of the catch by Indonesian fishers in the 1980s (Russell and Vail, 1988 cited in Smith *et al.*, undated). *H. whitmaei* was reported to be severely depleted, but *T. ananas* and *H. fuscogilva* were relatively abundant during the 2000 survey by Smith *et al.* (undated).

3. USES

Sea cucumber dishes are almost always prepared by soaking and boiling the dried form (trepang) until they are of the preferred consistency although in some cases, dishes may be prepared from the fresh product. During ancient times when processing methods were limited, sea cucumbers were often processed into trepang and then used later as a food ingredient; recently they have been marketed as jelly, powder, tablets or capsules and consumed as a health supplement (Chen, 2004; Choo, 2004; New Straits Times, 2007).

Chen (2003) considered sea cucumber to be an ideal tonic food; it has higher protein and lower fat level than most foods, and from the Western medical viewpoint, sea cucumber serves as a rich source of the polysaccharide, condroitin sulfate, which is known for its ability to reduce arthritic pain (as little as 3 g/day of dried sea cucumber has been helpful in significantly reducing arthralgia). Chen (2003) also noted that there is a Japanese patent for sea cucumber chondroitin sulfate used for HIV therapy.

In Japan, sea cucumbers are consumed mainly in three forms: fresh, dried and fermented. The dried form is least popular and is categorised into two groups: no more than 30 pieces/600 g and 31–70 pieces/600 g (Anon., 1989). Dried sea cucumbers are used mainly in Chinese restaurants and its quality is judged by the state of the cucumber after reconstitution with water (Anon., 1989). The reconstituted weight should be four to five times the dry weight. Sales of dried sea cucumber have decreased to about three tonnes a year with the decrease being attributed to the unattractive appearance of live sea cucumbers to Japan's younger generation (Anon., 1989). According to Anon. (1989), for the fresh market, the colour, size and origin of sea cucumbers are important, with the red, brown or green variety in the 200–500 g range being the most popular. Fresh or live Japanese sea cucumbers are usually sold for ¥500–1 500/kg (USD 4–13/kg), and are highest during August to September. After depuration in holding tanks, over 12 kilograms of sea cucumbers are packed to meet the net weight of about 10 kilograms upon arrival at market. About 20 percent of the original weight is lost during shipment through water loss. Specialists do not recommend freezing fresh sea cucumbers because they reportedly disintegrate when thawed. The fermented sea cucumber viscera known locally as "konowata", is a delicacy in Japan and is eaten mainly when drinking Japanese whisky or distilled Japanese sake. About eight to ten tonnes of "konowata" are sold at the Tsukiji Central Wholesale Market per year. It is prepared by first thoroughly cleaning the viscera, and then adding salt at an equivalent of 10–15 percent of the total wet weight of the viscera mass. The mixture is stirred frequently for about five hours, drained, and then put in barrels for about a week to age. "Konowata" is found only in specialty stores and the retail price of a glass jar containing about 100–120 g is about ¥3 000 (USD 26) each.

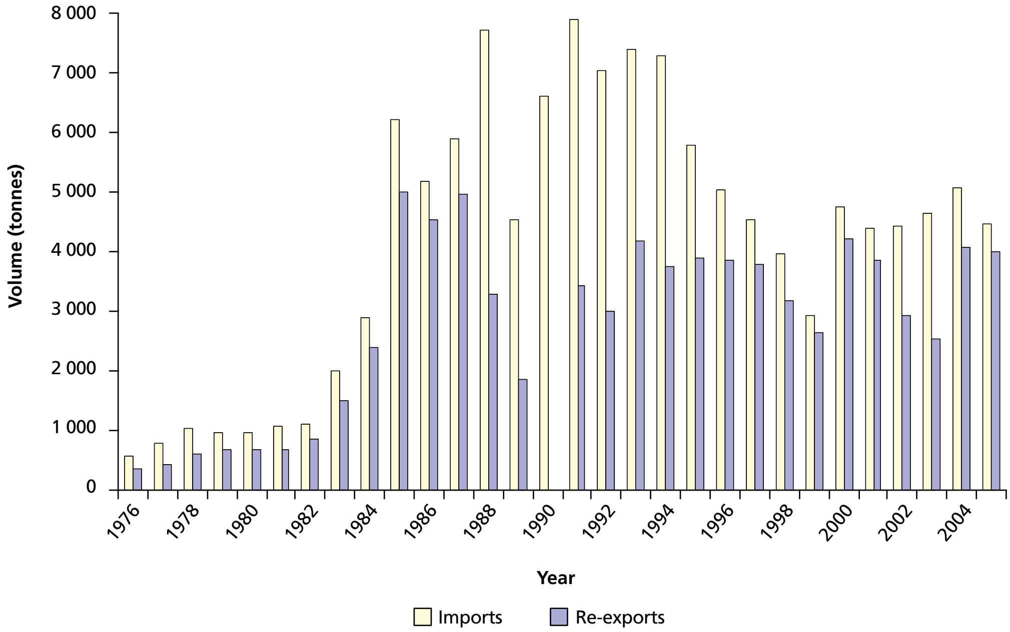
4. TRADE

Global sea cucumber trade meant for the food market is controlled by China, Hong Kong SAR, Singapore and Taiwan Province of China, with China Hong Kong SAR having the largest entrepôt controlling 80 percent of the global import-export sea cucumber trade (Jaquemet and Conand, 1999). The dominance of China Hong Kong SAR is due mainly to its ability to serve as a conduit of goods to the hinterland of mainland China (Clarke, 2002). The lower value products were traditionally shipped to China Hong Kong SAR for re-export to China (Conand and Byrne, 1993).

