THE UNIVERSITY OF BRITISH COLUMBIA

Institute for the Oceans and Fisheries

WORKING PAPER SERIES

Global seahorse trade defies export bans under CITES action and national legislation

Sarah J. Foster, Ting-Chun Kuo, Anita Kar Yan Wan and Amanda C.J. Vincent

Global seahorse trade defies export bans under CITES action and national legislation[+]

Sarah J. Foster[1]*, Ting-Chun Kuo[1,2], Anita Kar Yan Wan[1,3] and Amanda C.J. Vincent[1]

[1] Project Seahorse, Institute for Oceans and Fisheries, The University of British Columbia, 2202 Main Mall, Vancouver, BC, V6T1Z4, Canada

[2] Institute of Marine Affairs and Resources Management, National Taiwan Ocean University, No. 2, Beining Road, Zhongzheng District, Keelung City 202, Taiwan

[3] School of Life Sciences, Sun Yat-Sen University, 135 West Xingang Road, Guangzhou 510275, China.

*Corresponding author: s.foster@oceans.ubc.ca

Abstract

Illegal trade undermines efforts to achieve sustainable use of wildlife, including marine fishes. This study investigated the illegal trade of seahorses, among the first taxa of marine fishes to come under global trade restrictions. Seahorses are listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This designation allows exports of specimens that are sourced sustainably and legally (within CITES rules). However, all countries historically exporting large numbers of seahorses have since banned trade or are under CITES export suspensions. In particular, Thailand, previously considered the source of about 75% of all wild dried seahorses, suspended exports in January 2016. To investigate global compliance, 220 interviews were conducted with traders in Hong Kong Specialist Administrative Region (hereafter Hong Kong SAR), the largest entrepôt for dried seahorses. This study sought to understand current sources of seahorses (2016-17) and relative volumes from each source. Traders reported obtaining dried seahorses from many countries with bans on seahorse exports, most notably Thailand and the Philippines. Indeed, it is estimated that almost all dried seahorses in Hong Kong SAR (95%) had been imported from source countries despite export bans being in place, indicating a widespread lack of enforcement. More broadly, trade regulations, including bans, are likely to be undermined when indiscriminate extraction persists, as with seahorses in bottom trawls and other non-selective fishing methods. Attention must be directed at managing extraction as well as increasing enforcement of trade bans.

Keywords: *Hippocampus* sp., trade bans, illegal wildlife trade, marine fishes, multilateral environmental agreement, bycatch

Introduction

Unsustainable trade in wildlife is a key driver of global biodiversity loss (Milner-Gulland and Bennett 2003, Missios 2004, Harris et al. 2017), both in the oceans and on land. The majority of wild species

extracted for human use end up in trade (Roe et al. 2002), and many traded species are now threatened by over-exploitation (Hilton-Taylor et al. 2009, Bush et al. 2014). More than 2,500 animal species listed as threatened or near-threatened on the IUCN Red List of Threatened Species™ (hereafter Red List) in part because they are hunted or fished (Maxwell et al. 2016), and more than 1,000 tree species are threatened by extinction because of the trade in timber (Oldfield 2003). Across all wildlife, marine fishes are one of the largest groups in trade by value (Engler 2008). Acknowledging that marine fishes are wildlife would likely materially affect approaches to fisheriers management. A study recently estimated that 78% of wild-caught fish each year enter international markets while 30% of assessed fished stocks are overfished (FAO 2016). This points to a need to consider illegal, unregulated and unreported (IUU) fishing in conversations around illegal wildlife trade (IWT).

Management measures intended to control wildlife trade could well foster IWT without proper enforcement. To manage use of wildlife, national governments have imposed various restrictions on take and/or trade, including quotas, temporal/spatial restrictions on extraction, and in some cases complete bans (Roe et al. 2002, Challender et al. 2015). Where enforcement is weak, however, extraction and trade often continue despite these regulations (e.g. Shepherd 2010, Underwood et al. 2013, Phelps et al. 2016). Such persistent trade is IUU, and thus a major impediment to the management of wild populations for sustainable trade. Although it is almost impossible to quantify the value/volume of IWT because of its surreptitious nature, estimates put the minimum value of IWT at USD 19 billion dollars per annum (Myburgh 2011).

Marine species are threatened by IWT, especially as a result of IUU fishing. For example, the illegal trade of totoaba (*Totoaba macdonaldi*) continues, fueled by illegal bycatch, even though effectively all exports have been banned under CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora, www.cites.org) since 1975. As a result, this species has been included on the Red List as Critically Endangered since 1996 (Findley 2010). White sharks (*Carcharodon carcharias*, Vulnerable on the IUCN Red List; Fergusson et al. 2009) also continue to be illegally traded to Asian markets (Shivji et al. 2005) despite bans on their capture in many countries. A recent study found that at least 20-30% of the wild-caught seafood imported to the US had been illegally sourced (Pramod et al. 2014). Indeed, illegal, unreported and unregulated fisheries and trade have been estimated at between US$15.5 billion and US$36.4 billion per year (May 2017).

All species making up the entire genus of seahorses (*Hippocampus* spp.) are also vulnerable to IWT and were – along with two species of sharks – the first marine fishes to be brought under global trade restrictions. Seahorses are heavily traded, first and foremost, as dried (wild) specimens for traditional Chinese medicine (TCM), with smaller trades in live (wild and captive bred) seahorses for aquarium display and dried (wild) seahorses for curios; dried specimens made up 98% of the reported trade from 2004-2011, and 93% of the trade was reportedly imported by Hong Kong SAR, Taiwan and mainland China (Foster et al 2016). In 2002, all seahorse species were added to Appendix II of CITES. This provision requires that exported specimens be legally sourced at a level that is not detrimental to wild populations (Article IV paragraph 2[a] and [b], CITES 1973). The listing, which came into force in May 2004, actually also generated trade bans for many countries that historically exported the most seahorses (Vincent et al. 2011a, Foster 2016). As one example, India decided to ban seahorse fisheries and exports in 2001 – before the listing – after participating in a CITES consultation process (Indian Ministry of Environment and Forests 1972, 2003). For a second example, the Philippines automatically required the end of all extraction and trade of species listed on any CITES Appendix (Department of Agriculture 1998; as reviewed in Foster and Apale 2016). Other countries chose to suspend exports after being asked about their sustainability under the CITES enforcement process

known as Review of Significant Trade (RST) (Foster 2016, IUCN 2016a). Yet more countries had bans imposed by CITES after failing to meet their obligations under the RST (Foster 2016, IUCN 2016a). In total, imposition of such country-species bans would have eliminated 98% of reported wild seahorse exports in the CITES database from 2004-2011 (Foster 2016).

There is evidence of continued trade from at least some of the countries that banned exports of seahorses. Historic and recent fisheries and/or trade surveys in source countries with trade bans have all revealed persistent exports of dried seahorses through unofficial channels: India (T. Vaidyanathan, Project Seahorse, pers. comm.), Malaysia (Lawson 2014), the Philippines (O'Donnell et al. 2012) and Viet Nam (Foster et al. 2017). Surveys in mainland China, which serves primarily as an importer, also indicated persistent dried trade despite bans (X. Zhang, Project Seahorse, pers. comm.). In particular, during an informal trade survey in 2015, Hong Kong Specialist Administrative Region (hereafter Hong Kong SAR) traders reported sourcing dried seahorses from countries that had banned exports, including India, Malaysia, and the Philippines (T.C. Kuo, Project Seahorse, pers. comm.).

