CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Nineteenth meeting of the Conference of the Parties
Panama City (Panama), 14 – 25 November 2022

CONSIDERATION OF PROPOSALS FOR AMENDMENT OF APPENDICES I AND II

A. Proposal

Inclusion of all species in the genus *Thelenota*, which includes the three species *T. ananas*, *T. anax*, and *T. rubralineata*, in Appendix II, in accordance with Article II paragraph 2(a) of the Convention. The three species qualify for Appendix-II listing under Criteria A and B in Annex 2a of Resolution Conf. 9.24 (Rev. CoP17).

B. Proponent

European Union, Seychelles and United States of America *

C. Supporting statement

1. Taxonomy

1.1 Class: Holothuroidea

1.2 Order: Synallactida

1.3 Family: Stichopodidae

1.4 Genus, species or subspecies, including author and year:

Thelenota Brandt, 1835
Thelenota ananas (Jaeger, 1833)
Thelenota anax Clark, 1921
Thelenota rubralineata Massin & Lane, 1991

1.5 Scientific synonyms: based on WoRMS 2021

Thelenota synonyms:
Camarosoma Brandt, 1835
Holothuria (Thelenota)
Platysoma Brandt, 1835

Thelenota ananas synonyms:
Actinopyga formosa (Selenka, 1867)

* *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat (or the United Nations Environment Programme) concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.*

Holothuria (*Holothuria*) *ananas* Jaeger, 1833
Holothuria (*Thelenota*) *grandis* Brandt, 1835
Holothuria ananas Quoy & Gaimard, 1834
Holothuria hystrix Saville-Kent, 1890
Mülleria formosa Selenka, 1867
Trepang ananas Jaeger, 1833

Thelenota anax synonyms: N/A

Thelenota rubralineata synonyms: N/A

1.6 Common names:

Thelenota ananas

English:	Prickly redfish, pineapple sea cucumber
French:	Holothurie ananas, Barbara
Spanish:	

Thelenota anax

English:	Amberfish, giant sea cucumber, giant beche-de-mer
French:	Holothurie géante
Spanish:	

Thelenota rubralineata

English:	Red-lined sea cucumber, lemonfish, candy cane sea cucumber
French:	Holothurie à lignes rouges
Spanish:	

1.7 Code numbers: N/A

2. Overview

Thelenota is a genus of widely distributed sea cucumbers that are commercially exploited for consumption and threatened by the international beche-de-mer trade. *Thelenota ananas* is one of the highest-value and highest demand sea cucumber species (Purcell, 2014). There is concern over the sustainability of sea cucumber fisheries around the globe, including for *Thelenota* species, with depletions at many localities, often following a “boom and bust” cycle of overexploitation (Kinch et al., 2008; Anderson et al., 2011; Friedman et al., 2011, Conand et al., 2013a, Conand et al., 2013b; Conand et al., 2013b). Many coastal communities depend on artisanal sea cucumber fisheries, and depletion of stocks affects both the fisheries’ sustainability and community incomes and has led to fishing moratoria (Purcell et al., 2013), including for *Thelenota* species in several nations.

This proposal presents biological and commercial data to support for the inclusion of the sea cucumbers belonging to the genus *Thelenota* on Appendix II. All three species are commercially exploited and threatened by the international beche-de-mer trade. IUCN has assessed *T. ananas* as Endangered because populations have declined 80-90% in at least 50% of its range (Conand et al., 2013a). *T. anax* and *T. rubralineata* are considered IUCN-Data Deficient; information and data are lacking to fully assess the impact of fishing and trade on these species. However, their rarity, price and suspected life histories suggest high vulnerability to overexploitation (Conand et al., 2013c; Conand et al., 2013b).

Inclusion of the genus *Thelenota* in Appendix II will allow continued and more sustainable trade, supporting the interests of fishermen, exporters and importers and preserving these species and their important ecological role for future generations (Bruckner et al., 2003). Nations will be required to develop non-detriment findings, generating more data upon which to base management plans, helping to end the boom-and-bust cycle of exploitation faced by sea cucumber fisheries. Article IV requires that Scientific Authorities monitor exports and, whenever necessary, advise the Management Authority of suitable measures to maintain species at a level consistent with their role in the ecosystems. Appendix-II listing will also allow the sea cucumbers to continue their important role in coral reef ecosystems of recycling nutrients, bioturbating sediments, buffering sea water from ocean acidification and other benefits (Purcell et al., 2016a).

More specifically, *Thelenota ananas* is listed as Endangered under IUCN criteria because it is commercially exploited throughout its range for its medium-high value as beche-de-mer. The population trend is declining, and IUCN estimates that populations have declined by 80-90% in at least 50% of the species' range, and populations are overexploited in at least 30% of its range (Conand et al., 2013a). Declines and overexploitation have occurred primarily since the 1960s, and although generation length is not known, echinoderms are not considered to go through senescence, and therefore generation length may exceed several decades. There is a high level of concern for *T. ananas* (Bruckner, 2006; Purcell, 2014; Mulochau, 2018).

Thelenota anax is a relatively uncommon species, often occurring in low abundance. IUCN assessed the species as Data Deficient; however, the species has been heavily targeted in fisheries in recent decades as stocks of other species have declined (Conand et al., 2013c). This is the largest sea cucumber species in the world by body weight (Purcell et al., 2012) and thus easily harvested and is also likely to have longer lifespan. IUCN considers populations *T. anax* "very vulnerable to overexploitation" and recommends that "exploitation of this species should be avoided" (Conand et al., 2013c).

Thelenota rubralineata is considered very rare. IUCN assessed the species Data Deficient, as little is known about its biology and population status (Conand et al., 2013b; Lane, 1999). It is exploited in most of its range, but it is difficult to quantify the fishery's scale due to the lack of statistics (Kinch, 2005). However, given the species' rarity and the fact that it is likely to be slow-growing and long-lived, *T. rubralineata* is considered "likely very vulnerable to overfishing" according to IUCN (Conand et al., 2013b).

All three sea cucumber species in the genus *Thelenota* qualify for Appendix II.

3. Species characteristics

3.1 Distribution

Thelenota ananas is widely distributed throughout the Indo-Pacific, excluding Hawaii. It occurs in Australia, Bangladesh, Brunei Darussalam, Cambodia, Mainland of China, Cocos (Keeling) Islands, Comoros, Cook Islands, Djibouti, Egypt, Eritrea, Fiji, French Polynesia, Guam, India, Indonesia, Islamic Republic of Iran, Israel, Japan, Jordan, Kenya, Kiribati, Madagascar, Malaysia, Maldives, Marshall Islands, Mauritius, Mayotte, Mozambique, Myanmar, New Caledonia, Niue, Oman, Pakistan, Palau, Papua New Guinea, Philippines, Réunion, Samoa, Saudi Arabia, Seychelles, Singapore, Solomon Islands, Somalia, South Africa, Sri Lanka, Sudan, the island of Taiwan, United Republic of Tanzania, Thailand, Tonga, Tuvalu, United States of America (Northern Marianas Islands), Vanuatu, Viet Nam and Yemen (Conand et al., 2013a; Kinch et al., 2008).

Distribution of *T. ananas*, IUCN (2012). The IUCN Red List of Threatened Species. Version2020-2

Thelenota anax occurs throughout the Indo-Pacific. It occurs in Australia, Bangladesh, Brunei Darussalam, Cambodia, Mainland of China, Christmas Island, Comoros, Cook Islands, Djibouti, Federated States of Micronesia, Fiji, French Polynesia, Guam, India, Indonesia, Japan, Kenya, Kiribati, Madagascar, Malaysia, Maldives, Marshall Islands, Mauritius, Mayotte, Mozambique, Myanmar, Nauru, New Caledonia, Niue, Oman, Palau, Papua New Guinea, Philippines, Réunion, Samoa,Seychelles, Singapore, Solomon Islands, Somalia, South Africa, Sri Lanka, the island of Taiwan, United Republic of Tanzania, Thailand, Tokelau, Tonga, Tuvalu, United States of America (American Samoa and Northern Marianas Islands), Vanuatu, Viet Nam, Wallis and Futuna and Yemen (Conand et al., 2013c).

Distribution of *T. anax*, IUCN, 2012. The IUCN Red List of Threatened Species. Version 2020-2

Thelenota rubralineata is found only in the east Pacific; it has not been identified in the Indian Ocean(Kinch., 2005; Lane, 2008), unlike the other two *Thelenota* species. *T. rubralineata*'s range includes Australia, Mainland of aChina, Cook Islands, Fiji, Guam, Indonesia, Malaysia, Federated States of Micronesia, New Caledonia, Palau, Papua New Guinea, Philippines, Solomon Islands, the island of Taiwan,Timor-Leste, United States of America (Northern Mariana Islands) and Vanuatu (Conand et al., 2013b).