Producing countries all over the world export trepang to one of these three centres; from where they are re–exported mainly to Chinese consumers worldwide. China Hong Kong SAR, China, Singapore, Malaysia, Taiwan Province of China, Republic of Korea and Japan account for almost 90 percent of the total imports of trepang, with approximately 80 percent of the overall international trade destined initially for China, Hong Kong SAR (Bruckner, Johnson and Field, 2003). From 1996 to 2000, 87 percent of re-exports of trepang from China Hong Kong SAR were designated for China (Clarke, 2002). Due to varied purchasing power, China imports a wide variety and quality of trepang; however, the Chinese market is increasingly demanding good quality products irrespective of the species and consumers are willing to pay better prices for such products (Ferdouse, 2004).

According to Bruckner, Johnson and Field (2003), in 2000 and 2001, Taiwan Province of China imported sea cucumbers from 28 countries and Singapore receives about 50 percent of its imports from China Hong Kong SAR, with Papua New Guinea, Tanzania and Madagascar being the other main suppliers. Two-way trade also exists between the three main exporting centres. China Hong Kong SAR imports peaked in 1991 at 7 885 tonnes and gradually declined to 2 922 tonnes in 1999. From 2000 to 2005, imports averaged at around 4 626 tonnes. Consumption of sea cucumbers in China Hong Kong SAR, peaked in 1991 at 4 456 tonnes. The average consumption decreased from 3 812 tonnes between 1991 and 1994 to 999.9 tonnes between 1995 and 2005. Figure 4 provides the data on sea cucumber imports and re-exports from China Hong Kong SAR, from 1976 to 2005.

FIGURE 4
Sea cucumber (dried, salted and in brine) imports and re-exports from China Hong Kong SAR



Source: FAO.

Taiwanese consumers prefer the coldwater spiky sea cucumber species such as *A. japonicus* and are extremely quality conscious, preferring the high value species. Singaporeans prefer good quality smoked, cleaned and dried sandfish while Malaysian consumers have a preference for medium quality and medium-size sandfish and teatfish (Ferdouse, 2004). Consumers in China Hong Kong SAR, have preferences for good quality sea cucumber of large and medium sizes (Ferdouse, 2004).

The key factors in determining price are species/type, the size of the dried animal, the degree of dryness of the processed products and the time of year; prices can be 20–30 percent higher just before the Chinese Lunar New Year (Clarke, 2002). Most traders believe that the higher quality goods are those derived from Japan, the Pacific coast of South America, South Africa and Australia while those from Indonesia, the Philippines and China are of lower quality due to species composition and inferior processing techniques (Clarke, 2002).

According to the FAO global statistics on sea cucumber, Indonesia is the largest trepang exporter in the world. About 40–80 percent of the trepangs are exported to China, Hong Kong SAR, with other markets being Japan, Republic of Korea, Singapore, Taiwan Province of China, Malaysia and Australia (Tuwo, 2004). The most important collecting and export centre for marine product trade in Indonesia is Ujung Pandang in Sulawesi, which, in 1981, recorded foreign exports of 2 100 tonnes of reef invertebrates out of which 320 tonnes were trepang (Whitten, Mustafa and Henderson, 2002). The average annual price of Indonesian trepang exported from South Sulawesi from 1996 to 2002 ranged from USD 15.06/kg to USD 1.44/kg (Tuwo, 2004). Apart from the common factors influencing product price (e.g. species composition, size and post-harvest quality), exporters are known also to influence the price of sea cucumbers as they commonly manipulate the price in export documents for the purpose of tax evasion (Tuwo, 2004).

Among the high value species, price trends extracted from INFOFISH Trade News showed that sandfish fetched the highest price (Appendix II). Only the price of one temperate species, *A. japonicus*, has been listed in the INFOFISH Trade News.

The cultured *A. stichopus* fetched almost twice the price as the highest priced grade sandfish.

According to Chen (2004) the retail price of *A. japonicus* has increased dramatically since the 1980s. In 1960, retail price for one kilogram used to be Renminbi (RMB) 18 which increased to RMB500 in 1980 and to the present price of RMB3 000/kg (approximately USD 400).

Apart from the food trade, a large number, possibly hundreds of thousands of sea cucumbers are traded in the aquarium industry, but little data on species, quantities and source countries are available (Bruckner, Johnson and Field, 2003). The volume of sea cucumber used in the medicinal and cosmetic industries is also not known.

