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Tracking the international
trade of seahorses
(*Hippocampus* species)

Fisheries Centre, University of British Columbia, Canada

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by

Melissa Evanson, Sarah J. Foster, Stefan Wiswedel & Amanda C. J. Vincent

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LIST OF ACRONYMS

CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EFI	Exports from imports
FAO	Food and Agricultural Organization
GMAD	Global Marine Aquarium Database
GRM	Grams
IND	Individuals
IUCN	International Union for Conservation of Nature and Natural Resources
KIL	Kilograms
SAR	Special Administrative Region
TCM	Traditional Chinese medicine
TM	Traditional medicine
UAE	United Arab Emirates
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
USA	United States of America
WCMC	World Conservation Monitoring Centre
WHO	World Health Organization

DIRECTOR'S FOREWORD

This report provides the first analysis of the data reported by Parties to CITES for a group of commercially important fish species, the seahorses. With this report, Project Seahorse provides us with yet another important tool in support of an international instrument which has not yet shown its full potential for contributing to sustainable fisheries. Since 2004, seahorse exports have been regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Their listing on Appendix II obliges the signatory nations to limit exports to levels that will not damage wild populations.

Researchers at Project Seahorse compiled the first four years of seahorse data available in the CITES Trade Database – which is home to the trade records reported by CITES Parties in their annual report submissions. There were two main incentives for this work. The first was to document what the CITES data were suggesting about the international trade in seahorses immediately following implementation of the CITES Appendix II listing, from 2004-2008, and how this compared to the best understanding of the trade pre-CITES. The second was to examine the usefulness of CITES data for tracking international trade in threatened species – the benefits as well as suggesting areas for improvement.

Their analysis of CITES data for seahorses reinforced the sheer scale and complexity of the international trade in these marine fishes – with large numbers of seahorses reportedly traded by nations from every continent in the world, outside Antarctica. This first analysis of CITES data for an Appendix II fish also revealed prevalent issues in CITES annual report submissions, but in so doing indicates a way forward. The authors make sound recommendations for improving the accuracy of CITES data and thus increasing the utility of this globally important resource for tracking the international trade in threatened species.

I congratulate the authors on this important piece of work.

Ussif Rashid Sumaila, Director

UBC Fisheries Centre

ABSTRACT

The database generated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES: www.unep-cites.org) offers an unparalleled opportunity to analyse trade in species of conservation concern. We here evaluate its value and challenges in the context of trade in seahorses (*Hippocampus* spp), with a view to enhancing the CITES database to its full potential. All seahorses are included on Appendix II of the Convention, requiring that all 176 Parties to CITES (signatory countries) limit exports to levels that do not damage wild populations, and report their trade to CITES. This is the first examination of CITES data for any marine fish of commercial importance; seahorses are traded for traditional medicine, aquarium display and curiosities.

We analysed the records of seahorse trade submitted by Parties to CITES in the four years after implementation of the listing, which occurred in 2004, and compared reported trends to historical data sets collected in global trade surveys between 1998 and 2001. This allowed us to 1) see what CITES data can tell us about trends in the global trade of seahorse, 2) compare recent CITES data to historical pre-listing survey data, and 3) highlight the benefits and pitfalls of using the CITES Trade Database for analysing trade in threatened species.

Our evaluation indicated that Parties need to improve their entries by identifying the exports to species (23% of records were reported only to the level of genus), providing units for exports (e.g. individuals, kgs), and recording all trade shipments. In particular, the substantial mismatch in species and volumes between (i) mandatory export records for all Parties and (ii) voluntary import records by particular Parties emphasises the value of the latter and argues a need for greater universal compliance with CITES reporting requirements. The discrepancies among export and import data also suggested under-reporting to be a major problem with CITES data for seahorses. The challenges with the CITES database were more evident for the global trade in dried seahorses than the smaller and more discrete trade in live seahorses.

For all the limitations of the CITES data, they indicated that seven years after implementing CITES for seahorses, the trade in these marine fishes continues to involve tens of species, scores of countries and millions of animals – the vast majority of which were reportedly traded dried and from the wild. The CITES database reports more species in trade and lower volumes of trade than had been estimated historically, but the evident data gaps mean that we cannot deduce where the correct estimate lies. Asian countries were both the main exporters and importers for seahorses over time, with Thailand as the primary source for seahorses in dried trade, and Hong Kong SAR, Taiwan and mainland China as the major consumers. The inferences we were forced to make from CITES data suggested substantial new exports from Guinea. These patterns in source and consumption of dried seahorses were reflected in the species reported to CITES – with the vast majority of the dried trade by volume reported as one of three Asian (*Hippocampus trimaculatus*, *H. spinosissimus*, *H. kelloggi*) or one West African (*H. algiricus*) species. CITES data reported a level of export of live seahorses from 2004–2008 that was rather lower than that deduced pre-CITES, and indicated an increasing reliance on captive-breeding operations to supply the live trade. Southeast Asian countries declared most of the trade in live seahorses, a finding consistent with historic trade patterns, and the USA remained the primary destination for live trade. As with the dried trade, the live trade reported to CITES was focused on a few species. Two species, *H. kuda* and *H. reidi*, were reported to make up more than three-quarters of live trade volumes in CITES data.

Despite the challenges faced in using CITES data to analyse trade in seahorses, the CITES Trade Database gives us an unparalleled tool to investigate the trade in seahorses and other listed species. There is, however, a clear need to improve the reliability and thus increase the utility of the database. Some suggested improvements include: 1) automate record validation to help eliminate common sources of reporting discrepancies; 2) increased capacity to improve species identification and emphasize the importance of accuracy in volumes and units; 3) allowances for easier submission of records of derivatives (including species content); and 4) implement a system to cross-validate data through field and trade sampling. It is important to realise that even perfect CITES data would leave many questions unanswered. For example, for all Parties there is a great need to understand any domestic consumption of seahorses (which is sometimes very large) and the additional pressure it may apply.

INTRODUCTION

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is one of several international treaties (e.g. UN Convention on the Law of the Sea, Convention on Biological Diversity) that attempt to protect and conserve threatened habitats and/or species through diverse means and with varying levels of success (Lyster 1993; Herkenrath 2002; Blundell and Masica 2005; Dobson 2005; Carpenter 2006). CITES works by prohibiting or regulating the trade of selected species by subjecting them to certain controls depending on their degree of protection. The international commercial trade of species listed in CITES Appendix I, for example, is not permitted because it is recognized as a threat to the continued survival of the species in the wild. Species listed on Appendix II, however, are vulnerable, but less likely to be threatened with extinction and can be traded with an export permit and evidence that harvesting is not detrimental to the future of wild populations. Ultimately, the Convention attempts to take a proactive approach by controlling trade to prevent species extinction.

Despite concerns regarding the goals and efficacy of CITES (Kievit 2000; Martin 2000), the Convention has been described as among the most effective international conservation-oriented treaties due to its broad acceptance as evidenced by the number of participating nations (175 Signatory Parties) and its enforcement, relative to other treaties (Ong 1998; Ginsberg 2002). The captive rearing and managed extractions of crocodiles, for example, have been held up as a success story in the search for sustainable use of wildlife (Thorbjarnarson 1999). After 25 years of conservation efforts by CITES member states, eight of 23 historically endangered or threatened species were sufficiently abundant in numbers to sustain regulated commercial trade (Kievit 2000). This shift in status was believed to have demonstrated the effectiveness of conservation of terrestrial species through sustainable utilization endorsed by CITES.