Distribution of *T. rubralineata*, IUCN, 2013. The IUCN Red List of Threatened Species. Version 2020-2

3.2 Habitat

T. ananas is found along slopes and passes within reef zones (Kinch et al., 2008) and along outer reef flats to depths of 35 m but is more common in waters from 10-20 m. The species prefers rubble and hard bottoms covered with a layer of coral sand (Conand et al., 2013a).

T. anax is often found in low abundance and usually at depths between 10-30 m but may occasionally be found in shallower waters to about 4-5 m (Purcell et al., 2012; Hammond et al., 2020). It generally occurs on hard ground, large rubble and coral sand patches, on reef slopes, outer lagoons and near passes (Conand et al., 2013c; Kinch et al., 2008). Some specimens can be found onthe sides of reef slopes (Purcell et al., 2012).

T. rubralineata is a rare, reef-associated species, usually inhabiting the outer reef slope from a depth of 20 m (Lane, 1999; Lane, 2008; Conand et al., 2013b).

3.3 Biological characteristics

T. ananas is a large, conspicuous species, with low potential fecundity, relatively low weight gonads and late sexual maturity, making it vulnerable to overfishing (Conand et al., 2013a; Conand, 1998). The species' generation length is unknown. It is believed that many echinoderms do not go through senescence and simply regenerate. Therefore generation length cannot be estimated but may be greater than several decades (Conand et al., 2013a).

In Guam, *T. ananas* reproduces almost year round, except in March, September and October, and in New Caledonia, it has an annual reproductive cycle from January to March (Kinch et al., 2008), marked by one single spawning period during the warm season (Conand, 1981). *T. ananas* larvae are planktonic; juveniles and adults are benthic epibiontic, i.e., lives on the surface of another organism (Conand et al., 2013a). The epithelium of the gonads contains a red pigment which often makes it difficult to determine the sex, and it also contains several spicules similar to those of the body wall (Conand, 1981).

T. anax is the largest of the commercial sea cucumbers species but little is known about its biology (Conand et al., 2013c), including its reproductive biology (Purcell et al., 2012; Hammond et al., 2020). As with the other *Thelenota* species, body size is not a good indicator of age or longevity; the generation length of *T. anax* is therefore unknown but is assumed to be greater than several decades (Conand et al., 2013c).

T. rubralineata is a large, colorful sea cucumber and likely long-lived (Conand et al., 2013b; Lane, 2008). Its reproductive parameters, including age at maturity, generation length and productivity are unknown (Lane, 2008; Purcell et al., 2012). As with *T. anax*, the species' generation length is unknown but is assumed to be greater than several decades (Conand et al., 2013b).

3.4 Morphological characteristics

The three *Thelenota* species are distinguishable from other sea cucumber species, due in part to their large papillae. FAO has published an identification guidebook on commercially valuable sea cucumbers, including taxonomy, biology, distribution and exploitation (Purcell et al., 2012). The Secretariat of the Pacific Community (SPC) has also produced identification cards for Pacific Islands sea cucumber species (SSC, 2004).

Holothurians are soft-bodied echinoderms, characterized by their lack of segmentation, an endoskeleton of calcareous ossicles and a body cavity with complex chambering forming the water-vascular system where respiration, locomotion and sensory function are combined. The body symmetry is typically pentaradial with a secondary bilateral symmetry (Conand, 2006b). *Thelenota* species can be distinguished from other species of sea cucumbers as follows:

T. ananas is probably one of the largest sea cucumbers in the world by weight, with an average length of 45 cm but a maximum length of 80 cm, and an adult body weight often exceeding 5 kg (Purcell et al., 2012). The species varies in colour, with the dorsal side ranging from reddish-orange to brown or burgundy and the ventral side light pink to red. The dorsal side is covered with large, long and conspicuous papillae. The body is firm and rigid and is arched dorsally and flattened ventrally. The mouth ventral has 20 large, brown tentacles. For ossicles, the species has tentacles with large plates, 135 µm long and 95 µm wide, as well as some smaller rods (Purcell et al., 2012). Processed, *T. ananas* is 20-25 cm long, relatively elongate and brown to black in color. The dorsal surface is covered in brown to black-brown spikes, often in a star shape (Purcell et al., 2012).

T. ananas (live) iNaturalist ©Albert Kang

T. ananas (processed), photo by: J. Akamine

T. anax is also large, with an average length of 63 cm but a maximum length of 89 cm (Purcell et al., 2012). Its colour varies from creamy white beige to grey or light brown with dark brown and/or reddish spots and blotches dorsally. Those in the Indian Ocean may lack the reddish blotches.

T. anax also has large papillae located laterally on its body. Numerous light coloured, wart-like bumps occur mostly in rows along either side of the dorsal surface. The flat ventral surface is densely covered with fine, long podia. The species has a thick body wall, and the mouth is ventral with 18-20 tentacles. For ossicles, the species has tentacles with nodulous and branched rods, and perforated plates, 80-100 µm long (Purcell et al., 2012).

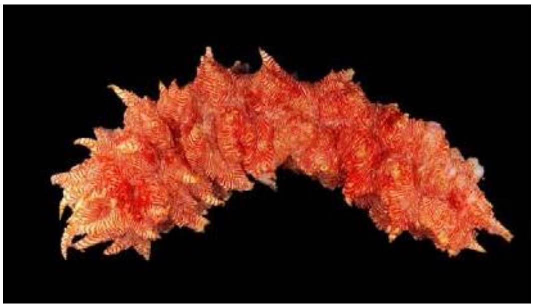
In its dried form, *T. anax* is 15-20 cm long, relatively elongate with a squarish cross-section, and brown in color. The dorsal surface is rough and covered with wart-like bumps. The ventral surface is grainy (Purcell et al., 2012).

T. anax (live) ©*Bernard DUPONT.* Wikimedia Commons

T. anax (processed) photo by: S.W. Purcell

T. rubralineata is also a relatively large sea cucumber, with an average length of 30-50 cm (Purcell et al., 2012). The species' appearance is striking: it is whitish with a complex pattern of crimson lines in a maze-like arrangement. Dorsally, the species has two rows of 13-15 large, conical, fleshy protuberances with pointed papillae at the ends, with yellowish brown tips. The body is roughly square or trapezoid in transverse section, and the posterior part of the body tapers slightly. The ventral surface is flattened and has numerous greenish-yellow or brownish-yellow podia scattered randomly. The mouth is ventral with 20 dull-red tentacles. For ossicles, the species has tentacles with only rods, which can be spiny or smooth, straight or curved, 10-150 µm long (Purcell et al., 2012).

T. rubralineata's processed appearance is generally brown, with a relatively elongate body and the characteristic large, pointed protuberances retained on the dorsal surface (Purcell et al., 2012).



Live *T. rubralineata* (left) ©François Michonneau. Wikimedia Commons. Processed *T. rubralineata* (right) photo by: L.B. Concepcion.

3.5 Role of the species in its ecosystem

Holothuroids (i.e., class Holothuroidea) feed on the sea bottom, reducing the organic load and redistributing surface sediments, making them bioremediators by enhancing the productivity of sea bottom life (Purcell et al., 2016a). This form of nutrient recycling is crucial in ecosystems with low nutrient levels. Feeding and excretion by sea cucumbers also increase seawater quality and alkalinity, which contributes to local buffering of ocean acidification. The extirpation of holothuroids has also resulted in the hardening of the sea floor, thereby eliminating potential habitat for other benthic organisms (Bruckner et al., 2003).

A recent study showed that *T. anax* is particularly efficient at processing reef sediments (Hammond et al., 2020), reworking 34 g dry weight of sediment per hour and contributing to bioturbation of half a kilogram of sediments per day. The sediment turnover by this species "surpasses those of other holothuroid deposit feeders," making it the most significant in this taxonomic class for sediment bioturbation on coral reefs and lagoons (Hammond et al., 2020).

Sea cucumbers are known to be consumed by diverse predators from at least seven phyla, including 19 species of seastars, 17 crustaceans, several gastropods and around 30 species of fish (Purcell et al., 2016a), although there is little information regarding predators of the *Thelenota* species. For predators that rely heavily on sea cucumbers as a food source, depletion of sea cucumber populations is likely to have a negative impact (Pucell et al., 2016a). Thus, overexploitation of sea cucumbers like *Thelenota* species may result in a loss of biodiversity or abundance of these predator species or cause them to switch to other prey species, with potential cascading effects in the ecosystem (Purcell et al., 2016a).

T. ananas are also important hosts for species, including the pearl fish *Carapus homei, C. boraborensis*, *Encheliophis vermicularis* and *E. gracilis* (Eeckhaut et al., 2004), and in doing so, enhances the biodiversity in the reef ecosystem.

