Population status, fisheries and trade of sea cucumbers in Latin America and the Caribbean

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Galapagos Islands: a hotspot of sea cucumber fisheries in Latin America and the Caribbean

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Toral-Granda,V. 2008. Population status, fisheries and trade of sea cucumbers in Latin America and the Caribbean. 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. 2008. pp. 213–229.

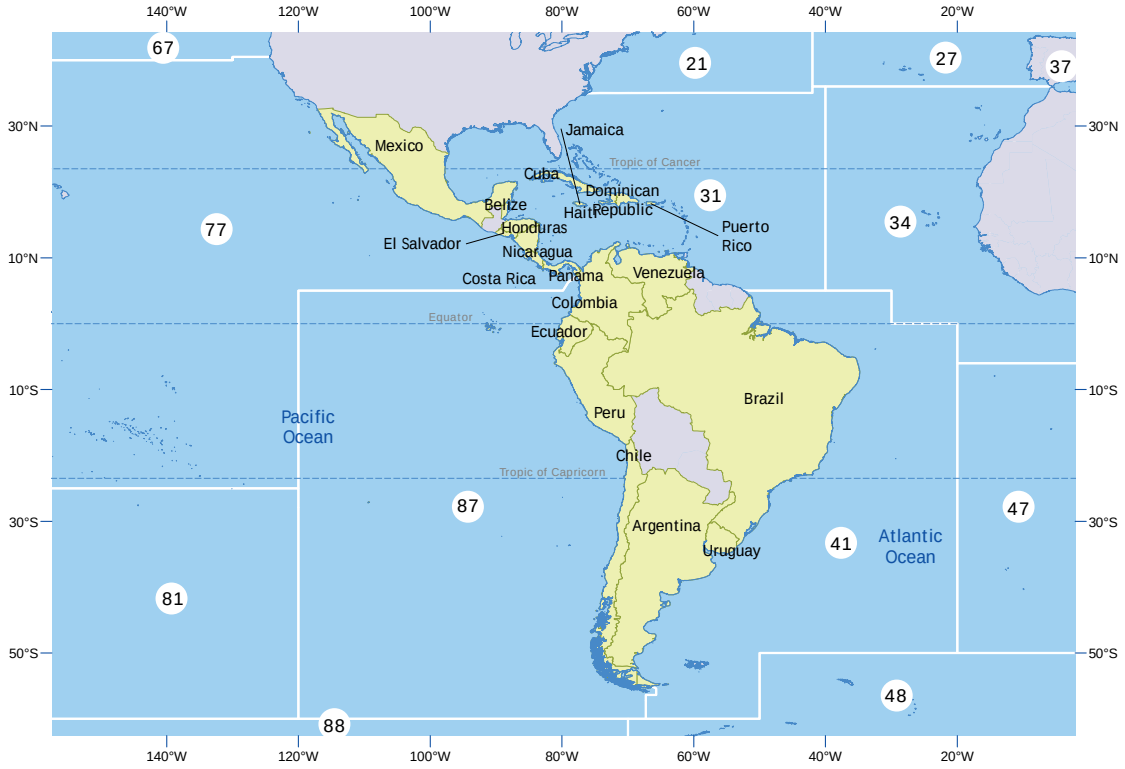
SUMMARY

The region under study comprises a total of 25 countries where, although there are some sea cucumber fisheries, scant information exists about them. There are eleven species of sea cucumbers currently harvested for commercial use in the region, with legal and illegal fisheries currently occurring in Mexico, Panama, Colombia, Ecuador, Nicaragua, Peru, Venezuela and Chile. In most of the countries where a fishery exists, there is hardly any biological or ecological information as well as little knowledge on the population status and even, in some cases, the taxonomy of the species under commercial exploitation. In most countries with ongoing fisheries, no management measures are in place and new species are normally being incorporated to the fishing activities. Although sea cucumber fishing it is not a traditional activity, some households have become highly dependent on this fishery, with increasing pressure towards decision makers to allow such activity. Despite the total bans on certain countries for this activity, exports are being recorded in China Hong Kong Special Administrative Region (SAR). Furthermore, the available catch and trade statistics reveal that a high level of illegal, unreported and unregulated (IUU) activities are currently taking place. Amongst the major threats to sea cucumber populations in the region, one can mention the development of fisheries with little or no information on the species, its biology, ecology and population status. Additionally, the permanent search of new species to supply the bêche-de-mer markets poses a serious threat to the wellbeing of not only sea cucumber populations but for the ecosystem as well. Sea cucumber fisheries have arrived to the furthermost fishing grounds available. The impact of this activity on the population status and socio-economic dependence by local fishers are noticeable, especially for an area where no knowledge or political will exists so as to avoid an overexploitation spiral that may leave few species in the brink of extinction.

1. THE REGION

The region under study comprises Mexico, Central America and South America (Figure 1). Information from countries in the Caribbean region, including Jamaica, Haiti and Cuba, is also reported.

FIGURE 1
Region under study and countries covered in this review (highlighted in yellow). The region encompasses the FAO Statistical Areas 31 (Western Central Atlantic), 77 (Eastern Central Pacific), 87 (Southeast Pacific) and 41 (Southwest Atlantic)



2. BIOLOGICAL AND POPULATION STATUS

2.1 Key taxonomic groups

Current legal fishing activities involve specimens from the Order Aspidochirotida and Dendrochirotida, with the families Holothuriidae and Stichopodidae as the most common; however, two species from the family Cucumaridae (Dendrochirotida) have also been recorded (Table 1).