This study reports on a formal investigation of whether bans on dried seahorse exports are being implemented, focusing on Hong Kong SAR, the largest known importer of dried seahorses (Foster et al. 2016). TCM and dried seafood traders (importers, wholesalers, and retailers) in Hong Kong were asked about their sources of dried seahorses. The focus was on 2016 and 2017, because more recent memory and records may be more accurate and because the most recent ban on exports of wild seahorses dates from then. After spending four years in the RST process, Thailand banned exports in January 2016 (CITES SC67 Doc. 15 Annex 2). This study sought to estimate the relative volumes from each reported source country or region, and then compare these reports to CITES official data. This study seeks to help evaluate the degree to which trade bans are being enforced, the scale of the illegal trade in seahorses, and possible areas of future management intervention. It also serves to probe the CITES RST process and IWT concerns more generally.

Methods

Data Collection

Semi-structured interviews were conducted with TCM and dried seafood traders in one of the world's biggest seahorse entrepôts, Hong Kong SAR. According to CITES data from 2004-2011, Hong Kong SAR imported between 2.5 – 5.2 million dried seahorses of a total globally reported 3.3 – 7.6 million individual seahorses (98% of which were dried) (Foster et al 2016). This work builds on the 23 years that the Project Seahorse team has been conducting surveys on seahorse fisheries and trade, and draws from its extensive experience with CITES implementation of the listings of seahorses and other marine fishes on Appendix II (Vincent 1996, Vincent et al. 2011a,b, 2013, Vincent and Foster 2017).

The authors were particularly well-placed to undertake this work because the Project Seahorse team has long-established relationships with the Hong Kong TCM community (see Acknowledgements), and particularly with the Hong Kong Chinese Medicine Merchants Association (HK CMMA), which initially referred the authors to several key seahorse importers/wholesalers. Hong Kong Chinese team members have been in dialogue with members of this association intermittently (sometimes on a daily basis for years) since 1998. The authors have been allowed access to members' warehouses, filmed in members' facilities, been invited as members to consultations and workshops, and contributed to Association events, exhibits and newsletters. Such repeat contact has developed a relationship of trust that allowed the authors access to traders who are willing to share information. All of Project

Seahorse's trade surveys in Hong Kong since 1998 have been with the knowledge and engagement of the HK CMMA, although without any oversight from that body.

In October 2017, the authors approached 332 traders for initial discussions, and were able to speak with 278 of them. To constrain the study to 2016-17, traders were asked about the last time they had re-stocked with seahorses and only traders who reported buying seahorses in 2016-17 (n=220) were interviewed and their data analyzed. Traders were identified by (i) an online yellow-book of TCM and dried seafood traders/retailers in Hong Kong (http://www.yp.com.hk/, accessed June 24, 2015), (ii) in-person scouting on the streets, or (iii) introduction by other respondents/locals. A Hong Kong Chinese researcher (the third author) conducted all interviews in Cantonese. Semi-structured interviews were used, in which respondents could skip questions posed during discussion with the researcher, or stop the interview at any time. Interviews lasted an average of 10-15 minutes but ranged from fewer than five minutes to more than two hours, depending on the respondent's willingness to engage. All interviews followed UBC Human Ethics Protocols (H12-02731).

Respondents were classified according to their first role (chronologically) in seahorse trade. For example, if a trader reported to be both a seahorse wholesaler and a seahorse retailer, they were classified as a wholesaler in this analysis. Overall, three importers, 60 wholesalers, and 157 retailers were interviewed. Triangulation was used, where each question was approached in different ways and compared within and across trade levels, to increase confidence in respondents' answers (Denzin and Lincoln 2011).

The interview questions varied but were aimed at obtaining three pieces of information from each respondent: (1) source jurisdictions (countries and other legal entities) for seahorses in 2016-17, (2) relative purchase volumes from each reported source, and (3) total annual purchase volume across all sources. The results for importers, wholesalers, and retailers were kept separate because of the potential overlap in reported volumes among trade levels; as mentioned above, one respondent could have been involved in more than one level of trade.

Analysis

Reported source countries and jurisdictions

Of the 220 traders who claimed to have bought seahorses in 2016-17, 189 provided information on the sources of their dried seahorses. Traders reported sources by country, region, or even the ocean from which they thought the seahorses originated. Only country/jurisdiction-level reporting was included in the analysis, which came from 165 respondents (3 importers, 49 wholesalers and 113 retailers). The geographical designations employed in this study are reported as they were by respondents, and do not imply the expression of any opinion whatsoever concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries.

Relative purchase volume for each reported source

Traders were asked about the relative volume of dried seahorses they obtained from each source they reported. If a trader reported only one source, all of their seahorses were assumed to be from that jurisdiction (100%) (n=109 of 165). Only two of the 165 traders provided a quantitative estimate (%) for the relative volumes obtained from reported sources. However, 34 traders provided qualitative information on relative volumes – describing the relative contribution of each source as 'more' ("主要"

or "比較多" in Cantonese) or 'less' ("少啲" or "比較少" in Cantonese). The subsequent analyses were carried out assuming that a source contributing 'more' provided 60, 70, 80, or 90% of the seahorses a trader obtained, and a source contributing 'less' provided 40, 30, 20, and 10% of seahorses, respectively. The final results presented in this paper are the mean results across all tests based on each assumption (the results of each analysis are in Table S1). If a respondent reported greater than one 'more' source (n=10), the proportion of trade (60, 70, 80, or 90%) was assumed to be shared evenly across these sources. The same approach was taken where respondents reported more than one 'less' source (n=4). The remaining 20 traders commented on more than one source but did not report the relative contribution from each (quantitatively or qualitatively). For those 20 traders, each source was assumed to contribute equally to the total reported purchase volume of that trader (2.2.3, below).

Total annual purchase volume per trader (across all sources)

Each trader was asked to quantify his or her total annual purchase volume of dried seahorses for 2016-17. Traders could choose to report their purchase volumes over any time period, e.g. per year, per two months, or per purchase. Traders were then asked how many times they purchased dried seahorses in a given year. With this information the reported purchase volume was scaled up to an annual volume by considering the frequency of purchases (e.g., 1 kg purchase every 2 months * 6 = 12 kg year^{-1}; 1 kg per purchase * 3 purchases year^{-1} = 3 kg year^{-1}). In the end, 47 traders provided enough information to estimate total annual purchase volumes (n=2 importers, n=21 wholesalers, n=24 retailers).

Annual purchase volume per trader for each source

The annual purchase volume per trader was calculated from each source for respondents who reported both relative purchase volume for each reported source (see 2.2.2) and total annual purchase volumes (see 2.2.3) (n=47; n=2 importers, n=21 wholesalers, n=24 retailers). A trader's reported relative purchase volume (%) for a source (from 2.2.2) was multiplied by their reported total purchase volume (from 2.2.3).

Total purchase volume per source across interviewed traders

The relative trade volume was estimated from each source across all interviewed traders for each trade level. The mean of annual purchase volume per trader (see 2.2.4) was calculated from each source. The mean per source was multiplied by the number of respondents who reported that particular source (see 2.2.1). Finally, the relative purchase volume was calculated from each source (%) by dividing the volume per source by the total reported volume at each trade level according to

$$P_j = \frac{\bar{V}_j \times N_j}{\sum_i \bar{V}_i \times N_i} \times 100\%$$

where P_j is the relative trade volume (%) of source j, $\bar{V}_j$ is the mean annual purchase volume per trader (kg) sourced from source j, and N_j is the number of traders that reported sourcing from j.