T. rubralineata's specific role in the ecosystem is poorly known.

4. Status and trends

4.1 Habitat trends

The three *Thelenota* species are all reef-associated and will be impacted by declining trends in reef habitat health. The world's coral reefs are under threat from overfishing and destructive fishing (including the use of explosives and cyanide), sediment pollution, nutrients and pesticides, coastal development and increased ocean temperatures and acidity due to climate change (WWF, 2015). If warming and acidification of the oceans reach the levels currently projected, coral reefs may disappear completely by 2050 (Hoegh-Guldberg et al., 2015). Recent studies indicate that coral reefs have lost more than half of their hard corals (reef builders) over the past 30 years (Hoegh-Guldberg et al., 2015), and, globally, it has been estimated that three quarters of the world's coral reefs are now threatened (WWF, 2015).

4.2 Population size

Published population surveys and fisheries statistics for *Thelenota* species remain relatively limited; however, available data suggest declines.

Thelenota ananas is considered more common than the other *Thelenota* species (Pinca et al., 2010); however, the species is now less prevalent in some regions. Within the Pacific, in New Caledonia, 6 individuals per hectare were found in the species' most preferred habitat (Conand et al., 2013a; Purcell et al., 2009; Andréfouët & Tagliaferro, 2020). In French Polynesia, the species is present but "in low numbers" following the lifting of a sea cucumber fishing moratorium (Andréfouët et al., 2019), with densities of 7.13 indiv./ha (Andréfouët & Tagliaferro, 2020). The species was reported to be found in low numbers in the Solomon Islands and in great abundances in the Federated States of Micronesia in 1985 (Conand et al., 2013a).

In East Africa, *T. ananas* is heavily exploited, though few statistics are available. In Eritrea, scientists estimated a population density of 3.5 indiv./ha (Conand et al., 2013a; Kaeleb et al., 2008). In Madagascar and Seychelles, the species has become increasingly rare (Conand et al., 2013a). In the Torres Strait, where there is a quota for this species, a stock survey conducted in 2019-2020 found an average density over four zones of 1.73 indiv/ha (Murphy et al., 2021) which was noted to be lower than earlier surveys (ranging from 1.81 to 2.41 indiv/ha), but was generally consistent with densities of 1-2 indiv./ha reported elsewhere Conand et al., 2013a; Skewes, 2010). *T. ananas* was recorded at 8 of 74 survey sites in Guam; Catch Per Unit Effort was found to be low in comparison to other species (Kerr et al., 2017).

Thelenota anax is considered relatively uncommon (Pinca et al., 2010) and is generally found at low densities (Conand et al. 2013c). In French Polynesia, surveys found *T. anax* but "never in high densities" (less than 0.2 of individuals per diving minute) except in areas that had "never [been] fished" (Andréfouët, 2019). In Papua New Guinea, densities decreased from 1 to 0.7 indiv./ha from 1992 to 2006 (Conand et al., 2013c; Kaly et al., 2007). This species was reported to be heavily exploited in Indonesia with densities from 2.5 to 7.6 indiv./ha (Lane & Limbong, 2015). Surveys in French Polynesia found densities lower than 0.5 individuals per minute diving in 23 islands and atolls in Society, Tuamotu and Gambier archipelagos (Andréfouët et al., 2019). In Samoa, this species was not found in any surveys (Vunisea et al., 2008). In Tonga, surveys in 1996 showed densities of 3.57 ± 1.55 indiv./ha. Following a moratorium on fishing and export of sea cucumbers, a 2019 survey found 9.2 ± 2.71 indiv./ha, though scientists recommend the moratorium continue to allow for further recovery (Shedrawi, 2020). The species was found "infrequently" in New Caledonia, with an average density of 14 indiv./ha (Conand, 2006). Surveys in Sri Lanka found 26 indiv./ha (Dissanayake & Stefansson, 2012). *T. anax* was found at only one site during a survey of 74 sites in Guam and was not considered a locally abundant species (Kerr *et al*., 2017).

Thelenota rubralineata is rare and not often found in fishery resource surveys (Pinca at el., 2010). In French Polynesia, *T. rubralineata* is not commonly found (Andréfouët, 2019). In Indonesia, wild population survey densities were recorded as 1 indiv./220m^2, but generally the species is found in densities of less than 1 indiv./ha (Conand et al., 2013b; Lane, 1999). In Papua New Guinea, the species was found at less than 0.1 indiv./ha, and only 4 specimens were found in 1000 survey dives (Conand et al., 2013b; Skewes et al., 2002; Kinch 2005). Other reports in PNG indicate that *T. rubralineata* is rarely observed during major sea cucumber stock assessments. For example, just 4 specimens of *T. rubralineata* were recorded during large-scale surveys (1126 dives over an area of 256,000 km^2) carried out throughout the province of Milne Bay, and only one individual was observed at Yap during a stock assessment conducted at depths of over 60 m (Lane, 2000). The highest densities recorded were at a single reserve in the Solomon Islands with 45 indiv./ha (Lane, 2008). *T. rubralineata* is rare in Guam, having been seen only once (Kerr *at al.,* 1992 cited in Kerr *et al.,* 2017).

Population declines over broad geographic ranges were sufficiently serious to result in the listing of 13 holothuroid species as vulnerable or endangered with extinction (Purcell et al., 2016c). Exploitation by fishing may have a cascading impact on biodiversity because depletions in host sea cucumber populations will also deplete symbiont populations (Purcell et al., 2016a).

4.3 Population structure

Little is known about the *Thelenota* species' population structure. Juvenile sea cucumbers are rarely observed in the field (Conand, 1989; Sweet et al., 2016), as they can be obscured from view within sediments or crevices or beneath coral, and occupy different habitats than larger specimens (Shiell, 2004).

4.4 Population trends

Increasing demand for sea cucumbers has fueled over-exploitation around the globe. Many sea cucumber stocks worldwide are overfished because of their high value and ease of capture. Overfished areas include Indonesia, Malaysia, Papua New Guinea, Solomon Islands, New Caledonia, Australia, Egypt, Madagascar, Fiji and the Philippines (Jontila et al., 2018). Nations report an increasing difficulty in finding commercial sea cucumbers (Rahardjanto et al., 2020).

All three *Thelenota* species are commercially exploited. Like many sea cucumber species, *T. ananas* has suffered substantial declines across its range, and the rarity, price and suspected life histories of *T. anax* and *T. rubralineata* suggest high vulnerability to overexploitation (Conand etal., 2013a; Conand et al., 2013b, Conand et al., 2013c,).

<u>Thelenota ananas</u>

According to IUCN's 2013 assessment, *T. ananas* is Endangered. It is depleted in at least 50% of many parts its range (Philippines, PNG, India, Indonesia, Madagascar) and overexploited in the majority if its range (Conand et al., 2013a). The 2006 CITES workshop on sea cucumbers expressed a "[h]igh level of concern" for the species, finding it "[g]enerally overfished" (Brucker, 2006).

In New Caledonia, *T. ananas* has declined more than 60% over the past 30 years, with 10-30 indiv./ha found in 1980s, compared to just 6 indiv./ha found in the most preferred habitat in themost recent survey (Conand et al., 2013a; Purcell et al., 2009). In Tonga, deep-water occurrence declined from 48 in 1984 (1 h search period at 21 sites) to just 4 in 2004 (100 m transects, even after a fishing moratorium) (Friedman et al., 2011). In French Polynesia, the species was reported to be present "but in low numbers" following the lifting of a sea cucumber fishing moratorium (Andréfouët et al., 2019). In the Torres Strait, density had been stable at 1-2 indiv./ha (Conand, et al. 2013a; Skewes, 2010), however anecdotal reports suggested at least localized depletions (Murphy et al., 2021).

T. ananas populations throughout much of Asia are also considered overexploited and populations severely depleted (Purcell, 2010). In India, catch per unit effort and size of specimens dramatically declined (Conand et al., 2013a; Bruckner et al., 2003).

In the Red Sea, densities decreased dramatically from 48.1 indiv./100 m^2 in 2000 to only 5.6 indiv./100 m^2 in 2006, and the species was not recorded in 2016 (Hasan, 2019). In Indonesia, it is heavily exploited (Conand, 2008), but there are few available statistics. In Madagascar and Seychelles, thespecies was reported to be becoming increasingly rare (Conand et al., 2013a).

Thelenota anax

Naturally relatively uncommon, *T. anax* is increasingly being targeted in fisheries as other species decline (Conand et al., 2013c; Choo, 2008; Pinca et al., 2010). While few published surveys are available, data reveal likely declines in some locations. For example, in Papua New Guinea, densities decreased from 1 to 0.7 indiv./ha between 1992 and 2006 (Conand et al., 2013c; Kaly et al., 2007). In Malaysia, reports suggest a decrease in population and average size of the species (Choo, 2008). In Tonga, occurrence in deep areas varied over a 20-year period, from 48 occurrences in 1984 (1 h search period at 21 sites) when the fishery was inactive, to 21 in 1996 during an active fishery, to 41 in 2004 (100 m transects, even after a fishing moratorium), 7 years after a moratorium (Friedman et al., 2011).