TABLE 1
Sea cucumber species under commercial exploitation in Mexico, Central and South America

Order	Family	Species	Commercial exploitation
Aspidochirotida	Holothuriidae	*Actinopyga agassizi*	Panama, Venezuela
		Holothuria mexicana	Nicaragua, Panama, Venezuela
		H. impatiens	Mexico
		H. theelii	Peru
		H. atra	Ecuador
		H. kefersteini	Ecuador
		H. inornata	Costa Rica
		H. arenicola	Nicaragua
	Stichopodidae	*Isotichopus badionotus*	Cuba, Nicaragua, Venezuela
		I. fuscus	Ecuador, Mexico, Panama, Peru
		Stichopus horrens	Ecuador
		Astchopus multifidus	Panama, Caribbean region
Dendrochirotidae	Cucumaridae	*Athyonidium chilensis*	Chile, Peru
		Pattalus mollis	Chile, Peru

On the Pacific coast of Mexico, South and Central America, the current species under legal commercial exploitation are *Isostichopus fuscus* (Ludwig 1875) in the Galapagos Islands (Ecuador) (Toral-Granda and Martínez, 2004) and in Baja California (Mexico) (Castro 1995, 1997; Aguilar-Ibarra and Ramírez-Soberón, 2002), *Holothuria impatiens* and *Parastichopus parvimensis* in Mexico (Castro, 1997), *Holothuria arenicola* in Nicaragua (Palacios and Brenes, 2008), *Holothuria theelii* in Peru (Elliott, González and Ramirez, undated) and *Athyonidium chilensis* and *Pattalus mollis* in Chile and Peru (Guisado, C., Universidad de Valparaiso, Chile, personal communication; Elliott *et al.,* 2000). Illegal activities have started in the Galapagos Islands targeting *Stichopus horrens* (Hearn and Pinillos, 2006; Reyes and Murillo, 2007), *H. atra* (Reyes and Murillo, 2007) and *H. kefersteini* (Toral-Granda *et al.,* 2005).

Guzman and Guevara (2002) reported that the most highly commercial species in the Caribbean region are *Isostichopus badionotus*, *Astichopus multifidus* and *Holothuria mexicana,* although Conand (2006) mentions that there is an incipient fishery for *Actinopyga agassizi* as well. A sea cucumber fishery within Venezuelan waters was registered in mid-1990s, based on *H. mexicana* and *I. badionotus* (Rodríguez-Milliet and Marquez-Pauls, 1998). Unfortunately, recent information on this fishery is not available. In Nicaragua, there are three taxonomically identified species currently exploited, however, there are at least seven more sea cucumber species being targeted. These are known with their local common names.

2.2 Biology and ecology of sea cucumbers

Little is known for all sea cucumber species in the region, with sparse information on few species that could be of commercial interest. Guzman, Guevara and Hernandez (2003) present basic reproductive biology parameters for *I. badionotus* and *H. mexicana* from the Caribbean coast of Panama. Both species present a unimodal population structure with a majority of mature individuals and a 1:1 male to female sex ratio. The size at sexual maturity (SOM) is between 13 and 20 cm total length (TL). These species also showed a continuous reproductive activity throughout the year, with a peak of reproductive activity between July and November for *I. badionotus* and between February and July for *H. mexicana* (Guzman, Guevara and Hernández, 2003). In northwestern Venezuela, the gametogenic cycle of *I. badionotus* is continuous, reaching maximum maturity during July and August (Foglietta *et al.*, 2004); whereas, in Brazil, *I. badionotus* presents a high gonadal index in October and November and in January and February, with a spawning event occurring only in January when the sea temperature is at its highest (Pires-Nogueira *et al.,* 2003). In Bonaire, Netherlands Antilles, spawning of this species was recorded after the full moon in August (Graaf, Geertjes and Videler, 1999). *I. badionotus* is a large species reaching up to 45 cm TL with a wide distribution in the Caribbean; its southern geographic distribution reaching to south of Brazil (Conand, 2006). It is a common shallow water species, inhabiting mud, sand and rocky bottoms. Adults are generally exposed, whilst the juveniles hide under rubble (Conand, 2006). To the author's knowledge, no information on aestivation is available.

H. mexicana is also a large species (reaching up to 50 cm TL), inhabiting offshore reefs between 2 and 10 m depth (Conand, 2006). The gametogenesis and spawning for *H. mexicana* occurs during spring–summer and late summer in southern Florida (Engshorm, 1980; Mosher, 1982), however, individuals with mature gametes can be found throughout the year (Guzman, Guevara and Hernandez, 2003). In Curaçao, 70 percent of the individuals spawned within five days of the full moon between August and October (van Veghel, 1993). Rodríguez-Milliet and Pauls (1998) reported the SOM for *H. mexicana* at 18 cm TL. To the author's knowledge, no information on aestivation is available.

A. multifidus can reach 50 cm TL and it is characteristic of soft bottoms, with muddy or sandy patches, in and around seagrass beds (Conand, 2006). *P. parvimensis*

has a geographical distribution from Cedros Island, Baja California to Carmel Bay, California. It occurs subtidally on both rocky and soft habitats down to 60 m depth. *A. agassizi* is also large (35 cm TL) inhabiting rocky areas and seagrass beds. It is a nocturnal species (Conand, 2006).

Out of the species of commercial importance within the region, *I. fuscus* is probably the species most studied. It can be found from Baja California to mainland Ecuador, including Galapagos, Socorro, Cocos and Revillagigedos islands (Deichman, 1958; Maluf, 1991), although Hooker, Solís-Marín and Leellish (2005) include Peru (Islas de Lobos de Afuera) in its geographical distribution. It can be found in the coastal zone from the shallow subtidal to 39 m depth (Deichman, 1958; Maluf, 1991). *I. fuscus* prefers rocky habitats with *Ulva* sp. (Toral-Granda and Martinez, 2007) whilst in Baja California, it is usually found in coral and rocky habitats (Herrero-Pérezrul *et al.*, 1999). In the Galapagos Islands, *I. fuscus* shows reproductive activity all year long irrespective of sea surface temperature (Mercier, Ycaza and Hamel, 2007; Toral-Granda and Martinez, 2007). However, Mercier, Ycaza and Hamel (2007) report that *I. fuscus* spawns every month between one and four days after the new moon. In Baja California the species shows an annual reproductive season influenced by the influx of warm water (Fajardo-León *et al.*, 1995; Herrero-Pérezrul *et al.*, 1999). In both localities, *I. fuscus* presents a unimodal population structure with a majority of mature individuals (Herrero-Pérezrul *et al.*, 1999; Toral-Granda and Martinez, 2007). This species is more active at night (Shepherd, Toral-Granda and Edgar, 2003). A more detailed analysis on the biology and ecology of this species is presented in the hotspot document (Toral-Granda, this volume).