Comparing relative purchase volumes to other official datasets

This study's estimates of relative purchase volumes for each source were compared to the same category of data in two official datasets: i) import data recorded by the Hong Kong Census and Statistics Department (CSD) (Hong Kong Census and Statistics Department 2015), and ii) export and import data reported in the CITES trade database (https://trade.cites.org/, accessed June 24, 2016).

The CSD data, which covers 1998-2014, was separated into two periods: pre-CITES (1998-2003, n=86 records) and post-CITES (2005-2014, n=65 records); the Appendix II listing for seahorses came into effect in May 2004. Post-CITES source volume information was obtained from the CITES database for 2005-2014. Records were analyzed for dried seahorses (records with the terms 'bodies', 'derivatives', 'specimens' and 'skeletons'), wild seahorses (records labeled R = ranched, W = wild) and seahorse trade for commercial purposes (purpose code = T) (n=106 records). All analyses of CITES data were executed as per Foster et al. 2016.

Results

Reported source countries and jurisdictions

Twenty-two countries were reported as sources of dried seahorses in 2016-17 (Figure 1); of these, Hong Kong SAR traders most frequently reported Thailand as a source (n=88 of 189 traders; Figure 1). The Philippines, Australia, mainland China and Indonesia were next, reported by 23, 20, 20 and 19 traders respectively. Seven or fewer individuals reported importing from other sources (Figure 1).
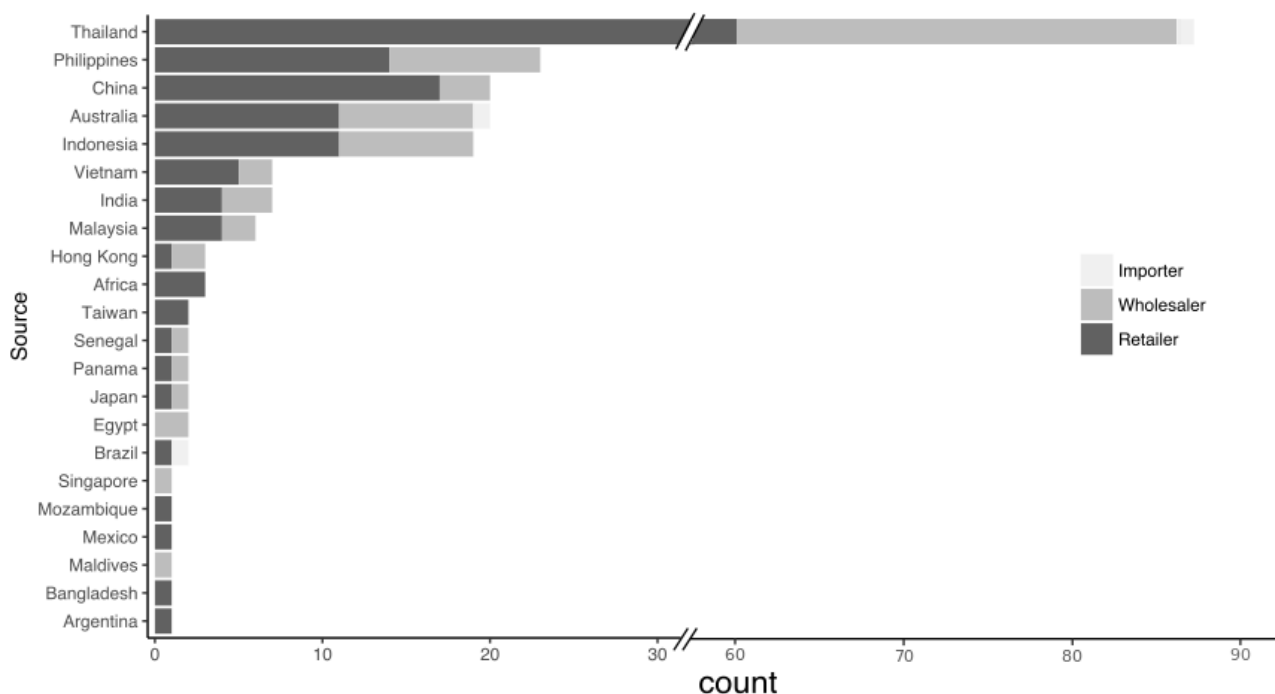

Figure 1. Number of traditional Chinese medicine (TCM) and dried seafood traders reporting different countries and jurisdictions as sources of dried seahorses (Hippocampus spp.) into Hong Kong SAR.

Relative purchase volume for each reported source

Hong Kong SAR traders reported Thailand as the greatest source of dried seahorses by volume in 2016-17 (n=17 of 34 traders who provided qualitative information on relative purchase volumes: Figure 2). Other reportedly 'more' important sources of dried seahorses into Hong Kong SAR included the Philippines and mainland China (n=4 of 34 traders each: Figure 2), followed by Australia, India, Malaysia, and Viet Nam (n≤2 traders each). Two traders (both wholesalers) provided quantitative estimates for relative volumes obtained from reported sources: one trader reported that 60% of his

purchased seahorses had come from Thailand, and the other trader reported that 60% had come from the Philippines and 40% from Thailand.
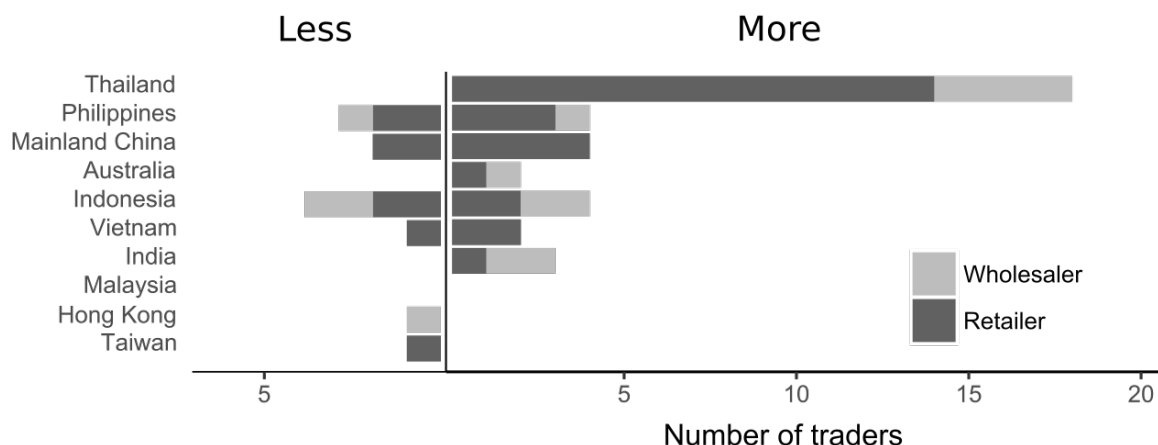

Figure 2. Number of traditional Chinese medicine (TCM) and dried seafood traders describing the relative contribution of each source as 'more' (i.e. the source of relatively more dried seahorses, Hippocampus spp.) or 'less' (i.e. the source of relatively fewer dried seahorses). None of the reported sources in Figure 1 from Senegal down to Argentina were reported as contributing more or less seahorses and so are excluded in this figure. No information was available from importers.

Six of the eight sources reported as 'more' important have export bans on wild, dried seahorses, for one or all species. Table 1 reports the existence and, where relevant, nature of bans on wild, dried seahorse trade from countries/jurisdictions that traditional Chinese medicine and dried seafood traders reported as sources of dried seahorses into Hong Kong SAR in 2016-17.

Table 1. The existence and, where relevant, nature of bans on wild, dried seahorse trade from countries/jurisdictions that traditional Chinese medicine and dried seafood traders reported as sources of dried seahorses into Hong Kong SAR in 2016-17. Other countries not reported by traders as sources during 2016-2017 may also have banned seahorse export. For more information on the bans self-imposed when a CITES Review of Significant Trade (RST) was initiated or in response to RST recommendations, see Foster 2016.