While CITES has proved an effective conservation tool for many highly valued commercial terrestrial species, differences of opinion regarding the role of CITES as a management tool for commercially exploited fishes have yet to be fully reconciled. There is a lack of consensus among FAO member countries, for example, on the role of CITES as an instrument to protect and promote the sustainable use of fisheries resources (FAO 2010). In addition, member countries have been concerned with whether CITES listing criteria, procedures and administrative mechanisms are structured to take account of the natural dynamics of commercial fish stocks (Berney 2000; Johansen 2002). Despite these concerns, CITES can assist in developing or improving fisheries management and a Memorandum of Understanding signed by CITES and FAO in 2006 formalized the intentions of the two organizations to strengthen cooperation on issues related to commercially-exploited aquatic species (FAO 2008).

The 2002 listing of all seahorse species (*Hippocampus* spp.) on CITES Appendix II was one of the first to limit the international trade of a marine fish of commercial importance (CITES 2003). Seahorses, there are currently thought to be c. 47 species (S. Lourie, Project Seahorse, unpublished data), are traded extensively and worldwide for use in traditional medicine, curios and live for display as aquarium fish, at levels that raise concern for sustainability of many populations (Vincent *et al.* 2011a). In addition to the inherent risk to population health associated with commercial exploitation, seahorses have certain life history characteristics (e.g. low population densities, low fecundity and small home ranges) that make them particularly vulnerable to overexploitation (Foster and Vincent 2004). Early investigations into the seahorse trade in the 1990s to early 2000s demonstrated that some species and populations were being overexploited by an increasing number of source countries (e.g. Vincent 1996; McPherson and Vincent 2004; Giles *et al.* 2006).

A CITES Appendix-II listing for seahorses aims to contribute to an accurate understanding of the global trade in seahorses and improve the ability to obtain global trade data on a species level – critical for understanding the impact of fisheries on local and regional seahorse populations. Parties provide annual reports to the CITES Secretariat, including full details of all permits and certificates issued during the previous year. These data are held in the CITES Trade Database, managed by The United Nations Environmental Programme's World Conservation Monitoring Center (UNEP-WCMC; <http://www.unep-wcmc-apps.org/citetrade/trade.cfm>). The required use of standardized export permit forms assists the collection of species-specific trade data and, along with historic surveys (e.g. Vincent 1996; Martin-Smith 2006; Perry *et al.* 2010) provided a unique opportunity to compare the seahorse trade pre- and post-listing. Challenges, however, are inherent in global database management and unreliable data provide a

possible impediment to CITES successfully regulating the trade in seahorses and other wildlife (Blundell and Masica 2005). Understanding the effectiveness of CITES, therefore, is linked to its ability to accurately track long term data for global volumes, species and trade routes, while minimizing reporting inaccuracies. The data on seahorse trade collected by CITES offers a unique opportunity to track the international trade in seahorses and provides an occasion to identify how best we can use these data to increase our capacity to manage trade and populations of fishes such as seahorses.

The objectives of this report were to:

- 1) see what CITES can tell us about trends in the global trade of seahorse volumes, species and trade routes since their listing in 2004;
- 2) compare recent CITES data to historical pre-listing survey data; and
- 3) highlight the benefits and pitfalls of using the CITES Trade Database.

METHODS

We begin this report by providing a synthesis of current global trends in international seahorse trade based on data reported by Parties to the CITES Trade Database for the years 2004-2008. We provide information on species, trade routes – source and consumer countries, and total volumes traded, of dried and live (wild and captive-bred) seahorses. We then compare these global trends to those observed in pre-CITES global trade surveys which we refer to as *second surveys* (Vincent *et al.* 2011a). Project Seahorse conducted these *second surveys* in 28 countries worldwide between 1998 and 2001 (Vincent *et al.* 2011a, b). Since it was impossible to survey entire nations, trade researchers attempted to identify the main seahorse landing or trade areas, and then focused survey effort on these areas. The limited geographic scope of these earlier surveys likely resulted in the underestimation of pre-CITES levels of seahorse trade. Trade data in published manuscripts were sometimes updated up until 2003 (e.g. Baum and Vincent 2005).

The core of our report is a country-by-country assessment of the trade in dried seahorses. Similar to the global analysis, the individual country sections first summarize CITES data from 2004-2008 for species, trade routes, and total trade volumes. After we summarize the data for each country, we compare observed trends to historical published and unpublished data based on Project Seahorse in-field surveys and official government customs records – the *second surveys*. The countries/regions presented include: Africa, Australia, East Asia [mainland China, Hong Kong SAR, Japan, Democratic People's Republic of Korea, Singapore, Taiwan (Province of China)], South East Asia (Indonesia, Malaysia, Philippines, Thailand, Vietnam) and Latin America (Costa Rica, Ecuador, Mexico, Peru).

TRADE DATA SOURCES

Trade Surveys and Government Trade Statistics (pre-CITES listing)

The first investigation into the international trade in seahorses involved extensive Asian field trade surveys in 1993 and 1995 (Vincent 1996). This early work (hereafter referred to as *first surveys*) raised concern regarding the sustainability of the seahorse trade.

The *second surveys* into the seahorse trade were conducted by Project Seahorse team members and occurred from 1998-2001. These *second surveys* covered a broader geographic scale (i.e., 28 countries) drawing on the *first surveys* to identify specific regions and countries that needed research. Both sets of field trade surveys drew on two main sets of information: (1) extensive *in situ* interviews with participants in the trade (e.g. fishers, buyers, importer/exporters, retailers) or those with knowledge of the trade (e.g. scientific researchers, non-governmental organisations); and (2) official data collected by government agencies detailing either the catch or trade of seahorses, primarily from Hong Kong SAR (from 1998) and Taiwan (from 1982). In addition, *second surveys* incorporated data collected by the Global Marine Aquarium Database (GMAD) documenting the international trade in live, marine ornamental species.

Interview respondents were located through a combination of haphazard and snowball sampling (a method where new respondents are located through already established contacts, Gubrium and Holstein 2002). Interviews were semi-structured and sought to obtain information on seahorse trade routes, volumes, values, uses, demand and temporal trends in supply. Responses from trade surveys were cross-checked by rephrasing the same question at different stages of the interview and by asking the same questions of people at the same and different levels of the trade. When possible, information obtained from surveys was compared to official government fisheries and trade statistics. For each region or country, a detailed trade report was produced, providing extensive technical information for resource managers. In order to make them more broadly available, the reports on regions outside Asia have now been compiled into a single publicly accessible volume (Vincent *et al.* 2011b) and the reports on Asian regions are being prepared for similar release. About half of all reports (Asian and non-Asian) have also been synthesised as primary papers (McPherson and Vincent 2004; Baum and Vincent 2005; Giles *et al.* 2006; Martin-Smith 2006; Perry *et al.* 2010).