IUCN has concluded that *T. anax* is "potentially very vulnerable to overexploitation" and has recommended that "the exploitation of this species should be avoided" (Conand et al., 2013c).

Thelenota rubralineata

T. rubralineata is rare and is only infrequently identified in surveys throughout its range (Pinca et al., 2010). However, "due to its rarity and low population densities," the species is "extremely vulnerable to overexploitation" (Kinch., 2005). IUCN has similarly concluded that "[g]iven the rarity of this species and the fact that it is slow-growing and long-lived, it is likely very vulnerable to overfishing" (Conand et al., 2013c).

4.5 Geographic trends

See section 4.4.

5. Threats

The main threat to sea cucumber populations is overfishing to supply the international for beche-de-mer market (Bruckner, 2006; Conand, 2006b; Conand, 2018). Beche-de-mer is the product after gutting, cooking, salting and drying sea cucumbers. Demand is primarily in Asia. Sea cucumbers are one of the five primary luxury foods consumed at festive dinners, along with bird nests, abalone, swim bladder, and shark fin (Purcell, 2014).

The volume of sea cucumber harvests began to increase in the late 1980s in Southeast Asia and the South Pacific in response to increasing international demand (CITES, 2002). There are no *Thelenota* harvesting statistics, however overall, global catch and production (including aquaculture) of sea cucumber fisheries has increased 13- and 16-fold over thepast two to three decades (Anderson et al., 2011). Prices have risen: two studies concluded that market prices across the species studied increased six- to twelve-fold over a decade (Purcell, 2014; Jontila, 2018). According to Purcell et al. (2013), ten percent of global sea cucumber fisheries were reported as depleted, 38% over-exploited, and 14% fully exploited.

For sea cucumbers, extinction risk is primarily driven by high market value, as well as accessibility of harvest (often dependent on shallowness of their habitat) and how well-known the species is in the marketplace (Purcell, 2014). Strong fishing pressure causes a decrease in species biomass density,and populations are unable to replenish once they have fallen below critical mass. As gonochorist broadcast spawners, sea cucumbers are particularly vulnerable to the Allee effect, which is characterized failure of reproductive output associated to insufficient density of ripe individuals (Courchamp et al., 2006; Bell et al., 2008). Likewise, despite their commercial importance, little is knownabout their biology, ecology and population dynamics. This lack of scientific information constitutes an indirect threat, since it is essential for management plans and harvesting regimes (Toral-Granda, 2006).

The *Thelenota* sea cucumbers are medium-to-high value species, are relatively easy to capture andare vulnerable to overexploitation due to their life history. Their primary threat is overexploitation for the international beche-de-mer trade.

Thelenota ananas is one of highest value sea cucumber species in international trade, sold for as much as USD 219 per kilogram (Purcell et al., 2018). IUCN assessed the species as "Endangered" on its Red List. It is targeted throughout its range, and fishing pressure has dramatically increased in the past 25 to 50 years and is expected to continue, even as stocks are depleted. According to IUCN, this species is considered depleted in at least 50% of many parts of its range and is considered overexploited in the majority if its range (Conand et al., 2013a).

Thelenota anax is the largest of the commercial sea cucumber species. It is lower value than *T. ananas* but prices are increasing: in Chinese markets, *T. anax* sold for USD 31 per kilogram on average in 2016, a 70% price increase from 5 years prior (Purcell et al., 2018). In Sri Lanka and Fiji,*T. anax* is considered a “medium value” species (Dissanayake & Stefansson, 2012; Mangubhai et al., 2017). It was once considered non-commercial but has become an increasingly important species in the past 20 years, as stocks of other species have been depleted (Conand et al., 2013c).

T. anax is considered naturally uncommon. Rare species may be reproductively precarious and thus vulnerable to overexploitation (Purcell, 2013). It is now being collected by skin diving or using diving gear, making the populations potentially very vulnerable to overexploitation. While more biological data needs to be collected on the species, the IUCN has concluded “the exploitation of this species should be avoided” (Conand et al., 2013c).

Thelenota rubralineata is not one of the most commercially important species, likely due to its rarity, but the species is expected to become more popular after the depletion of other species of higher commercial importance and value (Conand et al., 2013c). The species is commercially harvested in PNG, the Solomon Islands and the Philippines (Conand et al., 2013c; Jontila et al., 2018; Govan, 2017). While little price information is available, it is sold within the Philippines for prices close to those fetched for *T. ananas* (Jontila, 2018), suggesting *T. rubralineata* is also a medium-to-high value species. *T. rubralineata* is “extremely vulnerable to overexploitation” due to its rarity and low population densities (Kinch, 2005).

6. Utilization and trade

6.1 National utilization

Thelenota ananas: This species is commercially harvested throughout much of its range, as it is a high-value sea cucumber. In the Western Pacific Region, the species is commercially exploited in Palau, Federated States of Micronesia, Nauru, Kiribati, Tuvalu, Wallis and Futuna, Samoa, Tonga, Niue, Cook Islands, French Polynesia, PNG, Solomon Islands, Vanuatu, New Caledonia, Fiji and Australia (Conand et al., 2013a). It is an important species harvested in Tuvalu and New Caledonia (Conand et al., 2013a).

In some localities in the Pacific, this species is consumed in traditional diets or in times of hardship (i.e., following cyclones) (Purcell et al., 2012). There is subsistence fishery in Samoa and Cook Islands (Kinch et al., 2008).

In Asia, this species is commercially exploited in China, Japan, Malaysia, Thailand, Indonesia (heavily fished), Philippines and Viet Nam (Conand, et al. 2013a; Choo, 2008). In Africa, it is among the most commercially important species in Madagascar (Conand, 2008) and is also fished in Eritrea and Seychelles; in the latter it is considered fully exploited (Aumeeruddy & Conand, 2008; Conand, 2008). In Kenya, this species represents 10% of the catch of the sea cucumber fisheries (Muthiga et al., 2007). It is also fished in Maldives (Bruckner, 2006).

Thelenota anax: This species is increasingly being targeted in fisheries as the stocks of other species decline. However, little information or data exist to adequately assess fishing levels (Conand et al., 2013c). *T. anax* is exploited in the Indo-Pacific (Purcell et al., 2012), including in Fiji and Tonga (Purcell et al., 2016). In Fiji, exporters indicated that *T.anax* was the most exported species by volume in 2014 (Purcell, 2014; Govan, 2017). It is alsocommercially harvested in Sri Lanka, Kenya and Seychelles (Dissanayake & Stefansson, 2012; Conand & Muthiga, 2007), is considered a commercially important species in China, Indonesia and Malaysia (Choo, 2008).

Thelenota rubralineata: While historically there has been little trade in *T. rubralineata* due to its naturally very low population densities, the species is now commercially exploited in the Indo-Pacific (Purcell et al., 2012), including in Papua New Guinea and the Solomon Islands (Kinch , 2005; Kinch et al., 2008). There are few trade statistics on the species, as export figures are not recorded at the species-level in some nations (Kinch, 2005). In the Philippines, it is a consumed during the Ramadan season (Choo, 2008).

6.2 Legal trade

Import/export data is limited for *Thelenota* sea cucumbers; however, most sea cucumbers in international trade are exported to Hong Kong SAR, then redistributed to consumer nations (Purcell, 2014). The main import markets are traditionally Mainland of China, Hong Kong SAR, Singapore and the island of Taiwan; recently, however, demand has been rising in other Southeast Asian countries and beyond, including the United States of America (Baker-Médard & Ohl, 2019; Alejandro, 2019).

Regionally, the Central West Pacific is the main exporter of sea cucumbers with Indonesia and the Philippines as the top exporters (Conand, 2018). The legal beche-de-mer trade is lucrative and provides a source of income for many fishers (Baker-Médard & Ohl, 2019). Overall, global catch and production (including aquaculture) of sea cucumber fisheries has increased 13- and 16-fold over the past two to three decades (Anderson et al., 2011; Purcell, 2013). The CITES MA of Australia (*in litt.* to European Commission, 2022) noted that whilst there is some traditional use of the sea cucumbers domestically, the commercial catch from the country is exported primarily from the Queensland fishery to Hong Kong SAR as dried or frozen product, with small quantities of sea cucumber (including *T. ananas*) harvested and exported live for aquarium display purposes from Western Australia. *T. ananas* harvests included 40 t in Queensland (2019-2020) and 15.7 t in the Torres Straight in 2020 (CITES MA of Australia, *in litt.* to European Commission, 2022); It was reported that 9.3% of exports from the Queensland Fishery comprised *T. ananas* (Wolfe and Byrne, 2022).

There are no reliable estimates of the volume of *Thelenota* species in international trade. Sea cucumbers are frequently traded without species-level identification and under-reporting is common. Globally, reported exports are less than half of reported imports (Baker-Médard & Ohl, 2019).