Reported source	Ban?	Year	Species	Origin of ban	Reference
Argentina	No				
Australia	No				
Bangladesh	No				
Brazil	No				
China (mainland)	Yes	2011	All species	Self-imposed when RST initiated – "The export of wild *Hippocampus* spp. was banned on 01/01/2011 until further notice"	J. He, pers. comm. to UNEP-WCMC in AC26 Doc. 12.2 Annex – Review of Significant Trade, Species selected following CoP14 (UNEP-WCMC 2012)
Egypt	No				

Hong Kong SAR	No				
India	Yes	2001	All species	Self-imposed –"Prohibited to acquire, receive, keep in his control, custody or possession, sell, offer for sale, or otherwise transfer or transport"	The Indian Wildlife Protection Act. (Indian Ministry of Environment and Forests 1972, 2003).
Indonesia	Yes	2009	All species	Self-imposed when RST initiated – "ban on all harvest/export quota of all *Hippocampus* spp. since the beginning of 2009"	AC25 Doc. 9.5 Addendum – Review of Significant Trade, Species selected following CoP15 (CITES 2011)
Japan	No				
Malaysia	Yes	2009	All species	Self-imposed when RST initiated - "an administrative suspension of all seahorse exports"	AC25 Doc. 9.5 Addendum (CITES 2011)
Maldives	No				
Mexico	Yes	1994	All species – target caught only	Self-imposed – "The commercialization of cultured and incidentally-caught seahorses was legal in Mexico...the *intentional capture* of wild seahorses and their trade was illegal"	Baum and Vincent 2005
Mozambique	No				
Panama	No				
Philippines	Yes	2004	All species	Self-imposed in response to CITES listing – Republic Act (RA) 8550 Section 97 imposed a blanket prohibition on the fishing or collecting of all CITES-listed species without any distinction among the Appendices.	DA–BFAR 1998; reviewed in Foster and Apale 2016
Senegal	Yes	2016	*H. algiricus*	CITES imposed – Parties recommended to suspend trade in *H. algiricus* from Senegal for failure to meet RST recommendations by deadlines.	SC66 Summary Record (CITES 2016b)
Singapore	No				
South Africa	No				
Thailand	Yes	2016	All species	Self-imposed in response to RST recommendations – The Department of Fisheries issued "interim measure to cease the issuance of export permits for seahorses (*Hippocampus* spp.).... shall come into force starting from 1 January 2016 onwards, until further notification"	CITES SC67 Doc. 15 Annex 2 – Implementation of recommendations of the Animals and Plants Committees (CITES 2016a)
Taiwan	No				
Viet Nam	Yes	2013	*H. kuda*	CITES imposed – Parties recommended to suspend trade in *H. kuda* from Viet Nam for failure to meet RST recommendations by deadlines.	SC63 Summary Record (CITES 2013)

Total annual purchase volume per trader (across all sources)

Importers and wholesalers reported purchasing similar volumes of seahorses in a given year, with about 30 kg year^{-1} for importers (n=2) and a mean of 31.7 kg year^{-1} for wholesalers (SD=35.8 kg, n=22). Retailers reported buying many fewer seahorses, with reported mean purchase volumes per buyer totaling 6.7 kg year^{-1} (SD=14.4 kg, n=27).

Annual purchase volume per trader for each source

Combining information from the 47 traders who reported both relative purchase volumes from source countries (see 3.2) and total annual purchase volumes (see 3.3), purchase volumes per trader for each reported source were calculated (Table 2). The highest volumes for wholesalers were calculated for Thailand, the Philippines, and India (with estimated mean purchase volumes 4.5, 3.0 and 2.6 times higher, respectively, than the fourth country by volume, Indonesia). For retailers, the highest per-trader purchase volumes were estimated for mainland China and the Philippines (with estimated mean purchase volumes 2.3 and 1.8 times higher, respectively, than the third country by volume, Thailand).

Total purchase volume per source across interviewed traders

From trader reports it was estimated that Thailand supplied the Hong Kong TCM trade with the most seahorses by volume in 2016-2017; this was true for both wholesalers and retailers (Table 2). For wholesalers, the Philippines followed Thailand as the next largest source of seahorses into Hong Kong SAR (Table 2a). In contrast, retailers cumulatively reported that mainland China and the Philippines followed Thailand as the next largest reported sources (Table 2b). All other reported sources accounted for less than 10% of the total reported purchase volume.

Across all reported sources, the total reported purchase volume for the wholesalers interviewed was estimated at 1183.6 kg year^{-1} (~440,000 individuals based on an average of all published conversions - 2.69 g/seahorse, Foster et al. 2016), and for retailers at 437.1 kg year^{-1} (~162,500 individuals). The total for the two importers interviewed by the authors was ~60 kg year^{-1} (~22,300 individuals).

Comparing relative purchase volumes to other official datasets

Both official datasets indicated that Thailand supplied the greatest volume by weight of dried seahorses to Hong Kong SAR across all time periods (Table 2), consistent with what traders reported during the current study. Official data seldom mentioned some countries in either pre- or post-CITES periods – including Australia, mainland China, and Indonesia – that the respondents indicated were important sources (Table 2). The official data recorded similar relative volumes coming into Hong Kong SAR from the Philippines and India as was estimated in this study (Table 2). However, official data recorded only very small volumes being sourced from these countries after CITES implementation (Table 2).

Table 2. Estimated relative volumes of seahorses from reported sources in 2016-17, for (a) wholesalers, and (b) retailers, as calculated from interviews with traders in Hong Kong SAR. Only information for the top six countries for each trade level is presented. Countries are sorted from greatest to least relative purchase volumes for 2016-17. Estimates from traders are compared with those calculated from two official datasets: Hong Kong Customs and Statistics Department (CSD) and CITES trade database (CITES) (for 2005-2014). The CITES listing for seahorses was implemented in May 2004, so the functional period before listing is 1998-2003, and the period after listing is ≥ 2005.

Source	Ban on wild, dried seahorse exports (see Table 1 for details)	Number of traders reporting trade for 2016-17	Mean annual purchase volume reported by each sampled trader (kg) for 2016-17	Calculated annual purchase volume across sampled traders (kg) for 2016-17	Relative purchase volume for 2016-17 deduced in this study	Relative volumes reportedly exported to Hong Kong SAR in official datasets		
						Before CITES implementation (≤ 2003)	After CITES implementation (2005-2014)	
						CSD	CSD	CITES
(a) Wholesalers								
Thailand	Yes – all species	27	30.9±26.0 (n=11)	834.3	70.5%	48.2%	82.0%	90%
Philippines	Yes – all species	9	20.4±28.2 (n=9)	183.6	15.5%	34.4%	0.2%	0%
Indonesia	Yes – all species	8	6.9±5.5 (n=4)	55.2	4.7%	0.6%	1.3%	0%
India	Yes – all species	3	17.9 (n=2)	53.8	4.5%	7.2%	0.9%	0%
Australia	No	8	2.7 (n=1)	21.6	1.8%	0.5%	<0.1%	<0.1%
Hong Kong SAR	No	2	6 (n=1)	12	1.0%	--	--	--
Japan	No	2	6 (n=1)	12	1.0%	0%	0%	0%
(b) Retailers								
Thailand	Yes – all species	60	3.3±3.7 (n=13)	198	45.3%	48.2%	82.0%	90%
China (mainland)	Yes – all species	17	7.6±11.2 (n=4)	129.2	29.6%	0.1%	<0.1%	0%
Philippines	Yes – all species	14	6±10.1 (n=5)	84	19.2%	34.4%	0.2%	0%
Indonesia	Yes – all species	11	2.1±2.4 (n=6)	23.1	5.3%	0.6%	1.3%	0%
Viet Nam	Yes – one species	5	0.4 (n=1)	2	0.4%	0%	0%	<0.1%
Malaysia	Yes – all species	4	0.2 (n=1)	0.8	0.2%	1.8%	3.7%	2.7%