CITES Trade Database (2004-2008)

Background

CITES provides a legal framework under the United Nations Environmental Programme's World Conservation Monitoring Center (UNEP-WCMC) for regulating the international trade in species threatened, or potentially threatened, by that trade. Appendix II of CITES specifies that the export of any listed species requires the presentation of an export permit by the source country. The export permit is only granted when the Scientific Authority of the State of export (i.e., source country) can advise that "such export will not be detrimental to the survival of that species", and when the Management Authority of the State of export is satisfied that "the specimen was not obtained in contravention of the laws of that State for the protection of fauna and flora" and that any living specimens "will be so prepared and shipped as to minimize the risk of injury, damage to health or cruel treatment" (UNEP-WCMC 1979a). Each exporting Party is therefore obliged under the Convention to designate a Management Authority responsible for issuing permits and for compiling annual reports on their trade of CITES-listed species. The importing or consumer country, however, only has to ensure that shipments of Appendix II species have an associated export permit or re-export certificate, thereby putting the onus on the source country for providing trade information to CITES.

The information required in each permit is clearly outlined by CITES (<http://www.cites.org/eng/res/all/12/E12-03R15.pdf>), and includes (among other information) year, Appendix listing, the complete names of the importer and exporter, scientific name of the species, purpose and source of the transaction (using CITES codes), the quantity of specimens and unit of measure. Parties then compile these permits into an annual report, in accordance with UNEP-WCMC guidelines (<http://www.cites.org/eng/notif/2010/E013A.pdf>), and the reported data are entered into the CITES Trade Database which is searchable on-line. The reports must be submitted to CITES by October 31st of the year following the one in which the trade occurred – although some Parties submit their annual reports late, incomplete, or not at all due to internal problems such lack of personnel or resources (UNEP-WCMC 2010). These delays in reporting mean that the most recent year for which comprehensive trade statistics are available is normally two years before the current year.

Data Acquisition and Formatting

Seahorses were listed on Appendix II of CITES in 2002, but the listing was only implemented as of May 2004. CITES data from 2004 to 2008 (the most recent data available for analysis) were obtained from the UNEP-WCMC CITES Trade database (<http://unep-wcmc.org/citestrade/>) on July 15, 2010. The query included all export and import countries, terms, sources and purposes for the trade in all *Hippocampus* species. All 1,282 records were downloaded and transferred to an Excel spreadsheet. The CITES database is continuously updated and, therefore, data are never considered final (Malsch *in litt.* 2010). We verified country/Party data submission status in the CITES Annual Reports on CITES Parties (http://www.cites.org/common/resources/annual_reports.pdf) to ensure questionable trade trends or data gaps were not due to lack of submission. We included all trade purposes and all sources except 'preconvention specimens' in our analyses. It is important to note that since the CITES listing for seahorses only took effect in May 2004, the extracted 2004 data may represent only a partial year of trade.

Trade species source definitions used in this report were based on those provided by UNEP-WCMC (UNEP-WCMC 2004), which includes:

- C – captive-bred: refers to at least second generation offspring of parents bred in a controlled captive environment (or first generation offspring from a facility that is managed in a manner that has been demonstrated to be capable of reliably producing second-generation offspring in a controlled environment);
- F – F1 captive-bred: specimens born in captivity to wild-caught parents and that are not considered as captive-bred under CITES;
- I – confiscated or seized specimens;

- R – ranch-raised: specimens either directly removed from the wild and reared in a controlled environment or progeny from gravid females captured from the wild;
- U – source unknown; and
- W – wild: specimens taken from the wild;

When comparing the trade in wild vs. captive-bred seahorses, we included those labelled as F as captive-bred, as it is difficult to discern the difference between these and other captive-bred seahorses in trade. Records labelled R and W were pooled to represent all wild caught seahorses, whereas records labelled U or I were excluded from analyses of source as the sources were unknown, but were included in all other analyses.


The CITES Wiki Identification Manual (http://www.cites.org/eng/resources/wiki_id.php) recognizes 47 seahorse species (Kuitert 2001, 2003; Lourie and Randall 2003; Lourie *et al.* 2004; Piacentino and Luzzatto 2004; Lourie and Kuitert 2008; Gomon and Kuitert 2009; Kuitert 2009; Randall and Lourie 2009). Four species names encountered in the CITES data (*H. japonicas*, *H. ramulosus*, *H. takakurae* and *H. hybrid*) were deemed false based on Lourie *et al.* (2004), as well as subsequent unpublished morphometric and genetic research (S. Lourie, Project Seahorse, unpublished data). The first three names were converted to *H. mohnikei*, *H. guttulatus* and *H. trimaculatus*, respectively as they are believed to be synonyms of these species. *Hippocampus hybrid*, however, was not considered a species (S. Lourie, Project Seahorse, pers. comm.), and therefore this entry was re-categorized to the genus level.


Mainland China was considered a distinct trade region from Hong Kong SAR and Taiwan, Province of China. Hong Kong SAR rejoined mainland China in 1997 but was treated independently in this report because the Special Administrative Region still maintains its own trade management and record keeping. The word “country” will be applied broadly to all jurisdictions but is not meant to imply any opinion on the status of disputed regions.


Occasionally the country code under source and consumer country entries was given as XX, which denotes an unknown country. These entries were thus excluded from analysis of trade routes (sources and consumers), but retained for all other analyses.

CITES Data Conversion and Analyses

The CITES Trade Database provides a searchable database based on the compilation of data from all Party annual reports thereby allowing for the derivation of global statistics (Figure 1). We had to make certain decisions in regards to our treatment of the data – specifically with regards to the different sources for trade records, re-export records and units.







Comparative Tabulation Report

	Year	Appendix	Taxon	Importer	Exporter	Origin	Imp Quantity	Imp Unit	Imp Term	Imp Purpose	Imp Source	(Re-)Exp Quantity	(Re-)Exp Unit	(Re-)Exp Term	(Re-)Exp Purpose	(Re-)Exp Source
1	2004	2	<i>Hippocampus</i> spp.	NZ	CN		822		bodies		I					
2	2004	2	<i>Hippocampus</i> spp.	NZ	CN		1326		derivatives		I					
3	2005	2	<i>Hippocampus kuda</i>	CA	VN							150		live	T	W
4	2005	2	<i>Hippocampus kuda</i>	DE	VN							1300		live	T	W
5	2005	2	<i>Hippocampus reidi</i>	US	IE		6		live	T	C	6		live	T	C
6	2005	2	<i>Hippocampus reidi</i>	AT	LK		130		live	T	C	650		live	T	C
7	2006	2	<i>Hippocampus kuda</i>	US	HK	CN	1000		specimens	T	W					
8	2006	2	<i>Hippocampus kuda</i>	US	HK	CN	1360		specimens	T	C					

Figure 1. Example of output data from the CITES Trade Database for seahorses (*Hippocampus* spp.). Lines 1 and 2 are reported to the genus level only while lines 3 to 8 are reported to the species level. Lines 1 and 2 show data entries that have import data only and lines 3 and 4 show entries that have export data only. Line 5 has both export and import data, which match up exactly. Line 6 has import and export data that do not match up exactly – the reported export volume is greater than the reported import volume. Lines 7 and 8 show examples of re-exports, as the origin country is different to the export country.

Trade records – As stated above, only the reporting of CITES Appendix II export records is mandatory. Even so, many Parties voluntarily reported imports. When export and import trade entries are comparable, UNEP-WCMC enters the data on the same line, but keeps them separate otherwise (UNEP-WCMC 2010) (e.g. Figure 1, lines 5 and 6). In the case of seahorses, voluntary import records made up a large proportion of available data (e.g. Figure 1, lines 1 and 2); almost half of the entries were importing country records only (48%, $N=615/1,282$), while only one third were exporting country records only (34%, $N=437/1,282$) (e.g. Figure 1, lines 3 and 4). To avoid confusion between terms ‘export data’ and ‘import data’ we herein refer to export data derived from importing country records by using the acronym EFI - Exports from Imports.