Athyonidium chilensis can be found from Peru to south of Chile. It can be found intertidally down to 7 m in rocky areas with great amount of organic matter. *A. chilensis* presents a continuous reproductive season (Rojas, L. and Guisado, C., Universidad de Valparaiso, Chile, personal communication).

Stichopus horrens is found in the Pacific Ocean from Malaysia to the Society Islands, French Polynesia, and from southern Japan and Hawaii to New Caledonia (Massin *et al.*, 2002) and in the Galapagos Islands. It prefers rocky substrates from 5–20 m depth (Hickman 1998), with abundant population over 30 m in certain islands (Hearn, A. Charles Darwin Foundation [CDF], personal communication). *S. horrens* normally remains hidden during the day to emerge at night to feed (Hearn and Pinillos, 2006). The population showed a unimodal distribution with the absence of smaller animals (Hearn and Pinillos, 2006) perhaps due to different habitat preference. Ongoing research on the reproductive biology of *S. horrens* show that this species reproduces throughout the year (J. Mora, CDF, unpublished information).

No information was available for *Pattalus mollis*, *Holothuria theeli*, *H. arenicola* and *H. impatiens*.

Although sea cucumbers are known to exert an important ecological role, as they recycle nutrients and help in the bioturbation process that enables organic matter to be brought back to the surface for further use by other organisms (Massin, 1982; Birkeland, 1988), no specific studies on a species level were found for the region.

2.3 Population status

In Panama, population surveys showed that *H. mexicana* was the most abundant species (161.8 ind. ha^{-1}) followed by *I. badionotus* (117.4 ind. ha^{-1}) (Guzman and Guevara, 2002), however these values are only for one small region within the country. No information is available on a country basis. In Cuba, *I. badionotus* reaches its highest density (ca. 8 800 ind. ha^{-1}) in the southeastern region and in some bays in the northeastern region (Alfonso *et al.*, 2000; Alfonso, 2006). No population surveys were done in mainland Ecuador before the commencement of the fishery in 1988 and recent surveys showed only one *I. fuscus* in over 3 000 m^2 (Martínez, C., USFQ-ECOLAP, personal communication). No information was available for the remaining countries.

2.4 Sea cucumber fishery

For most of the countries within the region, information on the starting date of sea cucumber fisheries is absent, with some records of illegal activities still in place. Currently, only Cuba, Peru, Chile, Mexico and Ecuador have regulated fishing activities, with Mexico and Ecuador focusing mostly on *Isostichopus fuscus*, and Mexico, to a lesser degree, on *P. parvimensis* (Stichopodiade: Aspidochirotida). Fisheries in Chile target *A. chilensis* and *P. mollis*, (Cucumaridae: Dendrochirotida) (Guisado, C. Universidad de Valparaiso, personal communication), while in Peru the fishery is focused on *P. mollis* (Hooker, Y., Universidad Peruana Cayetano Heredia [UPCH], personal communication). Cuba has an ongoing sea cucumber fishery focusing on *I. badionotus* (Holothuriidae: Aspidochirotida) (Alfonso *et al.,* 2004; Alfonso, 2006).

2.4.1 Panama

Guzman and Guevara (2002) report fishing activities in Panama in 1997 focusing on *I. badionotus*, *Astichopus multifidus* and *H. mexicana*. In 1997, A fishing license was given to one oriental entrepreneur to fish in the Bocas del Toro Archipelago (Caribbean coast), however his fishing permit was revoked after only 41 days as the conditions under which the licence was given were not met (Ministerio de la Presidencia, 2004). Conservative values report a total of 750 000 individuals of all three species caught during the 1997 30-day fishing period, with a total of 25 fishers involved in the activity (Guzman and Guevara, 2002). Currently, this activity is banned for the entire Republic of Panama by means of the Decree 157-2003 (Ministerio de la Presidencia, 2004); nonetheless, there are reports of illegal fishing activities currently going on in Las Perlas and Coiba (Pacific coast) (Pretto, R., Autoridad de los Recursos Acuáticos de Panama, personal communication). Stock assessments of *H. mexicana*, *I. badionotus* and *A. multifidus* in Bocas del Toro indicated that these species have small population sizes and a high risk of collapse in the short term if fishing effort levels were to be maintained (Guzman and Guevara, 2002). Illegal fishing activities also target *I. fuscus* in the Pacific coast of Panama (Serrano, N., personal communication).

2.4.2 Venezuela

Rodríguez-Milliet and Pauls (1998) provide information on a sea cucumber fishery in Venezuela targeting *I. badionotus* and *H. mexicana*. This fishery began in 1991–1992 as an informal activity, and then in 1993 the Venezuelan Fisheries and Aquaculture Office Service of the Ministry of Agriculture issued the first licence (Rodríguez-Milliet and Pauls, 1998). However, this licence was revoked as no technical reports were submitted in order to regulate the fishery. In 1994, four commercial licences were given and two scientific institutions offered to contribute with information so as to help regulate the fishery and the concession of new fishing licences. This fishery was allowed only in the Cubagua and Coche Islands, northeastern Venezuela. The total catch for the 1994 season were 3 285 kg and 1 922 kg (dry weight), respectively. In 1995, an illegal shipment of 930 kg was impounded (Rodríguez-Milliet and Pauls, 1998). Sea cucumber fishing activities are banned in Venezuela since 1996. However, in 1996, 500 kg of *H. mexicana* with a value of USD 150 000 were confiscated in the Archipelago Los Roques National Park[1]. In addition, China Hong Kong SAR, reports approximately 0.5 tonnes of sea cucumbers imported from Venezuela for 2005 (see Table 3). No recent information for Venezuela was available.