Discussion

This study provides evidence of substantial illegal and unrecorded international trade in dried seahorses from multiple countries that ban such exports. It is particularly noteworthy that illegal dried seahorse imports from Thailand, the Philippines, and Indonesia persist at notable levels. India, Malaysia, and Viet Nam are also implicated in the banned international trade of dried seahorses. As Hong Kong SAR is the major entrepôt for seahorse trade, this study's surveys provide clear indications that CITES and national CITES Authorities must do considerably more to implement the Convention's management decisions. This study's findings identify failures in export and import control as well as a need to mobilise TCM and dried seafood traders as agents in generating compliance with trade bans. Given that export bans were implemented in response to concerns about the state of seahorse populations, ongoing illegal trade poses threats to the long-term future of the species.

With seahorses, as with most wildlife trade, key challenges with conservation measures lie in their implementation and enforcement. Virtually all dominant source countries for Hong Kong's TCM trade for seahorses – and all but one of those reported by more than ten respondents as sources in 2016-17 – actually ban exports of wild dried seahorses. Indeed, this study's calculations suggest that more than 95% of seahorses by weight reportedly purchased by Hong Kong SAR traders in 2016-17 were sourced from countries with export bans. Unsurprisingly perhaps, official Hong Kong CSD records and CITES datasets did not reflect many key sources reported by Hong Kong SAR traders, particularly for those jurisdictions that banned trade soon after CITES implementation (i.e. India and the Philippines). Discrepancies in reported source countries among interview data, Hong Kong's CSD records and the CITES trade database support previous conclusions that cross-validating approaches to trade surveys are especially important for CITES-listed species because often there is no single data source that is complete and wholly reliable (Lam et al. 2014). Such disparities also reinforce the need for field trade surveys to probe official data and illuminate challenges with management and conservation (Smith et al. 2011, Foster et al. 2016). Field surveys conducted in a known environment within long-established positive relationships, as here, can be of particular value.

This study, showing difficulties with the implementation of CITES, contributes to discussions directed at improving the conservation performance of the Convention (Reeve 2002, Chandler et al. 2015). CITES member countries (Parties) are required to limit export of Appendix II listed species to levels that are safe for wild populations (called making non-detriment findings - NDFs, see Rosser and Haywood 2002, IUCN 2016b for more on NDFs generally, and Foster and Vincent 2016, Foster 2016 for more on seahorse NDFs and country implementation thereof). Where Parties are unable to prove non-detriment, whether due to a lack of information, capacity, or political will, they may choose to stop official seahorse exports. Such decisions can occur at any time and some countries do take action to ban trade as a pre-emptive management measure (e.g. India before CITES listing and the Philippines after CITES listing, references in Table 1). However, many national trade bans for seahorses have arisen as a direct result of the CITES Review of Significant Trade (RST) process. Some Parties chose to implement bans on wild seahorse trade to remove themselves from RST early in the process (e.g. mainland China, Indonesia, Malaysia, references in Table 1), others waited until they effectively had little choice (e.g. Thailand, references in Table 1) and yet more had bans imposed through the RST process (e.g. Guinea for one species, Foster 2016; Senegal and Vietnam for one species each, references in Table 1). Despite the bans, this study indicates that trade continued from each of these Asian countries and Senegal at least, such that their seahorse populations may be no better off than before the RST. CITES needs a process by which Parties that are eliminated from RST as a result of declaring an end to wild exports, or for which bans are imposed by CITES, are tracked so that breaches can be identified and remedial action taken. The most likely mechanism is that

importing countries notify the CITES Secretariat if they are receiving shipments from Parties with bans. This in turn requires the CITES Secretariat to formally notify importing countries of export bans and to maintain an easily accessible database of such bans. The important cross-validation would come from independent surveys of fisheries, markets, and trades, thus making them a priority for funding.

The risk of ongoing trade despite established bans is especially high for valuable species that are caught incidentally (such as seahorses, Lawson et al. 2017). At least 37 million seahorses have been obtained as bycatch each year in the process of nonselective fisheries (Lawson et al. 2017) – mostly in developing countries. Unless capacity and/or political will to manage such fisheries is improved and their implications for endangered, threatened, or protected (ETP) species is considered, bans on trading incidental take are unlikely to reduce their impacts on such species. With rampant non-selective fishing (e.g. by trawlers), by-take specimens will either be discarded (dead, Foster and Vincent 2016), or enter illegal trade routes. As this study confirms, the latter has certainly been the documented case for seahorses in many countries with national trade bans (e.g. India, T. Vaidyanathan, Project Seahorse, unpublished data; Malaysia, Lawson 2014; the Philippines, O'Donnell et al. 2012). In this context, Thailand's recent announcement in early 2018 that it had banned seahorse fishing (The Nation 2018) may be of little conservation value, particularly if the ban is restricted to scant targeted catch (Bangkok Post 2018); seahorses will continue to be sourced in bycatch or as a secondary catch in nonselective gear, and thereafter find a market in global trade. What is needed instead is a huge reduction in the footprint of nonselective gears such as trawls and gillnets – by reducing the number and intensity of gears, and area fished. In this case implementing existing policies would be a step in the right direction (Aylesworth et al. 2017).

The ease of trading dried seahorses contributes to the problem of illegal trade; they can easily be smuggled across borders, on their own or among other dried seafood commodities. As just one example, several respondents in this study reported moving seahorses into Hong Kong SAR in their personal suitcases. Studies have shown that traders of other wildlife have been able to change where and how they sourced wildlife in response to trade regulations (Crook and Nakamura 2013, Moyle 2014). Without proper enforcement of export bans by both exporting and importing countries, incidental take and ease of transport mean that captured seahorses will continue to make their way across borders to meet market demands. Of course, for many species reducing demand would also serve to reduce the scale of illegal trade – though this is unlikely to have a conservation benefit for seahorses that are captured in non-selective fishing gears.

Even where export bans are well implemented, or demand reduced, conservation of species in bycatch or bytake will depend vitally on robust management of extraction to complement those trade bans. In addition to trade regulations, countries needing to implement national legislation or CITES Appendix listings for bycaught species should focus on improving management of the fisheries that extract them. For seahorses this includes mainly trawls, gill-nets, and seine nets (Lawson et al. 2017). Even though CITES is about international trade, meaningful implementation of CITES for seahorses and many species requires Parties to embark on management of exploitation, mostly through constraints on the number and intensity of gears and area fished (Foster and Vincent 2016). A reduction in the impact of nonselective gears would also reduce conflict with more selective fisheries that have lower environmental impacts and employ more people. In this way, scaling back the most destructive and nonselective gears would have positive results for fisheries overall (e.g. McClanahan et al. 2014, Campbell et al. 2018). For seahorses at least, the road map is there, the tools are in place, and the

protocols are available to make considerable progress in this regard (e.g. see Foster and Vincent 2016, IUCN 2016b for non-detriment advice for seahorses and marine fishes, respectively).