6.3 Parts and derivatives in trade

Foodstuffs: As with most sea cucumbers, *Thelenota* spp. are primarily consumed as food. These sea cucumbers are typically traded dried as beche-de-mer, trepang or haishen, though sea cucumbers are sometimes traded salted, smoked or frozen (Toral-Granda et al., 2008). In Japan, sea cucumbers are also consumed fresh or fermented (Toral-Granda et al., 2008).

Medicinal products: Sea cucumbers are also used as medicines in parts of Asia, used to treat weakness, malnutrition, constipation, kidney disorders and frequent urination (Rahman, 2020). Emerging research shows sea cucumbers are rich in bioactive chemicals (Rahman, 2020). While there are currently no publications confirming pharmaceutical use of *Thelenota* species, *T. ananas* has been noted to contain large amounts of sulfated poly-saccarides, of potential pharmaceutical interest (Pangestuti & Arifin, 2018).

Live in the aquarium trade: *T. ananas* is also harvested for the aquarium trade (Conand, 2013); however, the volume of trade is unknown, as it is considered underreported (Kinch et al., 2008).

Sea cucumbers continue to be widely exploited because of their perceived unique biological and pharmaceutical properties. More recently, there is also an emerging market for the use of sea cucumbers in cosmetic industries (Siahaan et al., 2007). However, the pharmaceutical and cosmetic products that contain sea-cucumber extract do not typically reference the source species.

6.4 Illegal trade

Illegal trade in sea cucumbers is known to occur generally (Conand, 2006b; Louw & Bűrgener, 2020; Purcell, 2013); however, there is little documentation of illegal trade in *Thelenota* species specifically. In 2020, India seized 22 dried sea cucumbers including *T. ananas* with an estimated value of US$27,000 (The Hindu, October 7, 2020; Hindustan Times, October 7, 2020; SPC Beche-de-mer Information Bulletin #41, March 2021).

Illegal trade in sea cucumbers is difficult to detect because of the complexity of trade routes, frequently involving subsequent export; shipments often include multiple species; and fishing prohibitions are often area-specific (Bruckner, 2006). Recent seizures have found dried sea cucumbers being transported alongside other high-value wildlife, including pangolin scales, ivory, abalone and seahorses (Louw & Bűrgener, 2020).

Illegal, unreported and unregulated (IUU) sea cucumber harvesting is known to occur in the Australian Fishing Zone, but exact levels of IUU harvesting are unknown (CITES MA of Australia (*in litt.* to European Commission, 2022). Reported IUU incidents in Australian waters over the past decade include the seizure of 860 kg sea cucumber from 19 Indonesian fishing vessels in 2022 (AFMA, 2021); the interception of a Vietnamese fishing vessel with a "substantial amount" of sea cucumber on board (AFMA, 2017); and the discovery of six tonnes of sea cucumber on board two Vietnamese vessels in 2016 (AFMA, 2016). It was not specified whether these seizures comprised fresh or dried product. The CITES Authorities of the United States of America (*in litt.* to European Commission, 2022) noted that smuggling of sea cucumbers in American Samoa occurred but was considered rare.

6.5 Actual or potential trade impacts

Overexploitation for the beche-de-mer trade has caused *T. ananas* to decline by 80-90% in at least 50% of its range, and the species is considered "Endangered" by the IUCN (Conand et al., 2013a). Declines and overexploitation have occurred primarily since the 1960s. The report on the 2006 CITES sea cucumber workshop reported a "high level of concern" for *T. ananas* populations (Bruckner, 2006). It is fished throughout its range, and fishing pressure has dramatically increased since the 1960s and is expected to continue. Trade is the primary threat and unregulated international trade is likely to lead to further declines to an already readily declining species.

Thelenota anax is rare throughout its Indo-Pacific range. The IUCN currently considers the species Data Deficient; however, the species is increasingly being targeted for fisheries (Conand et al., 2013c). IUCN consider this large sea cucumber "very vulnerable to overexploitation" and recommends that "exploitation of this species should be avoided" (Conand et al., 2013c).

Thelenota rubralineata is considered very rare. It is exploited in some parts of its range, but it is difficult to quantify the scale of the fishery due to the lack statistics. Given the rarity of this speciesand the fact that it is slow-growing and long-lived, IUCN considers the species to be "likely very vulnerable to overfishing" (Conand et al., 2013b).

The inclusion of these species in Appendix II will allow continued trade, supporting the interests of fishermen, exporters and importers, while preserving these species and thereforetheir important ecological role for future generations (Bruckner et al., 2003).

7. Legal instruments

7.1 National

There are numerous domestic restrictions throughout the species' ranges that apply generally to sea cucumbers (Baker-Médard & Ohl, 2019); however, the literature discusses few legal instruments that are specific to the *Thelenota* species. Some of the general sea cucumber restrictions include the measures outlined below:

Numerous countries have instituted **fishing moratoria and area closures** in response to overexploitation (Baker-Médard & Ohl, 2019). In India, sea cucumber fishing has been prohibited since 2001, when all sea cucumbers were listed in Annex I of India's Wildlife Protection Act (Nithyanandan, 2003). In French Polynesia, a 2012 moratorium banned sea cucumber fishingdue to overexploitation; since the ban was lifted, management measures now restrict fishing incertain locations and require monitoring of exports (Andréfouët et al., 2019). Tonga instituted amoratorium in 1996, which was lifted and then reinstituted due to continued overfishing (Pakoa et al., 2013). In Guam, no commercial export is allowed and local harvests are restricted to a daily limit; subsistence harvests are also permitted in American Samoa but commercial fishing and trade is prohibited (CITES Authorities of the United States of America *in litt*. to European Commission, 2022). A moratorium on fishing of sea cucumbers has been in place in the Northern Mariana Islands since 1998 (CITES Authorities of the United States of America *in litt*. to European Commission, 2022). In the Philippines, there is a **size limit** for harvesting sea cucumbers (Alejandro, 2019; Jontila, 2018). In the Federated States of Micronesia, a sea cucumber management plan sets **weight restrictions** and **export volume restrictions** (Baker-Médard & Ohl, 2019). Madagascar, Fiji, Kenya, Seychelles, Solomon Islands and Vanuatu set **gear restrictions**, such as prohibiting the use of SCUBA for harvesting sea cucumbers (Baker-Médard & Ohl, 2019; Mangubhai et al., 2017). Papua New Guinea has set a species-specific **Total Allowable Catch (TAC)**, requires licensing, and prohibits the use of SCUBA (Baker-Médard & Ohl, 2019). Seychelles also requires licensing and compliance with management measures (Baker-Médard, 2019).

In Australia, commercial harvest and export of sea cucumbers is regulated through the Environment Protection and Biodiversity Conservation (EPBC) Act. There are five commercial sea cucumber fisheries in the country, all of which have been assessed by the Australian Government as ecologically sustainable (CITES MA of Australia, *in litt.* to European Commission, 2022). In Queensland, Australia, the fishery has been managed by quotas since 1991 with a total allowable commercial catch (TACC). The TACC is allocated amongst individual transferable quota (ITQ) units for black teatfish, white teatfsh and other sea cucumber. The TACC is adjusted according to the decision rules in the harvest strategy each year. Size limits for the species are 50 cm in Queensland, 35 cm in the Torres Straight, and 30 cm in Northern Territory and Western Australia (CITES MA of Australia, *in litt.* to European Commission, 2022). Other harvest controls used by Australia include size limits, as well as temporal, spatial and gear restrictions (CITES MA of Australia, *in litt.* to European Commission, 2022). In 2021, the Australian Government identified concerns and uncertainties with regards to the Queensland fishery, and outlined ten new conditions, including independent surveys and stock assessments for *T. ananas,* alongside other sea cucumber species (*Stichopus herrmanni, S. vastus* and *Actinopyga palauensis*) (DAWE, 2021).

T. ananas: Palau instituted an **export moratorium** for *T. ananas* in 1994 (Friedman et al., 2011). In the Maldives, the Bay of Bengal programme recommended a 4-5 yr **ban on take** of *T. ananas*, and night fishing is discouraged (Conand, 2006). In Papua New Guinea, there is a **minimum size limit** (Conand et al., 2013a). In New Caledonia, there is also a **legal minimum length**, **gear restrictions** (collectionusing compressed air diving is prohibited) and there are **no-take reserves** (Conand et al., 2013a). In Queensland, Australia, the fishery is regulated by limited access, combined ITQ, vessel and tender restrictions, number of divers 'to take' restrictions and rotational harvest arrangement. The TAC is 40 tonnes (Queensland sea cucumber fishery harvest strategy: 2021–2026).

T. anax* and *T. rubralineata: The TAC for *T. anax* in Queensland Australia is 50 tonnes. However, there are no other known species-specific conservation measures for these species at this time. Both species may be present in some marine protected areas within their range (Conand et al., 2013c).