2.4.3 Chile

In Chile, sea cucumber fishing activities started in 1992 focusing mainly on *A. chilensis*, although this fishery is not constant and it may be self regulated by specific demand of

[1] http://www.parkswatch.org/parkprofiles/pdf/ronp_spa.pdf.

the product. Currently there is no information on the number of fishers involved in this venture and it is reported not to be of high importance to the local fishers (Guisado, C., Universidad de Valparaiso, personal communication). The fishery is considered artisanal with fishers free diving to collect the individuals. No management measures are in place to safeguard this species (Guisado, C., Universidad de Valparaiso, personal communication). Total catches for 1992 were 237 tonnes, increasing to 1 510 tonnes in 2000 and a showing a drastic decrease to 19 tonnes in 2002. All catches are used for the bêche-de-mer market and the main markets are Taiwan Province of China, China and Singapore (Guisado, C., Universidad de Valparaiso, personal communication). China Hong Kong SAR, reports almost 41 tonnes of sea cucumber imported from Chile between 2000 and 2005 (see Table 3). No information was available for *P. mollis*.

2.4.4 Peru

In Peru the fishery started in the late 1980s originally on *I. fuscus*, but upon depletion of this species the fishing effort moved to other species, nowadays focusing especially on *P. mollis*, although there are records of *I. fuscus*, *H. theelii* and *A. chilensis* also being caught. Historically, *A. chilensis* was traditionally eaten only in the Department of Labayeque. Nonetheless, currently *P. mollis* is readily available on local markets for domestic consumption (Hooker, Y., UPCH, personal communication). This activity is carried out upon request, and sea cucumbers are gathered as a bycatch of other sea food species, and it is regarded as a subsistence and artisanal venture. There are no management plans for this fishery (Hooker, Y., UPCH, personal communication).

2.4.5 Cuba

In Cuba, sea cucumber fishing activities started in 1999 targeting *I. badionotus* (Alfonso, 2006). Other species of sea cucumbers are also present but at much lower densities, and no fishery has been directed towards them (i.e. *A. agassizi*, *H. floridana*, *H. mexicana* and *A. multifidus*).

This activity was deemed viable after a study carried out by the Fishery Research Center in 1997; however, commercial exploitation started only in 1999. This season had a total allowable catch (TAC) of 320 tonnes (dry weight) with one license granted to a Korean company (Alfonso *et al.,* 2004). During the first years of the fishery (1999–2000) over 3 000 000 individuals were caught, with an average Catch per Unit of Effort (CPUE) of 1 153 ind. boat^{-1} day^{-1}. However, both catches and CPUE decreased to less than 500 000 individuals and 350 ind. boat^{-1} day^{-1} for the next two seasons. In 2004, the CPUE showed signs of recovery with over 1 500 ind. boat^{-1} day^{-1} (Alfonso *et al.,* 2004). By 2004, there were a total of 28 fishers and 18 processors operating this fishery (Alfonso, 2006). Fishers venture to sea in speed boats and each fishing outing lasts an average of 20 days, with 10 days resting period. Animals are collected from the sea floor using hookah at depths between 3 and 15 m (Alfonso *et al.,* 2004).

During the first fishing season, various studies were performed in order to provide information on how to manage this activity and to minimize its possible impact. There is a fishing ban over the reproductive season (June–October), minimum landing sizes (22 cm TL for the southwestern region and 24 cm TL for the southeastern region). Additionally, each locality has a TAC which regulates the number of active vessels (Alfonso, I., Fisheries Research Center, personal communication). Moreover, a Technical Operational Procedure (TOP) manual provides measures for accident prevention, information on decompression tables and TAC and bag sizes (Frías *et al.,* 2002) whilst another TOP was developed to improve the quality of the final product and to guarantee better yields (Castelo *et al.,* 2002), which has resulted in an increase of the percentage of Class A product being exported (Alfonso, 2006).

From 1999 to January 2007, approximately 99.4 tonnes (dry weight) *I. badionotus* have been exported from Cuba representing over USD 1.5 million revenue (Alfonso, I.,

Fisheries Research Center, personal communication). With prices per kilo ranging from USD 13.5 in 1999–2001 to USD 22.0 in April 2003 for dry *I. badionotus*; whilst the price for Class B has fluctuated from USD 6.0 to USD 10.0 per kg (Alfonso, 2006). These exports are solely to supply the bêche-de-mer market, whilst there are some studies to evaluate the possible commercial use of gonads and the processing water (the water in which *I. badionotus* has been boiled for producing bêche-de-mer) for bioactive and medicinal extracts, specifically as antifungal medicines (Alfonso, Tacoronte and Mesa, 2007). Cuba does not report any illegal sea cucumber fishery (Alfonso, 2006).