This study contributes to the debate on the merits and costs of banning extraction and/or trade in wildlife as a conservation measure (Dutton et al. 2013, Weber et al. 2015). On the one hand, bans certainly have a place where conservation need is acute, the bans can be implemented effectively and ending trade can make a material difference to wild populations (e.g. ivory from African elephants in Tanzania and South Africa, Lemieux and Clarke 2009). On the other, bans are too often paper declarations that lead trade to move underground, making it more difficult to monitor and/or manage markets (e.g. humphead wrasse, Wu and Sadovy de Mitcheson 2016; seahorses, O'Donnell et al. 2012, Lawson 2014; elephants (ivory), Burn et al. 2011; ornamental plants, Phelps and Webb 2015). Banning international trade in marine wildlife is clearly complex as evidenced by the high level of illegal, unregulated and unreported (IUU) fishing (Agnew et al. 2008, May 2017). While plenty of discussion is emerging about IUU damage to target fisheries and socioeconomic well-being, more efforts are needed into IUU damage to ETP species. Tracking trade in ETP from IUU fisheries is difficult enough in open markets, but yet more difficult when their sale is banned. In the case of seahorses, much of the exploitation is illegal but virtually all is unregulated and unreported. India and the Philippines theoretically ban extraction, but implementation is patently inadequate (T. Vaidyanathan, Project Seahorse, unpublished data; Foster and Apale 2016).

While enforcing bans may not, per se, address all conservation challenges, it must be undertaken with due seriousness in support of ETP species, not least to engender respect for the rule of law. Growing international awareness of the risks of IUU fishing and IWT should be marshalled for seahorses and other marine species. In this respect, new initiatives such as Interpol's Project Scale (https://www.interpol.int/Crime-areas/Environmental-crime/Projects/Project-Scale), can offer support in reducing IUU fishing, as can numerous technological surveillance projects (e.g. CCAMLR's Eye in the Sky: https://www.ccamlr.org/en/news/2016/eyes-sky). Governments are also beginning to understand that illegal engagement with extraction and trade of wildlife poses risks that extend well beyond conservation; such activity is commonly married to trade in arms, drugs, other controlled substances… and even human trafficking (Biggs et al. 2017). In this respect, CITES is actively engaged with partner organizations in seeking to control illegal trade in elephants, tigers, totoaba, and great apes (Reeve 2006, CITES 2016c).

The Convention needs to enhance its activities to ensure implementation of export restrictions on marine species, for which seahorses remain the pioneers. In particular, the Secretariat should make easily available a list of all Parties that have trade bans for any listed species and communicate the existence of these bans to CITES Authorities through any means available to them. The Secretariat should further encourage CITES Authorities to inform exporters and importers of bans so they can play their important role in compliance and enforcement. These traders should not accept seahorses from source countries with trade bans at risk of confiscation and stiff fines. It is going to take all actors in this game to curb the substantial illegal trade that riddles the commerce in wildlife.

Acknowledgements

References

Agnew, D., Pearce, J., Peatman, T., Pitcher, T., and Pramod, T. 2008. The global extent of illegal fishing. Marine Resources Assessment Group (MRAG) and Fisheries Centre, The University of British Columbia. London, UK. 32pp.

Aylesworth, L., Phoonsawat, R. and Vincent, A.C.J. 2017. Effects of indiscriminate fisheries on a group of small data-poor species in Thailand. *ICES Journal of Marine Science*. 75(2): 642–652. doi: 10.1093/icesjms/fsx193.

Bangkok Post. 2018. Seahorse kebabs spur fishing ban. Published January 24, 2018. https://www.bangkokpost.com/archive/seahorse-kebabs-spur-fishing-ban/1400930.

Baum, J.K., and Vincent, A.C.J. 2005. Magnitude and inferred impacts of the seahorse trade in Latin America. *Environmental Conservation* 32(4):305-319. doi:10.1017/S0376892905002481.

Biggs, D., Cooney, R., Roe, D., Dublin, H.T., Allan, J.R., Challender, D.W., and Skinner, D. 2017. Developing a theory of change for a community-based response to illegal wildlife trade. *Conservation Biology*, 31(1): 5-12. doi: 10.1111/cobi.12796.

Burn, R. W., Underwood, F.M., Blanc, J., McCubbins, M., and Leader-Williams, N. 2011. Global trends and factors associated with the illegal killing of elephants: a hierarchical Bayesian analysis of carcass encounter data. *PLoS ONE* 6:e24165. doi:10.1371/journal.pone.0024165.

Bush, E. R., Baker, S.E., and Macdonald, D.W. 2014. Global trade in exotic pets 2006-2012. *Conservation Biology* 28:663–676. doi:10.1111/cobi.12240.

Campbell, S.J., Edgar, G.J., Stuart-Smith, R.D., Soler, G., and Bates, A.E. 2018. Fishing-gear restrictions and biomass gains for coral reef fishes in marine protected areas. *Conservation Biology*. 32(2): 401-410. doi: 10.1111/cobi.12996.

Challender, D. W. S., Harrop, S.R., and MacMillan, D.C. 2015. Towards informed and multi-faceted wildlife trade interventions. *Global Ecology and Conservation* 3:129–148. doi:10.1016/j.gecco.2014.11.010.

CITES, Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973. https://www.cites.org/eng/disc/text.php#IV, Accessed 15 November 2017.

CITES. 2011. Twenty-fifth meeting of the Animals Committee: Review of Significant Trade in specimens of Appendix-II species, Species selected at AC24. https://www.cites.org/sites/default/files/eng/com/ac/25/E25-09-05.pdf, Accessed 15 November 2017.

CITES. 2013. Sixty-third meeting of the Standing Committee: Summary Record. https://www.cites.org/sites/default/files/eng/com/sc/63/E-SC63-SumRec.pdf, Accessed 15 November 2017.

CITES. 2016a. Sixty-seventh meeting of the Standing Committee: Review of Significant Trade in specimens of Appendix-II species, Implementation of recommendations of the Animals and Plants Committees. Information submitted by Thailand on *Hippocampus kelloggi, H. kuda* and *H. spinosissimus*. (SC67

Doc.15 Annex 2). https://cites.org/sites/default/files/eng/com/sc/67/E-SC67-15-A2.pdf, Accessed 15 November 2017.

CITES. 2016b. Sixty-sixth meeting of the Standing Committee: Summary record. https://cites.org/sites/default/files/eng/com/sc/66/ExSum/E-SC66-SR.pdf, Accessed 15 November 2017.

CITES. 2016c. Sixty-sixth meeting of the Standing Committee: Interpretation and implementation of the Convention, Totoaba (*Totoaba macdonaldi*) - Opportunities for international collaboration within the CITES framework. https://cites.org/sites/default/files/eng/com/sc/66/E-SC66-58.pdf, Accessed 15 November 2017.

Crook, V., and Nakamura, M. 2013. Assessing supply chain and market impacts of a CITES listing on Anguilla species. *TRAFFIC Bulletin* 25:24–30.

Denzin, N., and Lincoln, Y. 2011. The SAGE handbook of qualitative research. Sage Publications Inc. Thousand Oaks, California, USA.

Department of Agriculture, Bureau of Fisheries and Aquatic Resourtces (DA-BFAR) 1998. Republic Act No. 8550 - The Philippine Fisheries Code of 1998.

Dutton, A.J., Gratwicke, B., Hepburn, C., Herrera, E., and Macdonald, D.W. 2013. Tracking unsustainable wildlife trade. *Key Topics in Conservation Biology* 2:74-91.

Engler, M. 2008. The value of international wildlife trade. *TRAFFIC Bulletin* 22:4–5.

FAO. 2016. The State of World Fisheries and Aquaculture 2016. FAO, Rome, Italy, 200pp.