5. SOCIO-ECONOMIC IMPORTANCE TO LOCAL FISHING COMMUNITIES

Since historical times, the sea cucumber fishery and trepang processing have been a source of livelihood to many coastal communities. Harvesting, preparing and selling trepang constitute the pillar of the economy of the Bajaus from the Sulawesi Islands since the sixteenth century (Whitten, Mustafa and Henderson, 2002). The most sought-after trepang was painstakingly prepared by the Turijene, a Bajau group based in the Spermonde Archipelago in Sulawesi. The trepang was then sold to the Bugis seafarers for the China trade, which formed the basis of the economic interdependence of these two groups of people.

Up to the present time, in the coastal areas of many of the Southeast Asian countries, the harvesting of sea cucumbers and the processing of trepang constitute an important means of livelihood for the coastal poor. They comprise the sea gypsies from Myanmar, Thailand and Indonesia to the poor fishermen from Sabah, Indonesia and the Philippines who depend on the trepang industry to supplement their meager income. For this reason, increasing attention is being focused on monitoring the trepang trade and on sustainable management of the sea cucumber resources (Clarke, 2002). Tuwo (2004) noted that the exploitation of sea cucumbers in Indonesia is an important contributor to the economic development of the coastal and small island communities; for this reason the sea cucumber population has to be managed properly to sustain its economic and ecological benefits. In Sabah, Biusing (1997) and Choo (2004) noted that sea cucumbers are a valuable source of income for many of the poor rural fishing communities. In Myanmar, the sea gypsies have been reported to be forcibly resettled on land in the late 1990s by Myanmar's military regime, and the increased presence of foreign trawler fleets under joint-ventures with the military regime had also discouraged small-scale local fishing by the sea gypsies (Project Maje, 2004).

H. scabra (size range 3 specimens/kg) were sold at USD 0.12 for each specimen in Saugi Island (Tuwo, 2004). The price received by fishers in Buton in Southwest Sulawesi for their catch, their annual income and the price of sea cucumbers in the international market are shown in Table 7. Only the local names of the sea cucumbers were given by Asmedi (undated) in the table; reference was made to other sources for the scientific names of some of these species. Prices obtained by fishers are one–sixth the international market price, indicating that they are grossly underpaid by the middlemen.

In Phang Nga located in Phuket, Thailand, fishers sold fresh sea cucumbers to processors for prices ranging from Baht 3–35/kg (USD 0.09–1.08/kg); the processors then sold the processed products to middlemen for Baht 130–300/kg (USD 3.6–8.3/kg) (Bussarawit and Thongtham, 1999). Bussarawit and Thongtham (1999) also reported on an entrepreneur from Ranong who supplied fishers with capital and facilities for harvesting sea cucumbers. He would then buy sea cucumbers at a price lower than the market value. Fishers sold their sea cucumbers at prices between Baht 30–50/kg (USD 0.93–1.54/kg) which the middleman resold at Baht 100–200/kg (USD 3.08–6.17/kg).

TABLE 7
Average annual income of fishers and price received by them for their sea cucumber harvest (current USD prices within brackets)

Sea cucumber (local names)	Average price fishers receive per kg dry weight	Average price on the international market	Average annual income of target fishers
STR (low quality mix)	Rp7 000/kg (USD 0.8/kg)	Rp42 000/kg (USD 5/kg)	Rp1 400 000 (USD 164/kg)
Duyung *T. anax*	Rp10 000/kg (USD 1.2/kg)	Rp60 000/kg (USD 7/kg)	Rp2 000 000 (USD 235/kg)
CRDI (medium quality mix)	Rp20 000/kg (USD 2.4/kg)	Rp120 000/kg (USD 14/kg)	Rp4 000 000 (USD 647/kg)
Susu Polos Teatfish	Rp27 500/kg (USD 3.8/kg)	Rp165 000/kg (USD 20/kg)	Rp5 500 000 (USD 647/kg)
Susu Bintik Teatfish	Rp32 500/kg (USD 3.8/kg)	Rp195 000/kg (USD 23/kg)	Rp6 500 000 (USD 3 058/kg)
Gamma *Stichopus* spp.	Rp130 000/kg (USD 15.3/kg)	Rp780 000/kg (USD 92/kg)	Rp26 000 000 (USD 3 058/kg)
SSI (good quality mix)	Rp130 000/kg (USD 15.3/kg)	Rp780 000/kg (USD 92/kg)	Rp26 000 000 (USD 3 058/kg)

Source: JPKP Buton and Yayasan Lintas, Asmedi, undated.

Gleaning for sea cucumbers and other invertebrates constitutes a very important livelihood for many coastal communities in Southeast Asia. Although it is often classified as "informal work", gleaning requires skills and knowledge which are often passed down from one generation to another (LeBlanc, 1997). Gleaning provides a livelihood for the poor and landless – those that cannot afford to be unemployed and must obtain a source of income even if this implies "pitifully low earnings" (LeBlanc, 1997). In the Philippines, it is a highly organised activity which affects a large number of people (LeBlanc, 1997). In periods of fish scarcity, wives supplemented the family income by increasing their gleaning activities collecting species that are not affected by seasonality (Rowe, 1983). However, with the reported overfishing of sea cucumbers in many intertidal areas in the Asian region, gleaning for sea cucumbers will become less important as a source of income compared to gleaning for other invertebrates.