7.2 International

There is currently no existing international instrument to legally protect *Thelenota* species. Scientists have stated that "international regulations that control trade (such as CITES Appendix II) may be one of the best hopes for the conservation of highly valued sea cucumber populations" (Anderson et al., 2011).

8. Species management

8.1 Management measures

While Holothurian fisheries are still not regulated in a number of countries, some nations have adopted management measures to avoid overfishing. Baker-Médard & Ohl (2019) identified seven categories of sea cucumber management used globally: Details of where these measures have been implemented in range States of *Thelenota* spp. can be found in section 7.1.

− **Prohibited fishing zones:** around the world, fishing zones are recognized for the benefits they bring to exploited species. Numerous countries have instituted area closures in response to overexploitation (Baker-Médard & Ohl, 2019). In Egypt, areas where fishing was prohibited had a greater diversity and density of several commercial species of sea cucumbers (Lawrence et al., 2005).No-fishing areas can be beneficial especially when they have been established and approved in conjunction with actors such as fishermen (Bruckner, 2006).

− **Complete closure of fisheries**: Several nations have issued moratoria on sea cucumber fishing in response to overexploitation. Closures can benefit populations and are relatively easy to monitor and implement (Baker-Médard & Ohl, 2019). However, where fishermen rely heavily on a fishery, alternative livelihoods should be provided.

− **Limited access:** Several nations have adopted a licensing system limiting the number of fishers or vessels involved (Baker-Médard & Ohl, 2019). Licensing can improve compliance with management measures and help ensure that economic benefits accrue to local communities. Fishermen's cooperatives can be organized so that licenses are only granted to people whosemain source of income is the sea cucumber fishery (Alesna et al., 2004).

− **Quotas:** Quotas or total allowable catches (TACs) are the maximum number of individuals or biomass that can be exploited each year during a fishing season or fishing expedition (Baker-Médard & Ohl, 2019).

− Minimum size limits: Minimum size limits are based on size at maturity to ensure reproduction of the stock. However, for many commercial species, biological information is lacking to determine the minimum harvest size (Baker-Médard & Ohl, 2019).

8.2 Population monitoring

There is currently no comprehensive, systematic monitoring of *Thelenota* species.

The stock survey assessment for *T. ananas* in the East Torres Straight recommended that close monitoring was needed (Murphy et al., 2021).

8.3 Control measures

8.3.1 International

There are no control measures at the international level for these species. Scientists have stated that “international regulations that control trade (such as CITES Appendix II) may be one of the best hopes for the conservation of highly valued sea cucumber populations” (Anderson et al., 2011).

Commercial data represent only part of the global world exchanges because trade can be complex, exports are not being fully declared and exchanged products can take diverse aspects, dried, salted and refrigerated; distinction between species is also rarely made on a commercial basis.

8.3.2 Domestic

See section 8.1.

8.4 Captive breeding and artificial propagation

To protect their sea cucumber populations from overfishing, countries have developed new methods to produce beche-de-mer. These measures have gained importance since methods of reproduction and rearing of larvae and juveniles have been developed for some commercial species (Lovatelli et al., 2004). However, for the *Thelenota* species, there is no information regarding commercial captive breeding and artificial propagation.

8.5 Habitat conservation

Some coral reefs in the Pacific and Indian Oceans inhabited by *Thelenota* species are includedin MPAs (Baker-Médard & Ohl, 2019). MPAs are one of the most widely used management tools in reef conservation and can include restrictions on human activities, such as fishing and coastal development. However, designation of an MPA does not necessarily ban fishing.

8.6 Safeguards

Not available.

9. Information on similar species

The three *Thelenota* species are distinguishable from other sea cucumber species, due in part to their large papillae. FAO has published an identification guidebook on commercially valuable sea cucumbers, including taxonomy, biology, distribution and exploitation (Purcell et al., 2012). The Secretariat of the Pacific Community (SPC) has also produced identification cards for Pacific Islands sea cucumber species (SSC, 2004).

10. Consultations

A consultation was distributed by the European Union to all range States in March 2022. The Islamic Republic of Iran, Senegal and Sudan expressed support for the proposal. Australia provided comments on the proposal but did not indicate their position at the time of submission.

11. Additional remarks

12. References

AFMA (2016, 16 June). Environmental crime and illegal fishing. Available at: https://www.afma.gov.au/environmental-crime-illegal-fishing [Accessed 20/05/2022]

AFMA (2017, 12 April Vietnamese illegal fishing vessel apprehended in the Coral Sea. Available at: https://www.afma.gov.au/vietnamese-illegal-fishing-vessel-apprehended-coral-sea [Accessed 20/05/2022]

AFMA (2021, 5 June). Operation Jawline intercepts 19 illegal foreign fishing vessels. Available at: https://www.afma.gov.au/news-media/news/operation-jawline-intercepts-19-illegal-foreign-fishing-vessels [Accessed 20/05/2022]

Alejandro, M. B. (2019). Re-establishing the sea cucumber resources in the Philippines: The Masinloc experience. Fish for the People, 17(2), 35-41.

Alesna, E. B., Dizon-Corrales, J. Q., & Cabangbang, A. U. S. T. E. R. L. I. T. O. (2004). Commercial fisheries licensing system. DABFAR (Department of Agriculture-Bureau of Fisheries and Aquatic Resources), In turbulent seas: The status of Philippine marine fisheries. Coastal Resource Management Project, Cebu City, Philippines, 200-201.

Anderson, S. C., Flemming, J. M., Watson, R., & Lotze, H. K. (2011). Serial exploitation of global sea cucumber fisheries. *Fish and Fisheries*, *12*(3), 317-339.

Andréfouët, S., & Tagliaferro, A. (2020). A comparison of commercial sea cucumber communities in the French Polynesia and New Caledonia atolls listed as UNESCO Man and Biosphere and World Heritage Areas. SPC Beche-de-mer Information Bulletin #40 – March 2020

Andréfouët, S., Tagliaferro, A., Chabran-Poete, L., Campanozzi-Tarahu, J., Tertre, F., Haumani, G., & Stein, A. (2019). An assessment of commercial sea cucumber populations in French Polynesia just after the 2012 moratorium. *Beche-de-mer Information Bulletin*, *39*, 8-18.

Aprianto, R., Amir, N., Tresnati, J., Tuwo, A., & Nakajima, M. (2019). Economically important sea cucumber processing techniques in South Sulawesi, Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 370, No. 1, p. 012082). IOP Publishing.

Aumeeruddy, R. & Conand, C. (2008). Seychelles: a hotspot of sea cucumber fisheries in Africa and Indian Ocean I. In: Sea Cucumbers: A Global Review on Fishery and Trade (eds V. Toral-Granda, A. Lovatelli and M. Vasconcellos), FAO Fisheries Technical Paper. No 516, FAO, Rome, pp. 207–221.

Baker-Médard, M., & Ohl, K. N. (2019). Sea cucumber management strategies: challenges and opportunities in a developing country context. Environmental Conservation*, 1–11.*

Bell, J. D., Purcell, S. W., & Nash, W. J. (2008). Restoring small-scale fisheries for tropical sea cucumbers. *Ocean & Coastal Management*, *51*(8-9), 589-593.

Brandt, J. F. (1835). Echinodermata ordo Holothurina. In: Prodromus Descriptionis Animalium ab H. Mertensio in Orbis Terrarum Circumnavigatione Observatorum. Fasc. I: 75 pps. Petropoli. pp. 42-62., available online at https://books.google.com/books?id=9-KK6BsniXcC

Bruckner, A.W., Johnson, K. A., & Field, J. D. (2003). Conservation strategies for sea cucumbers: Can a CITES Appendix II listing promote sustainable international trade. *SPC Bêche-de-mer information Bulletin*, *18*(1), 24-33.

Bruckner, A. W. (2006). Proceedings of the CITES workshop on the conservation of sea cucumbers in thefamilies Holothuriidae and Stichopodidae. NOAA Technical Memorandum, 244 pp.

Choo, P. S. (2008). Population status, fisheries and trade of sea cucumbers in Asia. In: M.V. Toral-Granda, A. Lovatelli, M. Vasconcellos. (ed.), Sea cucumbers. A global review on fisheries and trade. FAO, Rome. CITES (2002). CoP12 Doc. 45: Comercio de cohombros de mar de las familias Holothuridae y Stichopodidae.

CITES Management Authority of Australia (2022). CITES MA of Australia *in litt*. to European Commission, 2 May 2022.

CITES Authorities of the United States of America (2022). CITES Authorities of the US *in litt*. to European Commission, 29 April 2022.