The remaining entries contained both importing and exporting country data. Of all the records we downloaded, 18% ($N=230/1,282$) had both export and import data on the same line (e.g. Figure 1, line 6); however, only 4% ($N=53/1,282$) had identical export and import volumes (e.g. Figure 1, line 5). To minimize double-counting, we assessed discrepancies within single records with both export and EFI data and removed any obvious duplicate data as per (Bruckner 2001; Nijman and Shepherd 2010). For example, if:

- matching EFI and export data were provided in a single line entry as per UNEP-WCMC guidelines, only export data was counted ($N=53/1,282$);
- on a single entry line, if EFI data < export data, then the EFI data were excluded as these data would presumably be accounted for in the larger number reported in the export number ($N=125/1,282$); and
- on a single line entry, if EFI data > export data, then the export data were excluded as these data would presumably be accounted for in the larger number reported in the EFI number ($N=52/1,282$).

Re-export records – Two hundred and twenty entries (17%) of the declared global trade in seahorses from 2004-2008 were classified as re-exports – a shipment imported into one country only to be re-exported to another ($N=220/1,282$). To prevent double-counting with respect to volumes, we excluded all re-export data from our analyses. We did, however, analyse the re-export data (species, routes and volumes) in a separate results section (Re-Exporter Trade).

Units – We had to make assumption regarding trade units for many of the trade entries. Seahorse trade can be divided into two large groups – dry and live trade – but this is not how it is reported to CITES. The import or export term of the record was used to group the records into these broad categories. All records with the term live were left as live, while all other records were assumed to belong to dry trade – including the terms bodies, derivatives, specimens and skeletons. Upon first inspection, all dried seahorse export and EFI data without units were assumed to have been traded in kilograms since dry seahorse trade is known to occur in kilograms, and not individual counts. The trade is in individuals but not often measured that way (Vincent 1996). Indeed all dried trade entries provided with a unit were recorded in either kilograms (KIL) or grams (GRM), and none were reported as individuals.

However, when we applied this assumption to unit-less entries, several trade entries appeared to be greatly inflated given known historic trends (those observed in *first* and *second surveys*). When data were further examined, we realized that half ($N=187/378$) of all dried seahorse trade entries obtained from the CITES database did not have corresponding units. In February 2011, therefore, we contacted the CITES Management and Scientific Authorities of countries with missing unit data and asked them to review their files and confirm if the units were individuals, kilograms or grams of traded seahorses. We received responses from 17 out of 21 countries, most of which were able to confirm the units traded (Table 1). When confirmed unit information was amended to our data, only 17% of dried trade entries remained without units ($N=65/378$). These were assumed to be kilograms, although it should be noted that based on the unit information we received from countries that did confirm units, some of these may have been traded as individuals, in which case our global and country totals may be overestimates. We explore the impact of this assumption in a sensitivity analysis (see section Sensitivity Analyses, below).

Table 1. Countries and their response with respect to our request regarding clarification of units for dried trade records reported to the CITES Trade Database from 2004-2008 without units.

Country	Responded?	Confirmed units?	Units	Reason if unable to confirm units
Australia	Y	Y	Kilograms	
Austria	Y	Y	Individuals	
Canada	Y	Y	Individuals	
China, mainland	Y	Y	Individuals or capsules	
Czech Republic	Y	Y	Individuals	
France	Y	Y	Individuals	
Germany	Y	Y	Individuals	
Hong Kong SAR	Y	Y	Individuals	
Hungary	Y	N	-	Hungary has no records of trade in dried seahorses from 2004-2008
New Caledonia	Y	Y	Individuals	
New Zealand	Y	Y	Individuals for export records only	
Poland	Y	Y	Individuals	
South Africa	Y	Y	Individuals	
Switzerland	Y	Y	Individuals	
United Kingdom	Y	Y	-	
USA	Y	Y	Individuals	
Vietnam	Y	N	-	Party data did not match with reported CITES data

Where data were indicated or assumed as kilograms, dried seahorse weights were converted to number of individuals based on published conversion rates. Region/country-specific conversion factors were used when available; otherwise we used the average of all published conversions - 2.69 g/seahorse (Table 2). Due to using various conversion factors when calculating volumes, values represent estimates rather than exact numbers and as such, total volumes were rounded and the symbol ‘ \approx ’ was used to show that the values were not exact.

Table 2. Estimates of average dry seahorse weight for each region or country including sample size when available. Latin America (Atlantic) consisted of Belize, Guatemala and Honduras. Latin America (Pacific) consisted of Costa Rica, Ecuador, Mexico, Nicaragua and Peru. NA = data not available.

Region/Country	Estimated Seahorse Dry Weight (g/seahorse)	Sample Size (N)	Reference
Australia	3.00	NA	(Martin-Smith 2006)
Latin America (Atlantic)	2.42	111	(Baum and Vincent 2005)
Latin American (Pacific)	3.51	105	(Baum and Vincent 2005)
Malaysia	3.18	56	(Perry <i>et al.</i> 2010)
Thailand	3.13	96	(Perry <i>et al.</i> 2010)
	3.30	NA	(Vincent 1996)
Philippines	3.33	Estimated by buyers	Pajaro <i>et al.</i> Project Seahorse, Unpublished Data
	1.38	NA	(Vincent 1996)
India	1.50	NA	(Vincent 1996)
Indonesia	2.00	NA	(Vincent 1996)
Vietnam	2.86	NA	(Vincent 1996)
Global Estimate	2.69		

Even fewer (only 2%) of the live trade entries were reported with units (N=11/683), and these were recorded as kilograms. However, it is highly unlikely that these units were correct, as the trade in live seahorses is known to occur mainly in individuals. When suppliers trade seahorses, they sell them as individuals and not by weight (H. J. Koldewey, Project Seahorse, pers. comm.). It is also difficult and stressful to the animals to weigh live specimens in transit. For live trade, therefore, all units were assumed to be individuals. We test this assumption with a sensitivity analysis (see section Sensitivity Analyses, below). In the unlikely case that the bags of live seahorses were weighed, the weight would include that of the water. In such cases it would still make sense to treat the reported value as individuals as the seahorses would only make up a very small amount of the total weight.

Sensitivity Analyses

We conducted the following sensitivity analyses to determine the effects of our treatment of the data as outlined in CITES Data Conversions and Analyses, above: (1) including EFI data in the trade by volume and trade by country analyses; and (2) assuming dried trade entries with no confirmed units were provided as kilograms as opposed to number of individuals, and that live trade entries recorded as kilograms were in fact traded as individuals and not in kilograms. These analyses allowed us to assess variation in the overall trade volumes under differing methodological assumptions. We realize there may be other assumptions inherent in our methods. However, these two sensitivity analyses are indicative of prevalent issues in CITES annual report submissions and provide an opportunity to explore possible recommendations for CITES submission guidelines, with the hopes of improving data accuracy in the future.

The purpose of 1) was to demonstrate the importance of voluntary import records in providing information on the international seahorse trade, and highlighting supposed gaps in the mandatory export records. To this end, we re-analysed the total trade by volume as well as by country excluding all EFI data, and compared these results to those obtained when we included the EFI data as described above.