6. CURRENT DEVELOPMENTS

In the Asian region, minimal efforts are being made towards conserving sea cucumber resources through the imposition of fisheries regulations, but some attempts have been made by some countries towards sea cucumber production through aquaculture. Research on the extraction of products from sea cucumber and new product formulation are also being carried out.

Among the tropical species, *H. scabra* is the only species that are currently mass produced in hatcheries. They have been bred mostly on an experimental scale in India, Indonesia, Solomon Islands, New Caledonia, Viet Nam and the Maldives with the reproductive, settling and feeding cycle completed (James, 1996; Battaglene, 1999; Pitt and Duy, 2004; Agudo, 2006). Juveniles measuring 10 to 25 mm in length are transferred to sandy substrata in the field (James, 1996). Polyculture of *H. scabra* with seaweeds and shrimps have also been attempted (Madeali *et al*., 1993; Daud *et al*., 1993; Battaglene, Seymour and Ramofafia, 1999).

Among the temperate species, the most successfully cultured is *A. japonicus* with most of the production attributed to China. Work on the culture of *A. japonicus* started in China in the early 1950s, but the breakthrough was achieved only in the 1980s (Chen, 2004).

Three methods (pond and pen culture, and sea ranching) are used in the grow-out culture of *A. japonicus* in China (Chen, 2004). In pond culture, stones or other non-toxic materials are laid in rows or in a pile at the pond bottom, acting as "homes" for the sea cucumbers. Farming sea cucumbers in ponds is popular in China where existing shrimp ponds are modified to meet the ecological needs of sea cucumbers. Pens are located near to the seashore; it has an advantage over pond culture since no pumping of water is required but this method is limited to areas along the coast. Sea ranching experiments were first initiated in the 1950s in Hebei Province and have been found to be an effective method that could help the recovery of wild sea cucumber stocks.

6.1 Indonesia

The species farmed in Indonesia is predominantly *H. scabra*. The potential area for sea farming (cage or pond culture) of sea cucumber in Indonesia is 720 500 ha (Dahuri, 2002, cited in Tuwo, 2004). However, presently only a few of the potential areas have been utilised for farming (Tuwo, 2004). Tuwo (2004) further stated that utilising only 10 percent of the potential farming areas could increase sea cucumber production to about 180 125 tonnes dry weight per year. The four most important areas where grow-out of wild caught animals of *H. scabra* takes place include: Papua, Central Sulawesi, South East Sulawesi and East Kalimantan which recorded a production of 378 tonnes, 200 tonnes, three tonnes and one tonne wet weight per year, respectively (Tuwo, 2004). Since 2002, in Laumbora Bay off Barangka village in Indonesia, cage culture of sea cucumbers using small specimens collected from the wild have been practised by fishers working together with Yayasan Lintas, one of the local NGOs (Asmedi, undated). The introduction of sea cucumber culture in this area has resulted in fishers moving away from destructive fishing practices, and becoming more aware of the importance of conserving the environment. The Buton Coastal Area Development agency and Yaysan Lintas, supported by Oxfam Great Britain since 2002, have approached and negotiated with several exporters of marine commodities to offer better prices to fishers. In turn, the fishers will need to meet the quality standards set by the companies (Asmedi, undated). Sea cucumber cultivation was also recently introduced to 10 villages in the western Seram district (Antara News, 2007).

Mass production of seeds in Indonesia faces many biological and technical problems, the main problem being the lack of broodstock (Handoko *et al*., 2002, cited in Tuwo, 2004) and the lack of suitable sites, since ponds may be located in acid-sulphate areas or experience low salinity in the monsoon season (Purcell, S., The WorldFish Center, New Caledonia, personal communication,). To optimally utilise 10 percent of the potential farming area, Indonesia needs about 7–14 billion sea cucumber seeds per year, based on a stocking density of 15–20 ind./m^2 (Tuwo, 2004).

6.4 Philippines

The University of the Philippines in Luzon and Mindanao and the National Fisheries Research and Development Institute (NFRDI) of the Bureau of Fisheries and Aquatic Resources (BFAR) are collaborating with the Australian Centre for International Agricultural Research (ACIAR) and the WorldFish Center in a four-year project on "Restocking and sea ranching of sandfish" (Purcell, S., The WorldFish Center, New Caledonia, personal communication). Purcell also mentioned that there is an ongoing sea cucumber research by the Marine Science Institute, University of the Philippines (MSI-UP), genetic studies by BFAR and a project on the distribution and inventory of sea cucumber species by the Department of Science and Technology (DOST). These agencies, together with the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) and the Aquaculture Department of the Southeast Asia Fisheries Development Center (SEAFDEC) are also involved in a National Program on Sea Cucumber Management (Purcell, S., The WorldFish Center, New Caledonia, personal communication).