Fergusson, I., Compagno, L.J.V. and Marks, M. 2009. *Carcharodon carcharias*. The IUCN Red List of Threatened Species 2009: e.T3855A10133872. dio: dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T3855A10133872.en.

Findley, L. 2010. *Totoaba macdonaldi*. The IUCN Red List of Threatened Species 2010: e.T22003A9346099. doi:10.2305/IUCN.UK.2010-3.RLTS.T22003A9346099.en

Foster, S.J., Aylesworth, L., Do, H.H., Bat, N.K., and Vincent, A.C.J. 2017. Seahorse exploitation and trade in Viet Nam. *Fisheries Centre Research Reports* 25(2):50pp. Available at: http://oceans.ubc.ca/files/2017/11/Final-FCRR-25-2-Withcover-2017-1121.pdf, Accessed 22 November 2017.

Foster, S. J. 2016. Seahorses (*Hippocampus* spp.) and the CITES Review of Significant Trade. *Fisheries Centre Research Reports* 24:48. doi:10.14288/1.0319240.

Foster, S.J., Apale, C.M. 2016. Exploitation, trade, conservation and management of seahorses in the Philippines. Project Seahorse and ZSL-Philippines. 40pp. Available at: http://www.projectseahorse.org/ndf-country-specific, Accessed 22 November 2017.

Foster, S. J., and Vincent, A.C.J. 2016. Making Non-Detriment Findings for seahorses – a framework. Version 4.0/Project Seahorse, Fisheries Centre, The University of British Columbia, Vancouver, Canada. Available at http://www.projectseahorse.org/ndf, Accessed 22 November 2017.

Foster, S. J., Wiswedel, S., and Vincent, A.C.J. 2016. Opportunities and challenges for analysis of wildlife trade using CITES data - seahorses as a case study. *Aquatic Conservation: Marine and Freshwater Ecosystems* 26:154–172. doi:10.1002/aqc.2493.

Harris, J.B.C., Tingley, M.W., Hua, F., Yong, D.L., Adeney, J.M., Lee, T.M., Marthy, W., Prewiradilaga, D.M., Sekercioglu, C.H., Sudayi, Winari, N., and Wilcove, D.S. 2017. Measuring the impact of the pet trade on Indonesian birds. *Conservation Biology* 31:394–405. doi:10.1111/cobi.12729.

Hilton-Taylor, C., Pollock, C.M., Chanson, J.S., Butchart, S.H.M., Oldfield, T.E.E., and Katariyam V. 2009. State of the world's species. In: Vie, J.C., Hilton-Taylor, C., and Stuart, S.N. (eds.) 2009. Wildlife in a Changing World: An Analysis of the 2008 IUCN Red List of Threatened Species. Threatened Species. Gland Switzerland, IUCN. 180pp.

Hong Kong Census and Statistics Department. 2015. Hong Kong Merchandise Trade Statistics Domestic Exports and Re-exports.

Indian Ministry of Environment and Forests. 1972. The Indian Wildlife Protection Act, 1972. Available at: http://envfor.nic.in/legis/wildlife/wildlife1.html, Accessed 15 November 2017.

Indian Ministry of Environment and Forests. 2003. The Wild Life Protection Amendment Act, 2002. Available at: http://envfor.nic.in/legis/wildlife/wild_act_02.htm, Accessed 15 November 2017.

IUCN. 2016a. Assisting Parties to meet their commitments: CITES Review of Significant Trade for seahorses (Hippocampus spp.), a taxon traded in high volumes. Information document for the 17th meeting of the CITES Conference of the Parties. (CoP17 Inf. 53 (Rev. 1)). Available at: https://cites.org/sites/default/files/eng/cop/17/InfDocs/E-CoP17-Inf-53-Rev1.pdf, Accessed 15 November 2017.

IUCN. 2016b. Implementation of CITES Appendix II listings for marine fishes: Important considerations when making non-detriment findings. Information document for the 17th meeting of the CITES Conference of the Parties. (CoP17 Inf. 52 (Rev. 1)). Available at: https://cites.org/sites/default/files/eng/cop/17/InfDocs/E-CoP17-Inf-52-Rev1.pdf, Accessed 15 November 2017.

Jacques, P. J. 2010. The social oceanography of top oceanic predators and the decline of sharks: A call for a new field. *Progress in Oceanography* 86:192–203. doi:10.1016/j.pocean.2010.04.001.

Lam, J. T. L., Koldewey, H.J., Yasué, M., and Vincent, A.C.J. 2014. Comparing interview and trade data in assessing changes in the seahorse *Hippocampus* spp. trade following CITES listing. *Oryx*:1–11. doi:10.1017/S0030605314000246.

Lawson, J. 2014. Rare seahorses have big implications for small fishes in bycatch. The University of British Columbia. doi:10.14288/1.0166949.

Lawson, J. M., Foster, S.J., and Vincent, A.C.J. 2017. Low bycatch rates add up to big numbers for a genus of small fishes. *Fisheries* 42:19–33. doi:10.1080/03632415.2017.1259944.

Lemieux, A. M., and Clarke, R.W. 2009. The International Ban on Ivory Sales and its Effects on Elephant Poaching in Africa. *British Journal of Criminology* 49:451–471.

May, C. 2017. Transnational crime and the developing world. Global Financial Integrity. Washington DC, USA.

Maxwell, S., Fuller, R., Brooks, T., and Watson, J. 2016. Biodiversity: The ravages of guns, nets and bulldozers. *Nature* 536:143–145. doi:10.1038/536143a.

McClanahan, T.R., Graham, N.A.J., MacNeil, M.A., and Cinner, J.E. 2014. Biomass-based targets and the management of multispecies coral reef fisheries. *Conservation Biology* 29:409–417. doi:10.1111/cobi.12430.

McClenachan, L., Cooper, A.B., and Dulvy, N.K. 2016. Rethinking Trade-Driven Extinction Risk in Marine and Terrestrial Megafauna. *Current Biology* 26:1–7. doi:10.1016/j.cub.2016.05.026.

Milner-Gulland, E. J., and Bennett, E.L. 2003. Wild meat: the bigger picture. *Trends in Ecology & Evolution* 18:351–357. doi:10.1016/S0169-5347(03)00123-X.

Missios, P. C. 2004. Wildlife trade and endangered species protection. *Australian Journal of Agricultural and Resource Economics* 48:613–627. doi:10.1111/j.1467-8489.2004.00264.x.

Moyle, B. 2014. The raw and the carved: Shipping costs and ivory smuggling. *Ecological Economics* 107:259–265. doi:10.1016/j.ecolecon.2014.09.001.

O'Donnell, K. P., Molloy, P.P., and Vincent, A.C.J. 2012. Comparing fisher interviews, logbooks, and catch landings estimates of extraction rates in a small-scale fishery. *Coastal Management* 40:594–611. doi:10.1080/08920753.2012.727734.

Oldfield, S. 2003. The trade in wildlife: regulation for conservation. Earthscan Publications Ltd. London, UK.

Phelps, J., Biggs, D., and Webb, E.L. 2016. Tools and terms for understanding illegal wildlife trade. *Frontiers in Ecology and the Environment* 14:479–489. doi:10.1002/fee.1325.

Phelps, J., and Webb, E.L. 2015. "Invisible" wildlife trades: Southeast Asia's undocumented illegal trade in wild ornamental plants. *Biological Conservation* 186:296-305. doi:10.1016/j.biocon.2015.03.030.