The purpose of 2) was to test our assumptions of trade units. For the dried trade we re-analysed global trade volumes, but this time we assumed all records that remained unit-less (N=70) to be individuals instead of kilograms (we left all units reported by CITES as well as those that were confirmed by the countries, as is). We then compared the total volumes traded for each of the years from 2004-2008 obtained using this method to that obtained using the method described above, where all unit-less and unclarified dried entries were assumed to be kilograms.

For the live trade, we re-analysed the global trade volumes, but this time we left the entries designated as kilograms as is (as opposed to changing the units to individuals). In this case we used an average wet weight of seahorses obtained from the literature of 12.5 g/seahorse (Vincent and Sadler 1995; Woods 2002; Baum *et al.* 2003; Planas *et al.* 2008) to convert the kilogram values into number of individuals. We then compared the total volumes traded for each of the years from 2004-2008 obtained using this method to that obtained using the method described above, where all live entries were assumed to be individuals, regardless of reported unit.

RESULTS

GLOBAL OVERVIEW OF TRADE IN DRIED AND LIVE SEAHORSES

Species Traded

Over three-quarters of all CITES trade records, excluding re-exports, for seahorses from 2004-2008 (77%; N=815/1,062) were reported to the species level (e.g. Figure 1, lines 3 to 8); the remaining records were only reported to the level of genus, *Hippocampus* (e.g. Figure 1, lines 1 and 2). Substantially fewer trade data entries were provided at the species level for the trade in dried (51%, N=192/378) than live (91%, N=623/684) seahorses. Based on both export and EFI data, three East Asian countries (in descending order – mainland China, Vietnam, and Hong Kong SAR) were the main source countries reporting the majority of their dried export entries to the genus level only (Figure 2A). Indonesia, New Zealand, and Vietnam were (in descending order) the main three source countries reporting their live export entries at the genus level (Figure 2B). Species level reporting appeared to improve over time for live seahorse trade only.

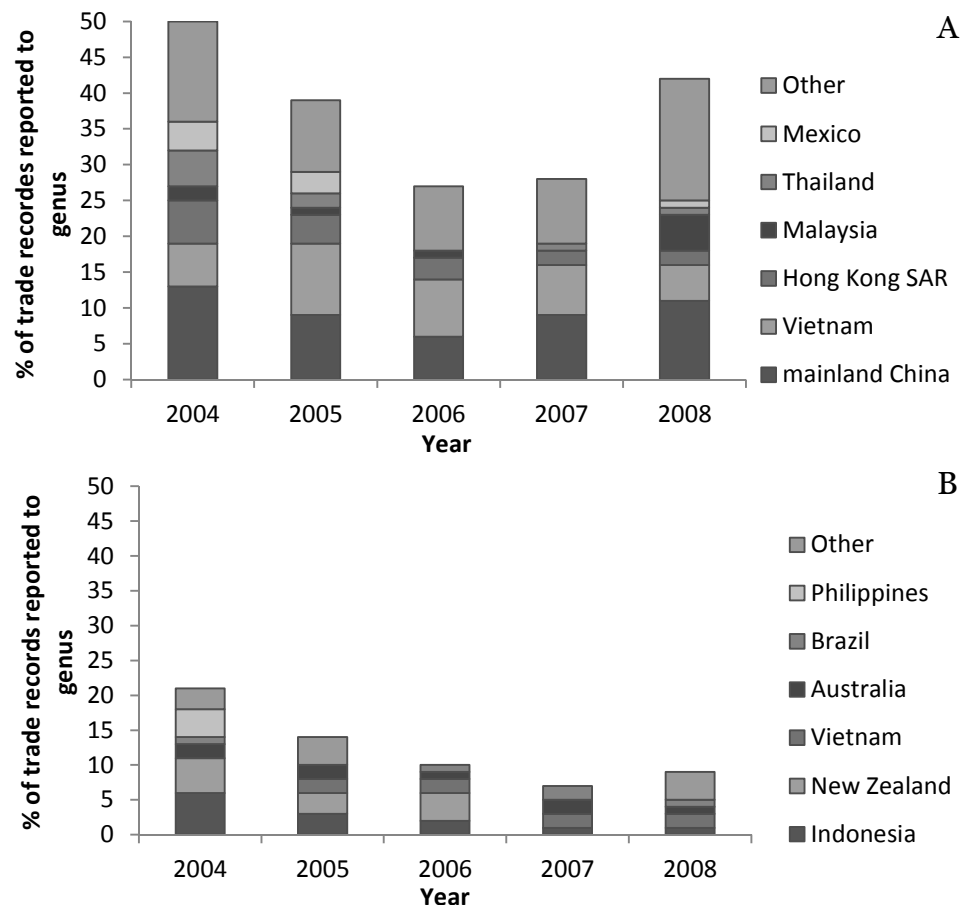


Figure 2. Percentage of trade records from the CITES Trade Database reported at the genus level for global trade in (A) dried and (B) live seahorses from 2004-2008. Data for the six countries that report the largest proportion of their trade records to the genus level are displayed. All other countries grouped into “other”. Data shows combined export and EFI data. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Based on combined export and EFI data, 28 seahorse species (Lourie *et al.* 2004) were declared in trade between 2004 and 2008 (Table 3, CITES). The reported dried trade involved 18 species overall: 12 were only reported as wild, two only as captive-bred, two were reported without declaring the source, and two more were reportedly extracted from both cultured and wild sources (Table 3, CITES, Dried). The reported number of seahorse species traded dried remained relatively stable from 2004-2008 with an average of 11 (Figure 3A). Over those years, the reported number of captive-bred species was low (N=0-3) relative to the number of reported wild-sourced species (N=9-13).

Table 3. Seahorse species involved in international trade before the listing of seahorses on CITES (1998-2001) as reported in published and unpublished literature (*second surveys*), and in the CITES Trade Database from 2004-2008 (CITES) organized by status (dried or live) and source (wild or captive-bred), where available. Question marks denote uncertainty in the species and/or purpose of trade.

Species	<i>Second surveys</i>		CITES			
	Dried	Live	Dried		Live	
			Wild	Captive	Wild	Captive
<i>H. abdominalis</i>	X	X	X	X	X	X
<i>H. algiricus</i>			X		X	
<i>H. angustus</i>	X	X			X	X
<i>H. barbouri</i>	X	X	X		X	X
<i>H. bargibanti</i>			X			
<i>H. borboniensis</i>	X					X
<i>H. breviceps</i>		X		X	X	X
<i>H. camelopardalis</i>	X	X				X
<i>H. comes</i>	X	X	X		X	X
<i>H. coronatus</i>		X			X	
<i>H. denise</i>					X	
<i>H. erectus</i>	X	X	X		X	X
<i>H. fuscus</i>	X	X	X			X
<i>H. guttulatus</i> (<i>H. ramulosus</i>) ¹	X	X	X		X	?
<i>H. hippocampus</i>	X		X		X	X
<i>H. histrix</i>	X	X	X		X	
<i>H. ingens</i>	X	X	X		X	X
<i>H. kelloggi</i>	X		X		X	
<i>H. kuda</i>	X	X	X	X	X	X
<i>H. mohnikei</i> (<i>H. japonicas</i>) ¹	X	X			?	?
<i>H. montebelloensis</i>					X	
<i>H. reidi</i>	X	X	X		X	X
<i>H. spinosissimus</i>	X	X	X		X	
<i>H. subelongatus</i>		X			X	X
<i>H. trimaculatus</i> (<i>H. takakurae</i>) ¹	X		X		X	
<i>H. whitei</i>	X	X			X	X
<i>H. zebra</i>	X				X	
<i>H. zosterae</i>		X	X		X	
TOTAL	20	19	17	3	23 (+1?)	15 (+2?)