6.3 Viet Nam

In Cam Ranh, some fishers have been attempting to culture wild-caught small sandfish to larger size in ponds (Pitt and Duy, 2004). Apart from that, the WorldFish Center scientists, working together with their Vietnamese counterparts in Nha Trang, aimed to develop large-scale breeding and rearing methods for commercial culture and/or restocking of sandfish.

Constraints to commercial culture of sandfish in Viet Nam included low prices paid by middlemen, high variability in survival rate at many stages, predation, theft and pond management problems. Positive factors included the wide temperature and salinity tolerance of sandfish, ease of containment, good growth in ponds and pens without the need for adding feed (Pitt and Duy, 2004).

6.4 Malaysia

A local firm in Malaysia, Luxor Network Sdn Bhd, has signed an agreement in 2007 with the International Islamic University in Malaysia for collaboration on research into the properties of gamat (*Stichopus* spp.) as well as research on its breeding and culture (New Straits Times, 2007). The company plans to expand its gamat-based product business overseas in Singapore, Indonesia and member countries of the Organisation of Islamic countries. Luxor Network recorded annual sales turnover of RM60 million (USD 17 391 304) and produces a range of products such as roselle gamat, gamat oral jelly, gamat topical gel, gamat cream, gamat hair shampoo, gamat whitening cream and toothpaste, as well as gamat "tongkat ali" (a plant aphrodisiac).

6.5 China

The largest farm producer of the sea cucumber *A. japonicus* in China is Liaoning Province, where the total area farmed is expected to reach around 51 000 ha with outputs projected to 6 750 tonnes dry weight per year (Chen, 2004). Shandong has become the second largest province to farm sea cucumber in China with a total farming area reaching 17 000 ha with an estimated production of 2 250 tonnes dry weight equivalent to the wet weight production of about 45 000–67 500 tonnes. Hebei province, which produces annually approximately 1 000 tonnes/year dry weight of *A. japonicus*, ranks third (Chen, 2004). Aquaculture production of sea cucumber in the southern provinces is still in its infancy where sandfish, black and white teatfish are considered as choice species for aquaculture development (Chen, 2004). Chen (2004) noted that in the next decade, sea cucumber farming and ranching will become a highly successful industry in China. It will involve an entire industrial supply chain from seed production to processing, the preparation of formulated feeds for culture, the development of special culture techniques and ranching facilities as well as the production of specific chemical products from sea cucumber (Chen, 2004).

6.6 Japan

In the last few years, the Japanese Government, together with the provincial governments has given emphasis to the commercial hatchery production of *A. japonicus* (Akamine, J., Nagoya City University, Japan, personal communication). In 2005, the Iwate Fisheries Technology Center in Kamaishi in the Iwate Prefecture started developing hatchery techniques for *A. japonicus* production as well as sea ranching techniques and breeding them in farms (Yoshimura, 2006). The Center hopes to boost the sea cucumber production in the Iwate Prefecture (which in 2004 had a capture production of 33 tonnes), through aquaculture and sea ranching techniques (Yoshimura, 2006). Some private companies in the Iwate Prefecture have also started commercial aquaculture production of sea cucumbers (Yoshimura, 2006).

6.7 The Russian Federation

In Far East Russian Federation, the first sea cucumber (species not specified but likely to be *A. japonicus*) hatchery valued at USD 1.2 million was established in July 2003 in Kievka Bay in cooperation with the Pacific Fishery and Oceanography Research Institute (TINRO) (Konstantinova, 2004). Aquaculture of sea cucumber in Far East

Russian Federation can apparently produce 10–15 thousands of marketable size sea cucumbers per hectare at an estimated production of 0.5 tonnes/ha.

7. ADDITIONAL THREATS TO SEA CUCUMBER POPULATION

7.1 Illegal fishing

Threats to sea cucumber resources include illegal fishing which dates back many decades in some countries. Indonesian fishers were known to have fished illegally in Australian waters since the eighteenth century. One of the first recorded arrests in Indonesia dates back to 1725 where unauthorized Bajau boats entered Nusa Tenggara illegally to gather trepang (Fox, 2005). Indonesian seafarers were financed and outfitted by the Chinese and other merchants in Makassar in the eighteenth century; they sailed to the north coast of Australia where they collected and processed vast quantities of trepang (Butcher, 2004).

Restriction of illegal trepang fishing was first imposed in 1907 in the form of a license fee which denied Makassan fishers without a license to exploit Australian waters (ACFOA, 2002). The Australian government's first official attempt to regulate Indonesian activity in north Australia occurred in 1968 which later led to the signing of the 1974 MOU between Indonesia and Australia. The MOU permits only traditional Indonesian fishing within the 12 nautical miles territorial sea adjacent to some islands within the MOU Box (Stacey, 2005). Due to illegal overfishing, the reefs in the MOU Box are no longer capable of providing an adequate means of livelihood to those fishers who have previously gathered trepang and trochus (Fox and Sen, 2002).