Pramod, G., Nakamura, K., Pitcher, T.J., and Delagran, L. 2014. Estimates of illegal and unreported fish in seafood imports to the USA. *Marine Policy* 48:102–113. doi:10.1016/j.marpol.2014.03.019

Reeve, R. 2002. Policing international trade in endangered species: the CITES treaty and compliance. The Royal Institute of International Affairs/Earthscan. London, UK.

Reeve, R. 2006. Wildlife trade, sanctions and compliance: lessons from the CITES regime. *International Affairs* 82:881–897. doi:10.1111/j.1468-2346.2006.00576.x.

Roe, D., Mulliken, T., Milledge, S., Mremi, J., Mosha, S., and Grieg-Gran, M. 2002. Making a killing or making a living? Wildlife trade, trade controls and rural livelihoods. *Biodiversity and Livelihoods* 59:109.

Rosser, A., and Haywood, M. 2002. Guidance for CITES scientific authorities : checklist to assist in making non-detriment findings for appendix II exports. IUCN, Gland, Switzerland and Cambridge, UK.

Shepherd, C. R. 2010. Illegal primate trade in Indonesia exemplified by surveys carried out over a decade in North Sumatra. *Endangered Species Research* 11:201-205. doi:10.3354/esr00276.

Shivji, M. S., Chapman, D.D., Pikitch, E.K., and Raymond, P.W. 2005. Genetic profiling reveals illegal international trade in fins of the great white shark, *Carcharodon carcharias*. *Conservation Genetics* 6:1035–1039. doi:10.1007/s10592-005-9082-9.

Smith, M. J., Benítez-Díaz, H., Clemente-Muñoz, M. Á., Donaldson, J., Hutton, J.M., McGough, H.N., Medellin, R.A., Morgan, D.H.W., O'Criodain, C., Oldfield, T.E.E., Schippmann, U., and Williams, R.J. 2011. Assessing the impacts of international trade on CITES-listed species: Current practices and opportunities for scientific research. *Biological Conservation* 144:82–91. doi:10.1016/j.biocon.2010.10.018.

The Nation. 2018. Thailand to ban commercial fishing of seahorses. Published January 25, 2018. http://www.nationmultimedia.com/detail/national/30337148.

UNEP-WCMC (2012). Review of Significant Trade: Species selected by the CITES Animals Committee following CoP14 and retained in the review following AC25. Available at: https://www.cites.org/sites/default/files/eng/com/ac/26/E26-12-02-A.pdf. Accessed 15 November 2017.

Underwood, F. M., Burn, R.W., and Milliken, T. 2013. Dissecting the Illegal Ivory Trade: An Analysis of Ivory Seizures Data. *PLoS ONE* 8:e76539. doi:10.1371/journal.pone.0076539.

van Uhm, D. P. 2016. The Illegal Wildlife Trade: Inside the World of Poachers, Smugglers and Traders. Springer Nature eBook, Switzerland. doi:10.1007/978-3-319-42129-2.

Vincent, A. 1996. The international trade in seahorses. TRAFFIC International, Cambridge, UK. vii+163pp.

Vincent, A. C. J., and Foster, S.J. 2017. Setting Precedent in Export Regulations for Marine Fishes with Seahorses. *Fisheries* 42:40–43. doi:10.1080/03632415.2017.1273658.

Vincent, A. C. J., Sadovy de Mitcheson, Y.J., Fowler, S.L., and Lieberman, S. 2013. The role of CITES in the conservation of marine fishes subject to international trade. *Fish and Fisheries* 15:563–592. doi:10.1111/faf.12035.

Vincent, A. C. J., Foster, S.J., and Koldewey, H.J. 2011a. Conservation and management of seahorses and other Syngnathidae. J*ournal of Fish Biology* 78:1681–1724. doi:10.1111/j.1095-8649.2011.03003.x.

Vincent, A.C.J., Giles, B.G., Czembor, C.A., and Foster, S.J. 2011b. Trade in seahorses and other syngnathids in countries outside Asia (1998-2001). *Fisheries Centre Research Reports* 19(1): 181pp. doi:10.14288/1.0058185.

Weber, D.S., Mandler, T., Dyck, M., De Groot, P.J.V.C., Lee, D.S., and Clark, D.A. 2015. Unexpected and undesired conservation outcomes of wildlife trade bans: An emerging problem for Stakeholders? *Global Ecology and Conservation* 3:389-400. doi:10.1016/j.gecco.2015.01.006.

Wu, J., and Sadovy De Mitcheson, Y. 2016. Humphead (Napoleon) Wrasse *Cheilinus undulatus* trade into and through Hong Kong. TRAFFIC Hong Kong, SAR.

Table S1. Sensitivity analysis for the assumption around the qualitative description of relative trade volume of dried seahorses being imported into Hong Kong SAR from 2016-17 as deduced from interviews with local traders. We present the mean annual purchase weight per trader based on different assumptions: 'More' = 60, 70, 80, 90%, and thus 'Less' = 40, 30, 20, 10%, respectively. The sources are in descending order of the frequency at which traders reported them. W: Wholesalers; R: Retailers. *indicates a source with a ban on wild, dried seahorse exports – for all or certain species (see Table 1 for details).

Source	Mean/median of annual purchase weight per trader (kg) 'More' = 60%		Mean/median of annual purchase weight per trader (kg) 'More' = 70%		Mean/median of annual purchase weight per trader (kg) 'More' = 80%		Mean/median of annual purchase weight per trader (kg) 'More' = 90%	
	W	R	W	R	W	R	W	R
Thailand*	28.2±23.0 (n=11)	3.3±3.7 (n=13)	30.0±24.8 (n=11)	3.3±3.7 (n=13)	31.8±26.9(n=11)	3.3±3.6 (n=13)	33.7±29.2 (n=11)	3.3±3.6 (n=13)
Philippines*	19.8±28.1 (n=9)	6±10.1 (n=5)	20.1±28.2 (n=9)	6±10.1 (n=5)	20.5±28.1 (n=9)	6±10.1 (n=5)	21.0±28.4 (n=9)	6±10.0 (n=5)
Australia	1.8 (n=1)		2.1 (n=1)		2.4 (n=1)		2.7 (n=1)	
Mainland China*	3.7 (n=1)	7.6±11.2 (n=4)	2.8 (n=1)	7.6±11.2 (n=4)	2.4 (n=1)	7.6±11.2 (n=4)	0.9 (n=1)	7.6±11.2 (n=4)
Indonesia*	8.3±8.1 (n=4)	2.2±2.3 (n=6)	7.5±5.5 (n=4)	2.1±2.3 (n=6)	6.4±4.1 (n=4)	2.1±2.4 (n=6)	5.2±4.1 (n=4)	2.0±2.4 (n=6)
India*	0.9±12.8 (n=2)		13.0±14.5 (n=2)		14.3±17.5 (n=2)		15.5±20.6 (n=2)	
Vietnam*		0.3 (n=1)		0.3 (n=1)		0.4 (n=1)		0.4 (n=1)
Malaysia*	2.9±1.5 (n=2)	0.2 (n=1)	2.9±0.9 (n=2)	0.2 (n=1)	2.9±1.5 (n=2)	0.2 (n=1)	2.9±2.1 (n=2)	0.2 (n=1)
Hong Kong	6 (n=1)		6 (n=1)		6 (n=1)		6 (n=1)	
Japan	12 (n=1)		12 (n=1)		12 (n=1)		12 (n=1)	
Senegal*	1.9 (n=1)		1.9 (n=1)		1.9 (n=1)		1.9 (n=1)	
Singapore	1.9 (n=1)		1.9 (n=1)		1.9 (n=1)		1.9 (n=1)	