2.4.6 Mexico

In Mexico, the sea cucumber fishery started in Baja California targeting *I. fuscus* in the eastern coast and *P. parvimensis* in the western coast. The fishery for *I. fuscus* started in the 1980s as a small-scale activity that responded to the international demand for bêche-de-mer in oriental countries (Aguilar-Ibarra and Ramírez-Soberón, 2002). The exploitation of *P. parvimensis* started in 1996. However, Castro (1997) state that the fishery for *I. fuscus* started in 1988 and for *P. parvimensis* in 1989, and for *H. impatiens* in 1994. The fishery for *I. fuscus* continued until 1994 when the government imposed a total closure because the species was considered "endangered" (NOM-059-ECOL-1994). This measure was taken because in 1992 and 1993 there was a sudden increase in the fishing effort which led to a considerable decrease of the CPUE and total landings (Castro, 1995). The closure was not obeyed by fishers, who continued fishing and the standing biomass of *I. fuscus* reached ca. 2 percent of the original biomass for the region (Aguilar-Ibarra and Martínez-Soberón, 2002). No significant recovery has been registered despite management measures set in place. The lack of recovery may be a result of continued illegal activities and/or decreased productivity because population densities may be below a minimal threshold level required for successful reproduction (Toral-Granda, 2007). In March 2002, *I. fuscus* was downlisted as a "subject to special protection" which allows the use of this species under restricted conditions. In 2005, an adaptive management plan was developed under a participatory scheme, which included local and national government, scientists and fisher associations. This plan includes the allocation of harvest quotas, catch reports and population monitoring reports to assess continuously the impact of the fishery. This management plan is reviewed on a yearly basis and adapted to the new results obtained (Toral-Granda, 2007).

Currently, the *I. fuscus* fishery is managed under concessions of "*Unidad de Manejo para la Vida Silvestre*" (UMAS) to organized fishers who in return must submit reports on the activity. This information is used to evaluate the impact of the fishery in the population and decide further management measures to ensure its sustainability (Herrero-Perezrul, D., Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional [IPN], personal communication). All *I. fuscus* from Mexico is exported to Taiwan Province of China and China Hong Kong SAR, either as chilled or dry products.

For *Parastichopus parvimensis*, the other Mexican species entering international trade, there are separate management provisions (as for any other fishery in Mexico) since this species is not included in the domestic threatened species list. No information was available for this species.

China Hong Kong SAR, reports over 14 tonnes of sea cucumber that enter the country imported from Mexico from 1995 to 2005 (see Table 3), whilst data available at FAO indicates a total of 2 564 tonnes caught from 1998 to 2005, with an average annual catch of 320.5 ± 86.3 tonnes (FAO, 2007). There is no information on catch and export at the species level. Sea cucumber fishery helps the local communities during the closed season of more profitable resources (i.e. red sea urchin (*Strongylocentrotus franciscanus*) and complements income from abalone (*Haliotis fulgens)* and keyhole limpet (*Megathura crenulata*) (Castro, 1997).

2.4.7 Ecuador

Sea cucumber fishing activities arrived to Ecuador in 1988, targeting *I. fuscus*. This fishery was centered mostly on the coast of Guayas and Manabí provinces and was fuelled by Asian entrepreneurs who taught the local fishers how to collect and process the catch (Carranza and Andrade, 1996). There are no official estimates of the total catch of *I. fuscus* in mainland Ecuador, however, Carranza and Andrade (2006) indicate that at least 420 000 individuals were caught monthly. The fishers would normally deplete one area and then move to nearby areas where they would proceed as before (De Paco *et al.,* 1993). This activity lasted about four years in mainland Ecuador (Carranza and Andrade, 1996), when the collapse of the population prompted the migration of this activity to the Galapagos Islands (De Paco *et al.,* 1993; Carranza and Andrade, 1996; De Miras, Andrade and Carranza, 1996). During the beginning of the sea cucumber fishery in the islands, the lack of knowledge on how to process the catch resulted in the waste of great quantities of animals and low prices paid for the final product, resulting in even less benefits to the local fishers of the Galapagos (Carranza and Andrade, 1996). Commercial exploitation of all sea cucumber species is forbidden in mainland Ecuador by the Ministerial Decree #147, RO/26 of 15 September 1992.

The arrival of this activity to Ecuador is also shown in the country reports to FAO (FAO, 2007) which shows exports of three tonnes sea cucumbers in 1988, increasing to 152 in 1992. From 1993 to 1997, there are 12 tonnes exported annually, and from 1998 to 2005, 15 tonnes (FAO, 2007). According to the Department of International Commerce from the Ecuadorian Central Bank over 74 percent of the sea cucumber exports are directed to Taiwan PC, followed by the United States of America and China (Altamirano, M., personal communication). In all, over 90 percent of the total sea cucumber catches are directed to the Asian countries. Only 80 kilograms of dry *I. fuscus* have been exported from an aquaculture venture (L. Ruidiaz, Subsecretaria de Pesca del Ecuador, personal communication), and there is only one sea cucumber aquaculture company legally registered. However, to the author's knowledge there are at least five more companies dedicated to rearing *I. fuscus* in abandoned shrimp ponds.

The Galapagos Islands are the only regulated and legal fishing ground for sea cucumber fisheries, where it focuses on *I. fuscus*, although there are illegal landings of *S. horrens*, *H. atra* and *H. kefesteini*. More detailed information for the Galapagos sea cucumber fishery is presented in the hotspot document (Toral-Granda, this volume).

2.4.8 Costa Rica

There are reports of commercial sea cucumber fishing activities focusing on *H. inornata* and *I. fuscus* in 1993 and 1994, although no official catch records exist (Anonymous, 2006). There were ten licenses, one per fisher, to carry out this activity. The fishers free dived or use hookah to collect the animals from the sea floor. This activity was regulated by means of a two-month fishing season, a minimum landing size of 20 cm, a bag limit of 1 200 individuals per fisher per month, restricted ports for landing, and closed areas (Anon., 2006). Currently, sea cucumber fisheries are banned in Costa Rica (Anon., 2006; Alvarado, J.J., The Nature Conservancy, personal communication). Nonetheless, China Hong Kong SAR reports imports from Costa Rica of approximately 1.3 tonnes from 1999 to 2005 (Hong Kong Census and Statistics Department, personal communication), indicating that there is still a substantial (illegal) fishery in the country.