Stacey (2000) described several measures in the form of apprehension, prosecution, confiscation of boats, catch and equipment, and jail-term for repeat illegal fishing offenders in Australian waters; despite all these measures, illegal Indonesian fishing continues. Indonesian fishers, however, who had been apprehended, detained, sent to jail and deported from Australia often received the status of a "hero" in their homeland, and detention in Australian jails was perceived as enjoyable akin to living in a five-star hotel (Adhuri and Visser, 2007). On the other hand, enforcement measures taken by the Australian Government have been criticised as lax by the local fishing sector in Australia; in the 15 months prior to March 2004, only 168 vessels out of the 1 588 sightings were apprehended (Fish Information and Services, 2004).

The Yomiuri Shimbun (30 December 2006) reported that sea cucumber poaching in Hokkaido and Aomori Prefectures is on the rise as prices of the product has soared because of the demand caused by the rapid expansion of the Chinese economy. The poaching at Aomori Prefecture on 26 July 2006 amounted to 880 kilograms of sea cucumbers worth ¥1.25 million (USD 10 788).

The poaching of sea cucumbers from national parks in Surin Island, Thailand was reported by Bussarawit and Thongtham (1999). Choo (2004) noted that the problems of illegal fishing in Sabah, East Malaysia, will be difficult to solve if the bigger challenge of illegal immigration mainly from the Philippines is not successfully resolved. Filipino fishers were known to fish illegally in Malaysian waters operating at night alone or in pairs, skin-diving for sea cucumbers (Akamine, 2001). Vietnamese fishers have been reported to fish illegally in Cambodian waters after sea cucumber resources in South Vietnamese waters have been depleted (Otero-Villanueva and Ut, 2007).

7.2 Overexploitation

Most of the Asian countries covered in this report have indicated that overfishing is the main problem for the depleting sea cucumber resources. Kim Friedman (Secretariat of the Pacific Community, New Caledonia, personal communication) noted that even the individual size of Asian sea cucumbers is small, with grade-A quality having many more pieces per kg than in the Pacific, and catches are not able to target large mature individuals. Overexploitation of holothurians can have adverse effects since small population sizes may lead to inbreeding and loss of genetic diversity, thus resulting in elevated extinction risks. Most tropical and subtropical holothurians are broadcast spawners and fertilisation success is highly dependent on population density; reduction of population densities by fishing may therefore render remaining individuals incapable of successful reproduction (Bruckner, Johnson and Field, 2003).

7.3 Habitat loss

In Singapore, the main threat to depleting sea cucumber populations is habitat loss due to reclamation or human activities along the coast that pollute the water (Tan, 2003). Sea cucumber collection has also resulted in the trampling of corals resulting in the loss of sea cucumber habitats (Bussarawit and Thongtham, 1999). Pollution has taken a toll on the survival of sea cucumbers in waters off Pangkor and Langkawi Island in Peninsular Malaysia where sedimentation of the coastal waters as a result of land clearing from unsustainable development has polluted the water (Pankor, 2004). Biusing (1997) attributed the severe decline in sea cucumber landings in Sabah to overfishing and the degradation of natural habitats resulting from destructive fishing methods and pollution.

The use of illegal fishing methods has often been documented in the Indo-Pacific region. Fishers who are desperately in need of a livelihood through catching fish and collecting sea cucumbers, have often resorted to the illegal use of explosives in fishing. This was commonly reported in the coastal waters of Palabusa, Uncume and Kapontori Bay in Indonesia (Asmedi, undated; Fox, 2005) and the Philippines (International Marinelife Alliance, 2003).

7.4 Lack of information and inaccurate resources statistics

The under-estimation of the Indonesian sea cucumber statistics due to the limited access of fisheries officers at sea cucumber landing sites have been reported by Tuwo (2004). He estimated that the Indonesian landings may be under-estimated by as much as 25 percent. Sometimes the origin of the fished stock is not clearly elucidated. The sea cucumber landings from Sabah are probably under-estimated due to the complexity of the fishery which has led to constraints in obtaining reliable catch and effort data (Biusing, 1997). In Viet Nam, Otero-Villanueva and Ut (2007) reported that sea cucumbers fished in Cambodian waters in the Phu Quoc Archipelago are usually sold in the Vietnamese side of the Phu Quoc Archipelago and recorded as domestic Vietnamese products, consequently giving the false impression that the Vietnamese side of the Archipelago still has a good sea cucumber supply.

7.5 Inaccurate trade statistics and confusion in commodity codes

In the absence of reliable catch statistics on some aquatic organisms, trade statistics may be used to provide useful information on the exploitation rates and an indicator of resource status. However, there is a tendency for trade figures to be under-reported, linked to reasons such as tax evasion. Moreover, like capture landings statistics, trade statistics are often incomplete or absent. When trading takes place across borders, sometimes no statistics are collected since the trading is clandestine. For instance, trepang trade in Thailand is mainly conducted across borders and does not pass through any customs checkpoint; hence no recent records are available from the Thai Fisheries Statistics Record (Bussarawit and Thongtham, 1999). The sea gypsies from Myanmar are known to sell their sea cucumber harvests to Thai traders in coastal towns such as Ranong and the statistics are therefore not captured in the Burmese fisheries statistics (Piprell, 2000).