¹ Species names in brackets were those reported in the CITES data that did not correspond with the taxonomy used for this report and were re-classified as per Lourie *et al.* (2004).

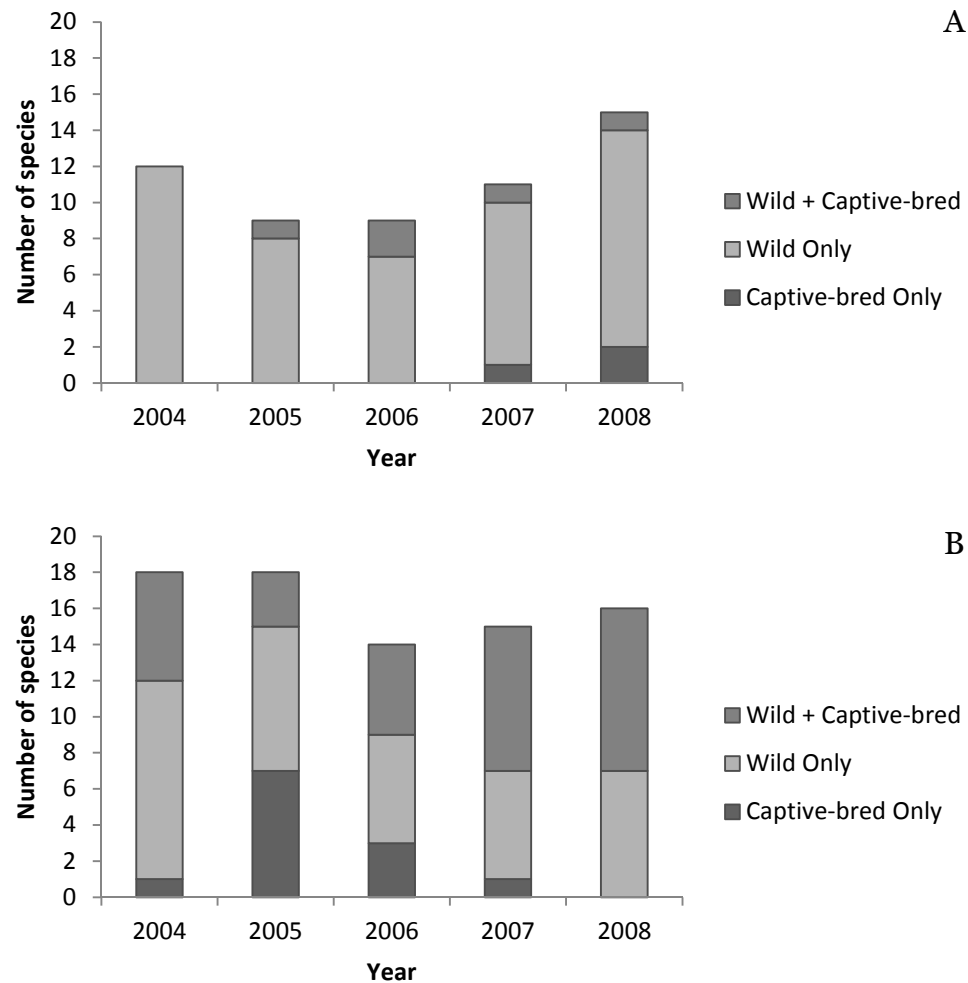


Figure 3. Number of (A) dried and (B) live seahorse species reported on the CITES Trade Database that were sourced only from the wild, only from captive-bred sources or from both wild and captive-bred sources. Data includes combined export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

The live trade reportedly involved a total of 27 different species: 11 were only reported as wild, three as captive-bred only, and 12 others as both wild and captive-bred (Table 3, CITES, Live). The source of one species, *H. mohnikei*, was not specified. The reported number of live seahorse species traded averaged 16 across all years with the maximum observed in 2004 and 2005 with estimates decreasing thereafter (Figure 3B). The number of species reported to CITES as captive-bred only was greatest in 2005 (N=7) but decreased to ≤ 3 in all subsequent years (Table 4). However, the total number of species that had some captive-bred trade increased from 2005 to a maximum in 2008 (Figure 3B).

Table 4. Seahorses species reported in the CITES Trade Database (2004 – 2008) with sources as either wild (W), captive-bred (C) or both (CW) for the live and dry international trade. Data include a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Live Trade					Dry Trade				
	2004	2005	2006	2007	2008	2004	2005	2006	2007	2008
<i>H. abdominalis</i>	CW	C	C	CW	CW				C	C
<i>H. algiricus</i>	W			W		W	W	W	W	W
<i>H. angustus</i>	C		C	CW	CW					
<i>H. barbouri</i>	CW	CW	CW	CW	CW		W	W	W	W
<i>H. borboniensis</i>		C								
<i>H. breviceps</i>	CW	C	C	CW	CW					C
<i>H. camelopardalis</i>				C						
<i>H. comes</i>	W	W	W	CW	CW	W			W	W
<i>H. coronatus</i>	W	W								
<i>H. denise</i>	W	W	W							
<i>H. erectus</i>	W	W	CW	W	CW	W	W			W
<i>H. fuscus</i>		C								
<i>H. guttulatus</i>	W					W				W
<i>H. hippocampus</i>	W	C				W				W
<i>H. histrrix</i>	W	W	W	W	W	W	W	W	W	W
<i>H. ingens</i>		C	CW	CW	CW	W		W	W	
<i>H. mohnikei</i>										
<i>H. kelloggi</i>		W	W	W	W	W	W	W	W	W
<i>H. kuda</i>	CW	CW	CW	CW	CW	W	CW	CW	CW	CW
<i>H. montebelloensis</i>					W					
<i>H. reidi</i>	CW	CW	CW	CW	CW		W	CW	W	W
<i>H. spinosissimus</i>		W	W	W	W	W	W	W	W	W
<i>H. subelongatus</i>	CW		W	W	W					
<i>H. trimaculatus</i>		W			W	W	W	W	W	W
<i>H. whitei</i>	W	C								
<i>H. zebra</i>	W									
<i>H. zosterae</i>	W				W	W				W
No. of species traded	18	18	14	15	16	12	9	9	11	15

Trade Routes

Overall

A total of 70 countries were reported in the CITES Trade Database as sources and/or consumers of seahorses from 2004-2008.

Sources

Based on CITES export and EFI data, 47 countries, from all continents except Antarctica, were reported as sources for dried and live seahorses from 2004-2008 (Table 5, CITES). Of these, 17 countries were reportedly involved in both live and dried exports, 20 were reportedly only involved in dried exports and ten in live exports only. This means that over three-quarters of reported source countries (79%, N=37/47), most of which were on the Asian continent, reportedly exported dried seahorses, and over half (57%, N=27/47) were reported to have exported live seahorses – five of which apparently only supplied captive-bred seahorses.

Table 5. Countries reported to have been sources for exports of dried and/or live seahorses before the listing of seahorses on CITES (1998-2001) as reported in published and unpublished literature (*second surveys*), and in the CITES Trade Database from 2004-2008 (CITES). ¹ denotes trade of unknown volumes.