Clark, H. L. (1921). The echinoderm fauna of Torres Strait: its composition and its origin. Department of Marine Biology of the Carnegie Institute. 10: vi + 223, 38 pls., available online at https://www.biodiversitylibrary.org/page/14515937

Conand, C. (1981). Sexual cycle of three commercially important holothurian species (Echinodermata) from the lagoon of New Caledonia. *Bulletin of Marine Science*, *31*(3), 523-543.

Conand, C. (1989). Les Holothuries Aspidochirotes du lagon de Nouvelle-Calédonie: biologie, écologie et exploitation.

Conand, C.P. (1998). Holothurians (sea cucumbers, Class Holothuroidea). In: Carpenter, K.E. & Niem,

V.H. (eds). FAO species identification guide for fishery purposes: The living marine resources of the Western Central Pacific. Vol. 2: Cephalopods, crustaceans, holothurians and sharks. Rome, FAO. 1998. 676-1396 pp.

Conand, C. (2006a). Ecology and biology of New Caledonia's main sea cucumber species. Sections of Chantal Conand's thesis: Les holothuries Aspidochirotes du lagon de Nouvelle-Calédonie : écologie, biologie et exploitation, originally published by ORSTOM (1989), translated and published by the Secretariat of the Pacific Community's Reef Fisheries Observatory, and Information and Translation Sections. Noumea: SPC, New Caledonia. 98 p. http://www.spc.int/DigitalLibrary/Doc/FAME/Reports/Conand_06_Thesis.pdf

Conand, C. (2006b). Sea cucumber biology: taxonomy; distribution; biology; conservation status:33-50 in Bruckner, A.W. (ed). 2006. The Proceedings of the CITES workshop on the conservation of sea cucumbers in the families Holothuriidae and Stichopodidae. NOAA Technical Memorandum, 244 pp.

Conand, C. (2006c). Harvest and trade: utilization of sea cucumbers; sea cucumber fisheries; current international trade; illegal, unreported and unregulated trade; bycatch; socio-economic characteristics of the trade in sea cucumbers: 51-73 in Bruckner, A.W. (ed). 2006. The Proceedings of the CITES workshop on theconservation of sea cucumbers in the families Holothuriidae and Stichopodidae. NOAA Technical Memorandum, 244 pp.

Conand, C., Muthiga, N.A. (Eds.). (2007). Commercial sea cucumbers: a review for the Western Indian Ocean. *WIOMSA* Book *Series.* No. 5 v + 66pp.

Conand, C. (2008). Population status, fisheries and trade of sea cucumbers in Africa and the Indian Ocean. In: M.V. Toral-Granada, A. Lovatelli, M. Vasconcellos. (ed.), Sea cucumbers. A global review on fisheries and trade. FAO, Rome.317p.

Conand, C., Gamboa, R. & Purcell, S. (2013a). Thelenota ananas. The IUCN Red List of Threatened Species 2013: e.T180481A1636021. https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T180481A1636021.en Downloaded on 06 October 2020.

Conand, C., Gamboa, R. & Purcell, S. (2013b). *Thelenota rubralineata*. *The IUCN Red List of Threatened Species* 2013: e.T180285A1610697. https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T180285A1610697.en Downloaded on 09 October 2020.

Conand, C., Purcell, S. & Gamboa, R. (2013c). *Thelenota anax*. *The IUCN Red List of Threatened Species* 2013: e.T180324A1615023. https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T180324A1615023.en Downloaded on 09 October 2020.

Conand, C. (2018). Tropical sea cucumber fisheries: changes during the last decade. *Marine pollution bulletin*, *133*, 590-594.

Courchamp, F., Angulo, E., Rivalan, P., Hall, R. J., Signoret, L., Bull, L., & Meinard, Y. (2006). Rarityvalue and species extinction: the anthropogenic Allee effect. *PLoS Biol*, *4*(12), e415.

DAWE (2021). *Assessment of the Queensland Sea Cucumber Fishery November 2021*, Commonwealth of Australia 2021.

Dissanayake, D. C. T., & Stefansson, G. (2012). Present status of the commercial sea cucumber fishery off the north-west and east coasts of Sri Lanka. *Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom*, *92*(4), 831.

Eeckhaut, I., Parmentier, E., Becker, P., Gomez da Silva, S., & Jangoux, M. (2004). Parasites and biotic diseases in field and cultivated sea cucumbers. *Advances in sea cucumber aquaculture and management*, 311-325.

Friedman, K., Eriksson, H., Tardy, E., & Pakoa, K. (2011). Management of sea cucumber stocks: patterns of vulnerability and recovery of sea cucumber stocks impacted by fishing. *Fish and Fisheries*, *12*(1), 75-93.

Govan, H. (2017). A review of sea cucumber fisheries and management in Melanesia. *SPC Fish. News*, *154*, 31-42.

Hammond, A. R., Meyers, L., & Purcell, S. W. (2020). Not so sluggish: movement and sediment turnover of the world’s heaviest holothuroid, *Thelenota anax*. *Marine Biology*, *167*, 1-9.

Hasan, M. H. (2019). Destruction of sea cucumber populations due to overfishing at Abu Ghosoun area, Red Sea. *The Journal of Basic and Applied Zoology*, 80(1), 5.

Hoegh-Guldberg, O. et al. (2015). *Reviving the Ocean Economy: the case for action.* WWF International, Gland, Switzerland.

Jaeger, G.F. (1833). De Holothuriis. Gessnerianis, Turici. 40 pp., available online at https://biodiversitylibrary.org/page/10588969

Jontila, J. B. S., Monteclaro, H. M., Quinitio, G. F., Santander-de Leon, S. M., & Altamirano, J. P. (2018). Status of sea cucumber fishery and populations across sites with different levels of management in Palawan, Philippines. Ocean & Coastal Management, 165, 225–234.

Jontila, J. B. S., Monteclaro, H. M., Quinitio, G. F., Santander-de Leon, S. M., & Altamirano, J. P. (2018). The sea cucumber fishery in Palawan, Philippines. *Kuroshio Science*, *12*(1), 84-88.

Kalaeb, T., Ghirmay, D., Semere, Y., & Yohannes, F. (2008). Status and preliminary assessment of thesea cucumber fishery in Eritrea. *BECHE-DE-MER*, 8.

Kaly, U., Preston, G., Opnai, J. and Aini, J. (2007). Sea Cucumber Survey in New Ireland Province. National Fisheries Authority. 7p.

Kerr, A. M., D. R. Norris, P. J. Schupp, K. D. Meyer, T. J. Pitlik, D. R. Hopper, J. A. Chamberlain and L. S. Meyer. 1992. Range extensions of echinoderms (Asteroidea, Echinoidea, Holothuroidea) to Guam, Mariana Islands. *Micronesica* 25: 201-216.Kerr, A. M., A. K. Miller, C. Brunson and A. M. Gawel. 2017. *Commercially valuable sea cucumbers of Guam. University* of Guam Marine Laboratory Technical Report 162: i - xii, 1 - 45.

Kinch, J.(2005). The commercial use of *Thelenota rubralineata* in the Solomon Islands. *SPC Bechede-Mer Information Bulletin*, *21*, 3-4.

Kinch, J., Purcell, S., Uthicke, S., & Friedman, K. (2008). Population status, fisheries and trade of sea cucumbers in the Western Central Pacific. *Sea cucumbers. A global review of fisheries and trade. FAO Fisheries and Aquaculture Technical Paper*, *516*, 7-55.

Lane, D. J. (2000). Actualisation des données sur la répartition et l’abondance de *Thelenota rubralineatadans* le Pacifique occidental et réflexion sur l’hypothèse d’une niche vacante. LA BÊCHE-DE-MER, 1(20), 29.

Lane, D. J. (2008). Distribution and abundance records updated for *Thelenota rubralineata* in the western Pacific, with notes on the “vacant niche” hypothesis. BECHE-DE-MER, 29.

Lane, D.J.W. (1999). Distribution and abundance of *Thelenota rubralineata* in the western Pacific: Some conservation issues. SPC Beche-de mer Information Bulletin 11: 19-21.

Lane, D. J., & Limbong, D. (2015). Catastrophic depletion of reef-associated sea cucumbers: resource management/reef resilience issues for an Indonesian marine park and the wider Indo-Pacific. Aquatic Conservation: Marine and Freshwater Ecosystems, 25(4), 505-517.

Lawrence, A. J., Ahmed, M., Hanafy, M., Gabr, H., Ibrahim, A., & Gab-Alla, A. A. F. A. (2005). Status of the sea cucumber fishery in the Red Sea-the Egyptian experience. *FAO Fisheries Technical Paper*, 79-90.

Louw, S. & Bűrgener, M. (2020). A Rapid Assessment of the Sea Cucumber trade from Africa to Asia. TRAFFIC Report (Sept. 2020).

Lovatelli, A., Conand, C., & Uthicke, S. (Eds.). (2003). Advances in sea cucumber aquaculture and management (No. 463). Food & Agriculture Org.