The average bias toward under-reporting in the Asian trepang market was greater than 49 percent and there were large discrepancies between the custom's statistics of trepang from China Hong Kong SAR and China (Clarke, 2002). In China, imports of sea cucumber for processing are not included in the customs statistics, thus distorting the actual import quantities (Clarke, 2002). In China Hong Kong SAR, local traders admitted to frequent under–reporting and customs officials do not maintain any inspection programme to discourage this practice (Clarke, 2002).

The use of different commodity codes for the same type of products makes comparison of trade statistics difficult. Clarke (2002) reported that there was a lack of clear relationships between commodity codes between Taiwan Province of China and China Hong Kong SAR. Choo (2004) encountered difficulties with the Standard International Trade Classification (SITC) commodity codes used in Sabah, Malaysia. There were some distinct changes in the category code and the introduction of a new category "fit for human consumption" in 1996 which appeared to have replaced the category "other than fresh, chilled or frozen", hence creating some confusion in the trade statistics.

7.6 New commercial uses for sea cucumber

The consumption of trepang has been reported to be decreasing in the younger population in countries where they have been traditionally consumed (as has been documented in Japan and China Hong Kong SAR and reported by Akamine [2004] and Clarke [2002], respectively). The process of rehydrating trepang is a tedious task and there is a noticeable trend towards the purchase of rehydrated trepang among restaurants, and chefs mentioned that seafood products such as lobster, abalone and fish maw may have overtaken sea cucumber in popularity (Lo, 2004). Although the production of trepang appears to be decreasing (Clarke, 2002), the use of sea cucumbers for new products for medicinal and cosmetic purposes have gained popularity in recent years.

Information from Patent Storm[2] from 2004 to 2006 indicated that there are a number of patent applications by Chinese groups relating to sea cucumbers as nutritional supplements (e.g. CN 1065019). Applications from Japanese groups relate to various carbohydrate moieties from sea cucumber as anticoagulants (e.g. JP 94070085 B2; WO 9008784) and as active components for treating AIDS (e.g. WO 9202231; WO 9009181) while applications from the United States of America (e.g. US 5985330) relate to inhibition of angiogenesis by sea cucumber fractions.

The quantity used for medicinal and cosmetic preparations are poorly documented and the quantity exploited for the aquarium trade is also unclear. Akamine (2005) noted that *H. coluber,* known locally in the Philippines as "patola white" is exported to China to use as fertiliser. Reporting mechanisms should be standardised for sea cucumbers used for medicinal, cosmetic, agricultural and aquarium trade as well as for those used for food.

7.7 Threats of global warming/climate change

Information on the impacts of global warming on sea cucumber fisheries is limited. Global warming may affect sea cucumber fisheries by influencing the stocks and the global trepang supply. Coral reefs, which are important habitats for sea cucumbers may adversely be affected by global warming, and damage to coral reefs will in turn reduce recruitment of sea cucumbers. Higher sea temperature is a major cause of coral bleaching and damage to reef ecosystems. Changing sea temperature and current flows will likely bring shifts in the distribution of sea cucumber stocks with some areas benefiting while others incurring losses.

ACKNOWLEDGEMENTS

I would like to thank V. Toral-Granda, M. Vasconcellos and A. Lovatelli for inviting me to participate in this project and for their comments on the manuscript. I am very

[2] http://www.patentstorm.us/patents/5985330–description.html

grateful to K. Kiso for helping me procure publications and information from Japan. I wish also to thank K. Fukusho for his help with some Japanese translation. Thanks are due to N. Tracey and Dedi Adhuri for forwarding their publications to me, and to Jun Akamine, Kim Friedman, Jeffrey Kinch, Steven Purcell and Sven Uthicke for their comments on the manuscript.

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APPENDIX I

Commercial sea cucumber species recorded from China, Taiwan Province of China, China Hong Kong SAR, Japan, Malaysia, Thailand, Indonesia, Philippines, Viet Nam, Singapore and Spratley Islands (species of commercial importance in each country are marked in red)