2.4.9 Nicaragua

Sea cucumber fishing activities in Nicaragua date back to 1994 when the first exports are recorded for this country. In 2005, oriental traders requested a permit to exploit this resource and a one-year permit was granted while scientific research was undertaken

in the Pacific coast. No taxonomic information exists on the species harvested during that year. Currently there are three taxonomically identified species under commercial harvest, whilst there are at least seven more unidentified sea cucumbers harvested. In the Pacific coast, the most important species is the "*Pepino rojo con espiculas*" and in the Caribbean *H. mexicana* and *I. badionotus*. There are about 45 fishers that make of this activity their mean of subsistence, with other 150 who alternate this fishery with other. All products are exported to China and Taiwan Province of China as there is no traditional consumption in Nicaragua. From the Caribbean there has been two main shipments with 5 tonnes in 2006 and 182 in 2007; in the Pacific coast, exports started in 2005 with 51 tonnes (dry weight) and increased to 93 tonnes (dry weight) for both 2006 and 2007. Presently, all sea cucumber fishing activities are not regulated, however, there is a plan to start applying total allowable catches and fishing seasons to both Pacific and Caribbean species (Palacios and Brenes, 2008; Brenes, B. Instituto Nicaraguense de la Pesca y Acuicultura, personal communication). In 2006, Nicaraguan fisheries managers also arrived to the Galapagos Islands looking for possible recommendations on how to manage this incipient activity.

2.4.10 Other countries

Currently, sea cucumber fisheries are banned in Venezuela (Rodríguez-Milliet and Pauls, 1998) and Panama (Ministerio de la Presidencia, 2004); whilst there is no fishery in El Salvador (Barraza and Hazbún, 2007), Honduras (Hasbún, C.R., Fundación Zoológica de El Salvador [FUNZEL], personal communication), Jamaica (Aiken, 2006) and Argentina (Tablado, A., Museo Argentino de Ciencias Naturales, personal communication). In Colombia, there is an illegal, unregulated and non-quantified fishery over *I. badionotus* (Navas, G., Instituto Investigaciones Marinas y Costeras [INVEMAR], personal communication). No information was available from Haiti, Brazil, Uruguay and Belize.

Most sea cucumber fishing activities within the region are unregulated or non-existent. Ecuador, Costa Rica, Cuba, Mexico, Panama and Venezuela have enacted regulations to control the harvesting of these species, whilst other countries provide no information on their management strategies. Table 2 summarizes management measures in place for the countries in the region.

TABLE 2
Management measures for the sea cucumber fisheries in Latin America and the Caribbean

Country	Management measures
Argentina	No known fishery
Belize	No information available
Brazil	No information available
Chile	No management measures in place
Colombia	No management measures in place
Costa Rica	Total ban on sea cucumber fishing
Cuba	Minimum landing sizes, temporal closure over the reproductive season, total allowable catches per region
Ecuador (Galapagos Islands)	Fishing season, minimum harvesting size, no take zones, total allowable catch
Ecuador (Mainland)	Total ban on sea cucumber fishing
El Salvador	No known fishery
Haiti	No information available
Honduras	No known fishery
Jamaica	No known fishery
Mexico	Fishery manager inside "*Unidad de Manejo para la Vida Silvestre*" for *I. fuscus*
Panama	Total ban on sea cucumber fishing
Peru	No management measures in place
Uruguay	No information available
Venezuela	Total ban on sea cucumber fishing

3. TRADE AND ILLEGAL, UNREPORTED AND UNREGULATED CATCHES

Although there is no official information on the main export destinations for most of the sea cucumber landings, it can be safely assumed that most of the catches are exported to supply the Asian market demand for bêche-de-mer. In some cases, fishing activities started upon request from oriental entrepreneurs (e.g. Panama and Cuba); whilst for other countries (e.g. Ecuador) most catches are send directly to China.

For many countries within the region, most of the catches seem to originate from illegal, unreported and unregulated (IUU) fishing. For some countries there is clear evidence of illegal trade and catches despite regulations forbidding the capture of the species (e.g. Panama). In other countries (e.g. Colombia) there are fishing activities that are not regulated.

For instance, according to the China Hong Kong SAR Census and Statistics Department there are 14 countries from Latin America that export sea cucumbers to China Hong Kong SAR (Table 3). Although the total percentage of the imports of such countries is generally less than 1 percent of the global imports, it indicates a considerable amount of IUU catches coming from countries in the region.

The greater amounts of sea cucumbers exported from the region originate from Peru (26.1 percent), Ecuador (25.9 percent), Chile (14.1 percent) and Cuba (10.1 percent) which have declared to have fishing activities for sea cucumbers. The remaining percentage (13.7 percent) originates from countries where either this fishery is banned (i.e. Panama and Costa Rica) or has no official record of it (Colombia).

In the FAO catch statistics only Chile, Ecuador, Mexico and Nicaragua report catch figures for sea cucumbers with a total of 6 035 tonnes from 1988 to 2005 (Table 4) (FAO, 2007). Ecuador reported 389 tonnes, with the first figures in 1988, approximate date on which sea cucumber harvesting began in mainland Ecuador. However, there is also substantial catch statistics from periods when the catch of *I. fuscus* was banned (1994–1998). These catches are probably from illegal activities in the Galapagos Marine Reserve, the only source of *I. fuscus* after the depletion of this species in mainland Ecuador. However, the data from Mexico, with 2 564 tonnes, is the second highest value after Chile (3 031 tonnes) and reports sea cucumber catches since 1998, with its peak catch in 2001 (481 tonnes). Chile started reporting in 1992, around the time in which commercial exploitation of *A. chilensis* started. The figures for Chile are quite erratic, with values ranging from 1 tonne in 1997 to 1 510 in 2000. Lastly Nicaragua, reports a total of 51 tonnes only for 2005, which corresponds to the total reported by Nicaragua. However, China Hong Kong SAR reports the first imports from Nicaragua in 2003. As a whole, catches from the region represent 1.46 percent of the total reported sea cucumber catches to FAO between 1988 and 2005 (Table 4).