Nithyanandan, N. (2003). Sea cucumbers: A resource in peril. Indiscriminate fishing of sea cucumber in Indian Seas has led to their overexploitation. *Samudra November*, 24-26.

Massin, C., Lane, D. (1991). Description of a new species of sea cucumber (Stichopodidae, Holothuroidea, Echinodermata) from the Eastern Indo-Malayan Archipelago: *Thelenota rubralineata* n. sp. Micronesica. Mirconessica. 24: 57–64.

Mangubhai, S., Lalavanua, W., & Purcell, S. W. (2017). Fiji's Sea Cucumber Fishery: Advances in Science. Wildlife Conservation Society. Report No. 01/17. Suva, Fiji. 70 pp.

Mulochau, T. (2018). Monitoring commercially important sea cucumber populations in the reefs of Mayotte (Indian Ocean). *SPC Beche-de-mer Information Bulletin*, *38*, 21-28.

Murphy N.E., Plaganyi, E., Edgar, S., Salee, K., Skewes, T. (2021) *Stock survey of sea cucumbers in East Torres Strait*. Final report. May 2021. CSIRO, Australia. 138 p.

Muthiga, N. A., Kawaka, J. A., & Ndirangu, S. (2009). The timing and reproductive output of the commercial sea cucumber Holothuria scabra on the Kenyan coast. *Estuarine, Coastal and Shelf Science*, *84*(3), 353-360.

Pakoa, K., Saladrau, W., Lalavanua, W., Valotu, D., Tuinasavusavu, I., Sharp, M. & Bertram, I. (2013). The status of sea cucumber resources and fisheries management in Fiji: Secretariat of the Pacific Community (SPC), Noumea, New Caledonia, 2013

Pangestuti, R., & Arifin, Z. (2018). Medicinal and health benefit effects of functional sea cucumbers. *Journal of traditional and complementary medicine*, *8*(3), 341-351.

Pinca, S., Kronen, M., Friedman, K., Magron, F., Chapman, L., Tardy, E., ... & Lasi, F. (2010). Regional assessment report: profiles and results from survey work at 63 sites across 17 Pacific Island Countriesand Territories. *Noumea, New Caledonia: Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFish/C/CoFish)*.

Purcell, S. W., Gossuin, H., & Agudo, N. N. (2009). *Status and management of the sea cucumber fishery of La Grande Terre, New Caledonia*. Programme ZoNéCo. WorldFish Centre Studies and Reviews No, 1901. The WorldFish Centre, Penang, Malaysia. 138 p.

Purcell, S. W., Lovatelli, A., Vasconcellos, M., & Ye, Y. (2010). Managing sea cucumber fisheries with an ecosystem approach. FAO Fisheries and Aquaculture Technical Paper. No. 520. Rome. 157p.

Purcell, S. W., Samyn, Y., & Conand, C. (2012). Commercially important sea cucumbers of the world. FAO Species Catalogue for Fishery Purposes. No. 6. Rome, FAO. 2012. 150 pp. 30 colour plates.

Purcell, S. W., Mercier, A., Conand, C., Hamel, J. F., Toral-Granda, M. V., Lovatelli, A., & Uthicke, S. (2013). Sea cucumber fisheries: global analysis of stocks, management measures and drivers of overfishing. *Fish and fisheries*, *14*(1), 34-59.

Purcell, S.W., Polidoro, B.A., Hamel, J.F., Gamboa, R.U. and Mercier, A., (2014). The cost of being valuable: predictors of extinction risk in marine invertebrates exploited as luxury seafood. *Proceedings of the Royal Society B: Biological Sciences*, *281*(1781), p.20133296.

Purcell, S. W. (2014). Value, market preferences and trade of beche-de-mer from Pacific Island sea cucumbers. *PloS one*, *9*(4), e95075.

Purcell, S. W., Conand, C., Uthicke, S., & Byrne, M. (2016a). Ecological roles of exploited sea cucumbers. In Oceanography and marine biology (pp. 375-394). CRC Press.

Purcell, S.W., Ngaluafe, P., Aram, K.T., Lalavanua, W. (2016b). Trends in small-scale artisanal fishing of sea cucumbers in Oceania. *Fisheries Research* 183: 99–110

Purcell, S. W., Williamson, D. H., & Ngaluafe, P. (2018). Chinese market prices of beche-de-mer: Implications for fisheries and aquaculture. *Marine Policy*, *91*, 58-65.

Queensland sea cucumber fishery harvest strategy: 2021–2026. Queensland government. Available at: https://www.publications.qld.gov.au/ckan-publications-attachments-prod/resources/f9ec2eab-9f61-4d49-930f-6f9446102b85/sea-cucumber-fishery-harvest-strategy.pdf?ETag=%22848ee78250de7e433d9427bd4a5c57b5%22

Rahardjanto, A., Hadi, S., Rofieq, A., & Wahyono, P. (2020). Community structure, diversity, and distribution patterns of sea cucumber (Holothuroidea) in the coral reef area of Sapeken Islands, Sumenep Regency, Indonesia. *Aquaculture, Aquarium, Conservation & Legislation*, *13*(4), 1795-1811.

Rahman, M. A., Chowdhury, S. H., Hasan, M. J., Rahman, M. H., Yeasmin, S. M., Farjana, N., ... & Parvez, M. S. (2020). Status, Prospects and Market Potentials of the Sea Cucumber Fisheries with Special Reference on Their Proper Utilization and Trade. *Annual Research & Review in Biology*, 84-101.

Secretariat of the Pacific Community. (2004) Pacific Island sea cucumber and beche-de-mer identification cards. Available at: https://spccfpstore1.blob.core.windows.net/digitallibrary-docs/files/f0/f0c89091de792ecae88996fc6b841cde.pdf

Shedrawi, G., Bosserelle, P., Siola'a Malimali, V. F., Mailau, S., Magron, F., Havea, T., ... & Halford, A. (2020) The status of sea cucumber stocks in the Kingdom of Tonga.

Siahaan, E. A., Pangestuti, R., Munandar, H., & Kim, S. K. (2017). Cosmeceuticals properties of Sea Cucumbers: Prospects and trends. *Cosmetics*, 4(3), 26.

Shiell, G. (2004). Field observations of juvenile sea cucumbers. *SPC beche-de-mer inf. Bull*, *20*, 6-11.

Skewes, T., Dennis, D., Wassenberg, T.J., Austin, M., Moeseneder, C., Kutosoukos, A., Haywood, M., Pendrey, R. & Bustamante, R. 2002. Surveying the distribution and abundance of Holothuria scabra (sandfish) in Moreton Bay. CSIRO Division of Marine Research Final Report, Brisbane.

Skewes, T.D., Murphy, N.E., McLeod, I., Dovers, E., Burridge, C. & Rochester, W. (2010). Torres Strait Hand Collectables, 2009 survey: Sea cucumber. CSIRO, Cleveland.

Sweet, M. J., & Bateman, K. S. (2016). Reprint of 'Diseases in marine invertebrates associated with mariculture and commercial fisheries'. *Journal of sea research*, *113*, 28-44.

Toral-Granda, V. (2006). Situation biologique et commerciale des concombres de mer des familles Holothuriidae et Stichopodidae. AC22 Doc. 16 Annexe (CITES)

Toral-Granda, V., Lovatelli, A. & Vasconcellos, M. (2008). Sea cucumbers. A global revue of fisheries and trade. Rome: Food and Agriculture Organization of the United Nations, N° 516. 317 p

Toral-Granda, V.M. (2006). *Fact sheets and identification guide for commercial Sea cucumber species*. Tuwo, A. (2004). Status of sea cucumber fisheries and farming in Indonesia. Advances in sea cucumber aquaculture and management 463: 49-55.

Tuwo, A. (2005). Status of sea cucumber fisheries and farming in Indonesia. *FAO fisheries Technical Paper*, 49-56.

Vunisea, A., Friedman, K., Awira, R., Kronen, M., Pinca, S., Chapman, L., Magron, F., Sauni, S., Pakoa, K. & Lasi, F. 2008. Somoa Country Report: Profiles and Results from Survey Work at Manono-Uta, Salelavalu, Vailoa and Vaisala. Secretariat of the Pacific Community, Noumea, New Caledonia.

Wolfe, K., & Byrne, M. (2022). Overview of the Great Barrier Reef sea cucumber fishery with focus on vulnerable and endangered species. *Biological Conservation*, *266*, 109451.

WoRMS (2021). *Thelenota ananas* (Jaeger, 1833). Accessed at: http://www.marinespecies.org/aphia.php?p=taxdetails&id=210916 on 2021-12-10

WWF (2015). *Living Blue Planet Report*. *Species, habitats and human well-being*. [Tanzer, J., Phua, C., Jeffries, B., Lawrence, A., Gonzales, A., Gamblin, P. & Roxburgh, T. (Eds)]. WWF International, Gland, Switzerland