Continent	Source Country	<i>Second surveys</i>		CITES	
		Dried	Live	Dried	Live
Africa	Cote d'Ivoire			X	
	Egypt		X	X	
	Gambia	X			
	Guinea	X		X	X
	Kenya		X		
	Madagascar	X ¹			
	Mauritania				X
	Mauritius				X
	Mozambique	X ¹	X ¹		
	Nigeria	X			
	Senegal	X		X	X
	Seychelles	X ¹			
	South Africa	X			
	Tanzania	X			
	Togo	X		X	
Asia	Bangladesh	X			
	Cambodia	X		X	
	China, mainland	X ¹		X	
	Hong Kong SAR	X		X	X
	India	X	X		
	Indonesia	X	X	X	X
	Japan			X	X
	Korea, Republic of	X		X	
	Kuwait	X ¹			X
	Lao People's Democratic Republic			X	
	Macau			X	
	Malaysia	X	X	X	X

Continent	Source Country	<i>Second surveys</i>		CITES	
		Dried	Live	Dried	Live
	Maldives	X ¹			
	Myanmar	X ¹			
	Pakistan		X		
	Philippines	X	X	X	X
	Singapore	X ¹	X ¹	X	X
	Sri Lanka		X		X
	Taiwan, Province of China	X ¹		X	
	Thailand	X	X	X	
	United Arab Emirates	X ¹		X	
	Vietnam	X	X	X	X
Oceania	Australia	X	X	X	X
	Fiji		X ¹	X	
	New Caledonia			X	X
	New Zealand	X ¹	X ¹	X	X
	Solomon Islands		X		
	Vanuatu				X
Europe	Czech Republic			X	
	France			X	
	Germany			X	
	Ireland				X
	Portugal			X	X
	Spain	X			
	United Kingdom		X		X
North America	Bahamas			X	
	Belize	X	X		
	Canada		X	X	
	Costa Rica		X	X	
	Cuba		X ¹		X
	Dominican Republic				X
	Guatemala	X			
	Haiti				X
	Honduras	X			
	Mexico	X	X ¹	X	X
	Nicaragua	X ¹			
	USA	X	X	X	X
South America	Bolivia			X	
	Brazil	X	X	X	X
	Ecuador	X	X ¹	X	
	Peru	X		X	X
	Suriname	X			
	Venezuela	X			
TOTAL		41	25	37	27

Consumers

Based on export and EFI data, 47 countries were reported to have consumed seahorses from 2004-2008 (Table 6, CITES). Of these, 22 countries reportedly consumed both live and dried seahorses, 23 reportedly consumed only live seahorses, and only one was reported to consume only dried individuals. Thus, the majority of reported consumer countries imported live seahorses (98%, N=46/47), with most of these found in Asia and Europe. Alternately, half (49%, N=23/47) were reported as consumers of dried seahorses; again, the majority of these countries were located in Asia and Europe.

Table 6. Countries reported to have been the final importer for dried and live seahorse species before the listing of Seahorses in CITES (1998-2001) in published and unpublished literature (*second surveys*), and in the CITES Trade Database from 2004-2008 (CITES). ¹ denotes trade of unknown volumes.

Continent	Consumer Country	<i>Second surveys</i>		CITES	
		Dried	Live	Dried	Live
Africa	Cameroon				X
	Namibia				X
	Senegal	X			
	South Africa	X ¹	X	X	X
	Swaziland				X
	Tanzania	X ¹			
	Zimbabwe	X			
Asia	Brunei Darussalam				X
	China, mainland	X	X ¹	X	X
	Hong Kong SAR	X	X	X	X
	India		X		
	Indonesia	X			
	Israel				X
	Japan	X	X ¹	X	X
	Jordan		X ¹		
	Korea, Republic of	X	X	X	X
	Kuwait				X
	Malaysia	X	X	X	X
	Pakistan		X		
	Philippines	X ¹			
	Saudi Arabia		X	X	X
	Singapore	X	X	X	X
	Sri Lanka				X
	Taiwan, Province of China	X	X	X	X
	Thailand	X	X	X	
	United Arab Emirates				X
Oceania	Australia	X	X	X	X
	New Zealand	X ¹	X ¹	X	X
Europe	Austria		X	X	X
	Belgium		X		X
	Czech Republic			X	X
	Denmark		X		X

Continent	Consumer Country	<i>Second surveys</i>		CITES	
		Dried	Live	Dried	Live
	France		X	X	X
	Germany	X	X		X
	Hungary		X	X	X
	Ireland		X		X
	Italy	X	X		X
	Monaco				X
	Netherlands	X	X		X
	Norway				X
	Poland			X	X
	Portugal		X	X	X
	Romania				X
	Spain	X	X	X	X
	Sweden		X		X
	Switzerland		X	X	X
	Ukraine				X
	United Kingdom	X	X	X	X
North America	Barbados				X
	Belize	X ¹			
	Canada	X	X ¹	X	X
	Costa Rica		X		
	Guam				X
	Guatemala				X
	Mexico	X ¹	X		X
	Panama	X			
	USA	X	X	X	X
South America	Argentina	X ¹	X ¹		X
	Bolivia	X ¹			
	Chile	X ¹			
	Uruguay		X		
TOTALS		29	25	23	46

Trade Volumes

Overall

Overall: Based on combined export and EFI data, the reported overall trade in seahorses from 2004-2008 was estimated at an average of 7 million individuals per annum, with a range of 5 to 10 million (Figure 4). Reported exports appear to have peaked in 2005, although 2004 data represent only a partial year (Figure 4)

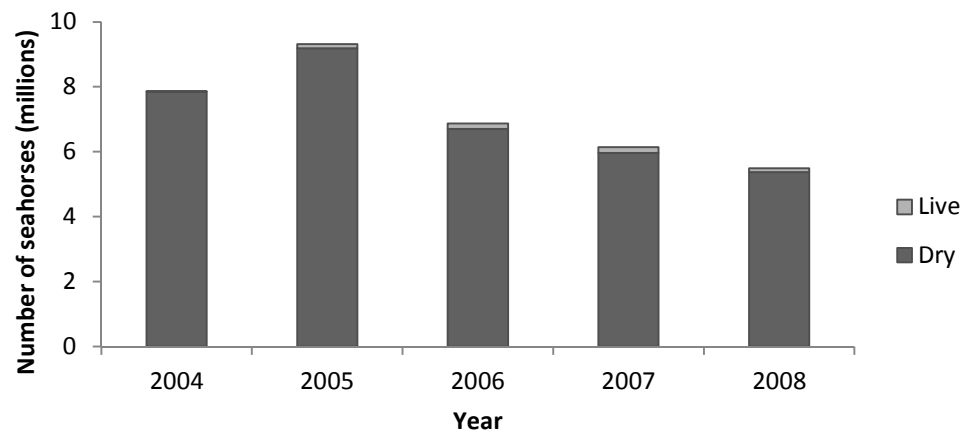


Figure 4. Total reported volumes of live and dry seahorses on the CITES Trade Database exported globally from 2004-2008. Data shows combined export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Dried: Dried seahorses (wild and captive-bred) dominated the reported trade, averaging 99% of total volume in all years (range=98.0-99.8%; $N \approx 5$ -10 million individuals) and therefore showed the same trends as total volumes (Figure 4). The reported trade was composed primarily of non-captive-bred seahorses which made up over 98% of annual dried volumes across all years. Peak exports of dried seahorses appeared to occur in 2005, although 2004 data represent only a partial year.