	China	Taiwan PC	China HK SAR	Japan	Malaysia	Thailand	Indonesia	Philippines [1]	Viet Nam	Singapore	Spratly
O: Aspidochirotida F: Holothuriidae											
Actinopyga lecanora	x	x			x	x	x	x		x	x
Actinopyga mauritiana	x	x		x	x	x	x	x			x
Actinopyga echinites	x	x			x	x	x	x			
Actinopyga miliaris	x				x	x	x	x			
Bohadschia argus	x	x		x	x	x	x	x	x		x
Bohadschia graeffei					x	x	x	x			x
Bohadschia marmorata	x	x			x	x	x	x	x		
Bohadschia similis							x				
Bohadschia vitiensis						x	x		x		
Bohadschia tenuissima							x				
Bohadschia bivittata				x					x		
Holothuria atra	x	x		x	x	x	x	x	x		
Holothuria coluber					x	x	x	x			
Holothuria rigida						x	x	x			
Holothuria pulla								x			
Holothuria edulis	x			x	x	x	x	x	x		
Holothuria pardalis	x	x	x		x	x	x				
Holothuria cinerascens	x	x				x					
Holothuria moebii	x	x	x		x	x					
Holothuria whitmaei	x	x			x	x	x	x	x		
Holothuria fuscogilva	x				x		x	x	x		
Holothuria difficilis		x				x		x			
Holothuria arenicola	x	x				x	x				
Holothuria hilla		x			x	x	x	x			
Holothuria impatiens	x	x			x	x	x				
Holothuria leucospilota	x	x	x		x	x	x	x	x		x
Holothuria pervicax	x	x			x		x				
Holothuria conusalba						x	x				
Holothuria scabra	x		x	x	x	x	x	x	x	x	
Holothuria scabra versicolor					x		x	x			
Holothuria similis							x				
Holothuria fuscopunctata					x	x	x	x	x		
Holothuria ocellata					x	x	x				
Holothuria fuscocinerea	x	x	x		x	x		x			
Holothuria vagabunda							x				
Holothuria vatiensis							x				
Pearsonothuria graeffei		x			x		x				
O: Aspidochirotida F: Tichopodidae											
Stichopus chloronotus	x			x	x	x	x	x	x		x
Stichopus sp.					x						
Stichopus horrens	x	x			x		x	x	x		
Stichopus herrmanni	x	x			x	x	x	x	x		
Stichopus vastus					x		x				
Stichopus quadrifaciatus							x				
Parastichopus nigripunctatus				x							
Thelenota ananas	x	x		x	x	x	x	x	x		x
Thelenota anax	x				x		x	x			x
Apostichopus japonicus	x			x							
O: Dendrochirotida F: Cucumariidae											
Mensamaria sp.	x										
Cucumaria frandosa japonica				x		x					
Pentacta quadragulis						x			x		
O: Moldavia F: Caudinidae											
Acaudina leucoprocta	x										
O: Molpadida F: Molpadiidae											
Paracaudina sp.					x						
No. of commercial species	27	0	0	11	19	8	35	26	11	0	0

[1] A more complete list for the Philippines is available in Table 1 in the hotspot paper (this document).

APPENDIX II

Dried sea cucumber price trend

Product	Price (USD/kg) 1 October 2003	Price (USD/kg) 17 October 2005	Price reference & market area	Origin
White teatfish (skin–on), *H. fuscogilva*				
3–5 pcs/kg (Grade A)	23	45	Southeast Asian ports	South Pacific
4–8 pcs/kg Grade B	13	35	Southeast Asian ports	South Pacific
Prickly redfish, *T. ananas*				
6–15 pcs/kg	15	–	Southeast Asian ports	South Pacific
6–20 pcs/kg	–	25	Southeast Asian ports	South Pacific
Black teatfish, *H. whitmaei*				
3–5 pcs/kg (Grade A)	18	–	Southeast Asian ports	Australia
Grade B	10	–	Southeast Asian ports	Australia
4–15 pcs/kg (Grade A)	–	30	Southeast Asian ports	South Pacific
Stonefish, *H. lecanora*			Singapore	Indonesia
10–30 pcs/kg	18	28	Southeast Asian ports	South Pacific
30–55 pcs/kg	–	20	Southeast Asian ports	South Pacific
Sandfish, *H. scabra*				
Grade A	48	–	Singapore	Indonesia
10–30 pcs/kg	56	–	Singapore	South Pacific
15–40 pcs/kg	40	–	Singapore	South Pacific
10–30 pcs/kg	–	66	Southeast Asian ports	South Pacific
30–55 pcs/kg	–	40	Southeast Asian ports	Indonesia
50–90 pcs/kg	–	30	Southeast Asian ports	Indonesia
Greenfish, *S. chloronotus*				
50–120 pcs/kg	25	–	Singapore	South Pacific
50–200 pcs/kg	–	35	Southeast Asian ports	South Pacific
Surf redfish, *A. mauritiana*				
15–35 pcs/kg	11	–	Singapore	South Pacific
15–30 pcs/kg	–	20	Southeast Asian ports	South Pacific
30–50 pcs/kg	–	15	Southeast Asian ports	South Pacific
Tigerfish, *B. argus*				
25–55 pcs/kg	3	–	Singapore	South Pacific
20–50 pcs/kg	–	10	Southeast Asian ports	South Pacific
Brown sandfish, *B. marmorata*	5	–	Singapore	South Pacific
25–100 pcs/kg	–	10	Southeast Asian ports	South Pacific
Curryfish, *S. variegatus*	19	–	Singapore	South Pacific
	–	20	Southeast Asian ports	South Pacific
Elephant trunkfish, *H. fuscopunctata*				
3–8 pcs/kg	5	–	Singapore	South Pacific
3–8 pcs/kg	–	15	Southeast Asian ports	South Pacific
Lollyfish, *H. atra*	1.50	–	Singapore	South Pacific
	–	3	Southeast Asian ports	South Pacific
Chinese Liaofish (farmed)				
50–100 pcs/kg	–	120	Wholesale China	China
100–250 pcs/kg	–	100	Wholesale China	China

Source: INFOFISH Trade News.