The data provided by FAO and the China Hong Kong SAR Census and Statistics Department show that there is a substantial trade of sea cucumbers from Mexico, Central and South America; with the FAO figures providing an overall picture of the amount being harvested, whilst the information from China Hong Kong SAR indicates the diversity of countries that export their produce.

4. SOCIO-ECONOMIC IMPORTANCE

Although recent in arrival and importance, sea cucumber fisheries are an important source of income to coastal communities in the region, however, no official quantification of the level of dependence of fishers on the income generated from this activity exists. Nonetheless, it can be assumed that new fisheries keep emerging in the region as a result of previous experiences elsewhere. No quantification of number of fishers, prices, and trade exist, as in most countries, this is an illegal or unregulated activity.

In Ecuador, with the Galapagos Islands as the case study for the region, further information is provided in Toral-Granda (this volume).

TABLE 3
Total volume of sea cucumber imported by China Hong Kong SAR from Latin American and the Caribbean countries from 1996 to 2005 (kg dry weight)

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
Brazil	1 600	–	–	–	–	444	50	–	–	–	2 094
Chile	–	–	–	–	22 318	7 599	2 906	527	4 485	5 123	42 958
Colombia	–	–	–	–	–	540	–	–	–	1 646	2 186
Costa Rica	–	–	–	108	664	325	–	7	164	–	1 268
Cuba	–	–	–	2920	19 023	13 941	3 800	7 648	5 080	8 641	61 053
Dominican Republic	–	–	–	–	–	–	2 562	45	–	–	2 607
Ecuador	120	–	–	24 567	15 285	991	10 130	3 026	11 322	13 248	78 689
Haiti	–	–	–	–	–	–	1 000	9 680	–	–	10 680
Mexico	405	500	–	–	150	1 818	3 302	1 270	4 294	2 378	14 117
Nicaragua	–	–	–	–	–	–	–	252	–	5 826	6 078
Panama	–	–	–	–	–	–	–	–	281	408	689
Peru	137	2 364	376	4 170	7 331	3 881	1 828	8 354	19 906	31 002	79 349
Puerto Rico	–	–	–	–	–	–	1 300	–	–	256	1 556
Venezuela	–	–	–	–	–	–	–	–	–	456	456
Total - countries from the region[1]	**2 262**	**2 864**	**376**	**31 765**	**64 771**	**29 539**	**26 878**	**30 809**	**45 532**	**68 984**	**303 780**
Total - world wide[2]	**5 021 828**	**4 524 832**	**3 977 324**	**2 924 331**	**4 760 719**	**4 384 273**	**4 419 356**	**4 675 043**	**5 071 839**	**4 480 643**	**44 240 188**
% from Region[3]	0.05	0.06	0.01	1.09	1.36	0.67	0.61	0.66	0.90	1.54	0.69

Source: Hong Kong Census and Statistics Department.

[1] Sum of kg for the countries from the region.
[2] Sum of kg of the total of sea cucumber imported into China Hong Kong SAR from all countries worldwide.
[3] Percentage of the imports from the region in comparison from those worldwide.

TABLE 4
Volume of sea cucumbers reported to FAO by Chile, Ecuador, Mexico and Nicaragua in comparison to the total tonnage reported worldwide (in tonnes)

Year	Mexico	Chile	Nicaragua	Ecuador	Total in the region	World harvest total	Percentage from region
1988	–	–	–	3	3	19 905	0.02
1989	–	–	–	10	10	17 467	0.05
1990	–	–	–	12	12	19 976	0.06
1991	–	–	–	29	29	21 790	0.15
1992	–	237	–	152	389	20 892	1.95
1993	–	13	–	12	25	19 348	0.13
1994	–	4	–	12	16	24 505	0.08
1995	–	106	–	12	118	24 050	0.59
1996	–	115	–	12	127	26 795	0.64
1997	–	1	–	15	16	24 672	0.08
1998	271	30	–	15	316	22 004	1.59
1999	234	108	–	15	357	20 462	1.79
2000	426	1510	–	15	1 951	24 509	9.80
2001	481	107	–	15	603	20 431	3.03
2002	290	106	–	15	411	23 445	2.06
2003	285	307	–	15	607	28 085	3.05
2004	265	234	–	15	514	27 540	2.58
2005	312	153	51	15	531	26 002	2.67
Total	**2 564**	**3 031**	**51**	**389**	**6 035**	**411 878**	**1.46**

Source: FAO Fisheries and Aquaculture Information and Statistics Service 2007.

5. RECENT DEVELOPMENTS

Guisado (2005) reports the interest to develop a mariculture program for *A. chilensis* in central Chile. This initiative will help generate scientific knowledge on the ecology, biology and nutrition of this species, as well as assure the supply of a wanted resource in a known market. Additionally, it will help the artisanal fishers to diversify their activities (Guisado, 2005). However, to the author's knowledge there is no clear evidence that this venture ever took off. Additionally, the Chilean Government, has recently approved a project to start the aquaculture of *Apostichopus japonicus* in northern Chile. This will need the introduction of specimens from China, which will be placed in quarantine and then in ponds. All effluent waters will be dealt according to the local laws. At the moment, this activity is waiting for the approval of the introduction of the specimens in order to start with the mariculture project (Guisado, C., Universidad de Valparaiso, personal communication).

Mercier, Ycaza-Hidalgo and Hamel (2004) report the successful rearing of *I. fuscus* larvae under laboratory conditions and juveniles in abandoned shrimp ponds in mainland Ecuador. *I. fuscus* juveniles can grow up to 8 cm in length in 3.5 months, with a survival rate between 30 and 50 percent. Currently, there is only one legally registered aquaculture firm focusing on *I. fuscus*. However, to the author's knowledge, there are at least five more with aquaculture ventures working with the same species. There is only 80 kilograms of dry *I. fuscus* that has been exported to Taiwan Province of China from these ventures (Ruidiaz, L., Subsecretaria de Pesca, personal communication). Initiatives to develop similar ventures in the Galapagos Islands is analysed thoroughly in the hotspot document (Toral-Granda, this volume).

In Mexico, Gutierrez-García (1999) indicated the potential of starting aquaculture activities over *I. fuscus*, and currently there are studies to start the aquaculture production of *I. fuscus* prompted by the local fishers as an alternative to capture fisheries (Herrero, A., Gobierno del Estado de Baja California Sur, personal communication). No information is available on the status of this project.

6. ADDITIONAL THREATS TO SEA CUCUMBER POPULATIONS

The exploitation of sea cucumber species without the use of the precautionary approach is probably the biggest threat to their populations within the region. For many of the species under legal or illegal fishing there are no or little scientific information available on biology, ecology, population abundance and dynamics. The lack of information to assess the status of stocks, their productivity and resilience to exploitation (e.g. minimum densities required for successful reproduction) precludes the development of management strategies and plans based on sound scientific knowledge.

The constant searches of new species to supply the bêche-de-mer Asian market also pose a threat to the wellbeing of sea cucumbers in the region. Upon depletion of the most valuable commercial species, trade scouts will find new species on which to focus. This procedure is facilitated by the existence of the know-how, the socio-economic dependence on the resource and the constant demand in the international market. This may promote fishing activities, both legal and illegal, in countries that already have it, as well as in others that have not started it yet. It is possible to infer that, without proper management attention, the development of new sea cucumber fisheries will have a similar faith to that observed in other countries and species.

An additional threat is habitat loss and degradation, either due to climate oscillations (e.g. El Niño), environmental disasters (e.g. tropical cyclones) and human-induced causes such as unsustainable fishing practices, coastal pollution and sedimentation. Aiken (2006) suggests that the decrease in the abundance of *H. mexicana* in Jamaica may be due to the effect of two tropical cyclones that damaged the habitat of this species.

Although there are not many ongoing aquaculture ventures, this activity may pose a threat to sea cucumbers populations. In Chile, there are studies to evaluate the possibility of introducing *Apostichopus japonicus* for mariculture. This introduction could become a threat if not enough care is exerted during the procedure and the activity itself. Lubchenco *et al.* (1991) recognised that human-mediated bioinvasions are one of the main threats to the marine environment and, although no information is available on the possible impacts of introduced sea cucumbers, an introduction of an exotic marine species should be evaluated with great care, especially on the eventuality of larval escape hence promoting inter-species competition. In the Galapagos Islands, an interest to explore the feasibility of restocking the sea cucumber *I. fuscus* to enhance depleted populations and as an alternative to the local fishing sector has been proposed. But under the current management policies of the Galapagos Marine Reserve (GMR) it is not advisable, as this may cause the translocation of *I. fuscus* without any knowledge on genetic delineation of stocks, possible destruction of parts of the terrestrial National Park, and potential stress to the individuals under study as no information on larval and juvenile natural history, optimal release conditions, diseases and predation is available (Toral-Granda, 2005). More information on this is presented in the Galapagos as a hotspot (Toral-Granda, this volume).

7. CONCLUSION

Although there are relatively few species under commercial exploitation in Mexico, Central and South America, most of the fishing activities are being carried out at random and without planning. Most of the sea cucumber species exploited lack biology and ecology studies that will help yield management plans that will provide sustainable use of this resource with the consequent economical benefit to local human populations. For the few countries that have management plans in place, there is little enforcement and illegal activities are common.

Sea cucumber fisheries have arrived to the furthermost ground from its place of origin, where it is a non-traditional activity that is changing the fishing behaviour of the local community. The boom-and-bust cycle has already taken its tokens in the

region, with few species overexploited and new ones on the brink of overexploitation. This activity does not require qualified workmanship and/or mechanised fishing gear, which means that is a gold-rush fishery, providing high incomes with little work and investment.

The little published information on sea cucumber fisheries in the region should be viewed as an urgent call to researchers on this field to evaluate the extent to which this fishery is happening within their area of expertise, hence helping to draw management plans that could be applied on a regional base or as species specific. As some species have a wide geographical distribution, joint research programmes should be initiated in order to help gather all possible biological and ecological information on which to base decisions about fishing activities.

ACKNOWLEDGEMENTS

My sincere thanks to Alessandro Lovatelli who believed in me and made me part of the team. To Marcelo Vasconcellos and Alex Hearn who provided inputs so as to improve this document. To Annie Mercier and Priscilla Martínez who helped improving this document and gave key inputs so as to make this document more accurate. My sincere thanks to all colleagues within the region who collaborated with information on the sea cucumber fishing activities within their country or area of expertise, especially to Alejandro Tablado, Armando Herrero, Buffy Rebekah-Beth Turner, Camilo Martínez, Carlos Roberto Hasbún, Chita Guisado, Dalva Arosemena, Dinorah Herrero-Perezrul, Eréndira García, Gabriel Navas, Héctor Guzmán, Irma Alfonso, Juan José Alvarado, Lorena Ruidiaz, Luis Morales, Luis Rojas, Nelly Serrano, Nora Palacios, Patricia Fuentes, Richard Pretto and Yuri Hooker. To Tom Poulsom, who provided great cups of tea, support and editorial assistance. This is Charles Darwin Foundation contribution number 1072.

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