Live: The number of live seahorses (wild and captive-bred) comprised a mean of 1% (1-2%) of the reported total traded each year, averaging 120,000 ($N \approx 20,000$ -170,000) individuals annually (Figure 5). The proportion of reported captive-bred seahorses in the live trade increased steadily from 36% ($N \approx 45,000$) in 2005 to 80% ($N \approx 100,000$) in 2008 (Figure 5).

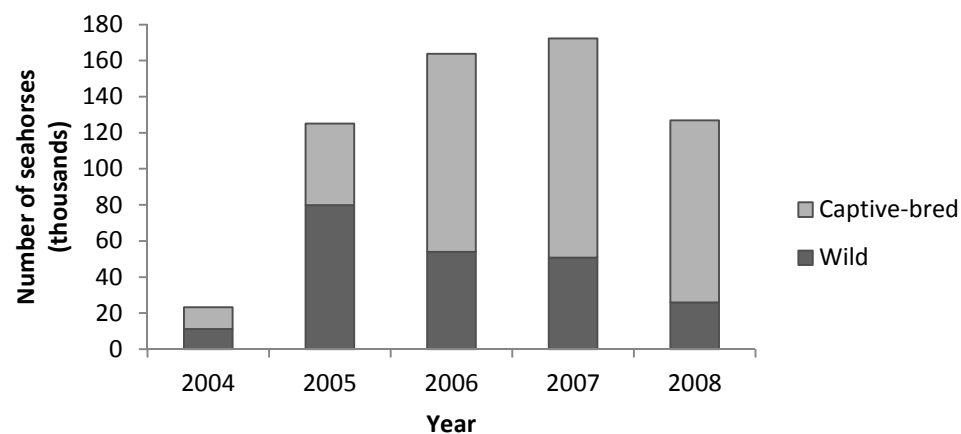


Figure 5. Total reported volumes of live seahorses, captive-bred or wild, in the CITES trade Database exported globally between 2004 and 2008. Data shows combined export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

By Species

Overall: Based on export and EFI data, three Asian species dominated the reported trade overall – in descending order: *H. trimaculatus* (16-32% of total trade across years; $N \approx 1.2$ -2.5 million individuals per annum), *H. spinosissimus* (18-28%; $N \approx 1.3$ -2.5 million individuals per annum) and *H. kelloggi* (9-20%; $N \approx 745,000$ -1.9 million individuals per annum) (Figure 6). The west-African seahorse, *H. algiricus*, was also traded in large number (8-13%; $N \approx 500,000$ to 1.2 million individuals per annum) (Figure 6).

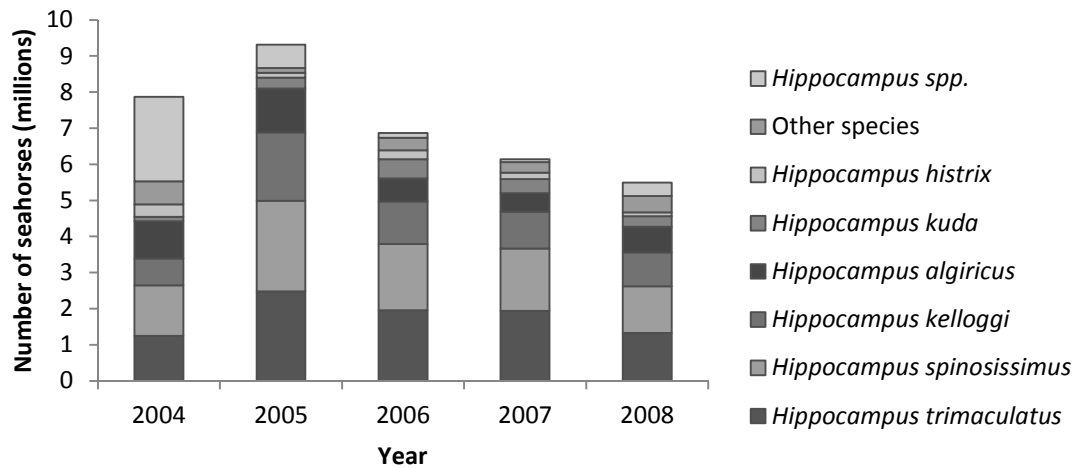


Figure 6. Total number of seahorses exported, by species as reported in the CITES Trade Database 2004-2008. Data shows combined export and EFI data. Data for the six species that made up the largest proportion of the trade, as well as all records reported to the genus level (*Hippocampus* spp.) are displayed. All other species are grouped into “Other species”. The order of the species in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Dried: As mentioned above, dried seahorses composed the vast majority of all reported trade from 2004-2008, and the majority of those were extracted from the wild; consequently, trends in dominant species remained the same whether examining trends across dried trade (so including wild and captive-bred sources) or trends in dried, wild trade only. Temporal patterns revealed *H. spinosissimus* dominated the trade in 2004 and 2005, and *H. trimaculatus* in 2006, 2007 and 2008. *Hippocampus kelloggi* and *H. algiricus* were also reported in large volumes totalling 5.7 million and 4.1 million individuals from 2004-2008 respectively.

Only four species were apparently traded cultured and dried: *H. kuda*, *H. breviceps*, *H. abdominalis*, and *H. reidi*, in descending order by volume (Table 7). The majority of cultured, dried trade in these species was reported in 2008 – most notably the volume of cultured *H. kuda* reported in dried trade went from tens to almost ten thousand individuals (Table 7).

Table 7. Total volume (numbers of individuals) of dried, captive-bred seahorses exported, by species as reported in the CITES Trade Database from 2004-2008. Data shows combined export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Year					Total
	2004	2005	2006	2007	2008	
<i>H. abdominalis</i>				33	682	715
<i>H. breviceps</i>					1,000	1,000
<i>H. kuda</i>		93	1	71	8,277	8,442
<i>H. reidi</i>			9			9
<i>Hippocampus</i> spp.	50			81	833	964
Total	50	93	10	185	10,792	11,130

Live: Based on export and EFI data, *H. reidi* dominated the trade of live seahorses in 2004 and 2005, comprising over a third of the total trade in these years (37 and 34%; $N \approx 8,100$ and $43,000$ individuals, respectively). In 2006, *H. kuda* began to dominate the live trade in seahorses, consistently making up at least half (55-72%; $N \approx 90,000$ - $98,000$ individuals per annum) of total volumes ($N \approx 125,000$ - $172,000$ individuals per annum) in the remaining three years (Figure 7A).

Hippocampus kuda comprised at least 30% of all reported live, wild-only individuals each year, and averaged half (50%; $N \approx 22,000$) across all years (Figure 7B). Smaller volumes of *H. kelloggi*, *H. histrix* and *H. barbouri* were also traded. Temporal patterns showed substantial fluctuations in the volumes of live, wild *H. kelloggi* (up to 50-fold), *H. histrix* (14-fold) and *H. kuda* (10-fold) reportedly exported over time.

Trends in species composition for live, captive-bred seahorses were similar to those for all live seahorses (Figure 7C versus Figure 7A, respectively) – a trend that was expected considering that captive-bred seahorses comprised more of the live trade than wild-caught seahorses.

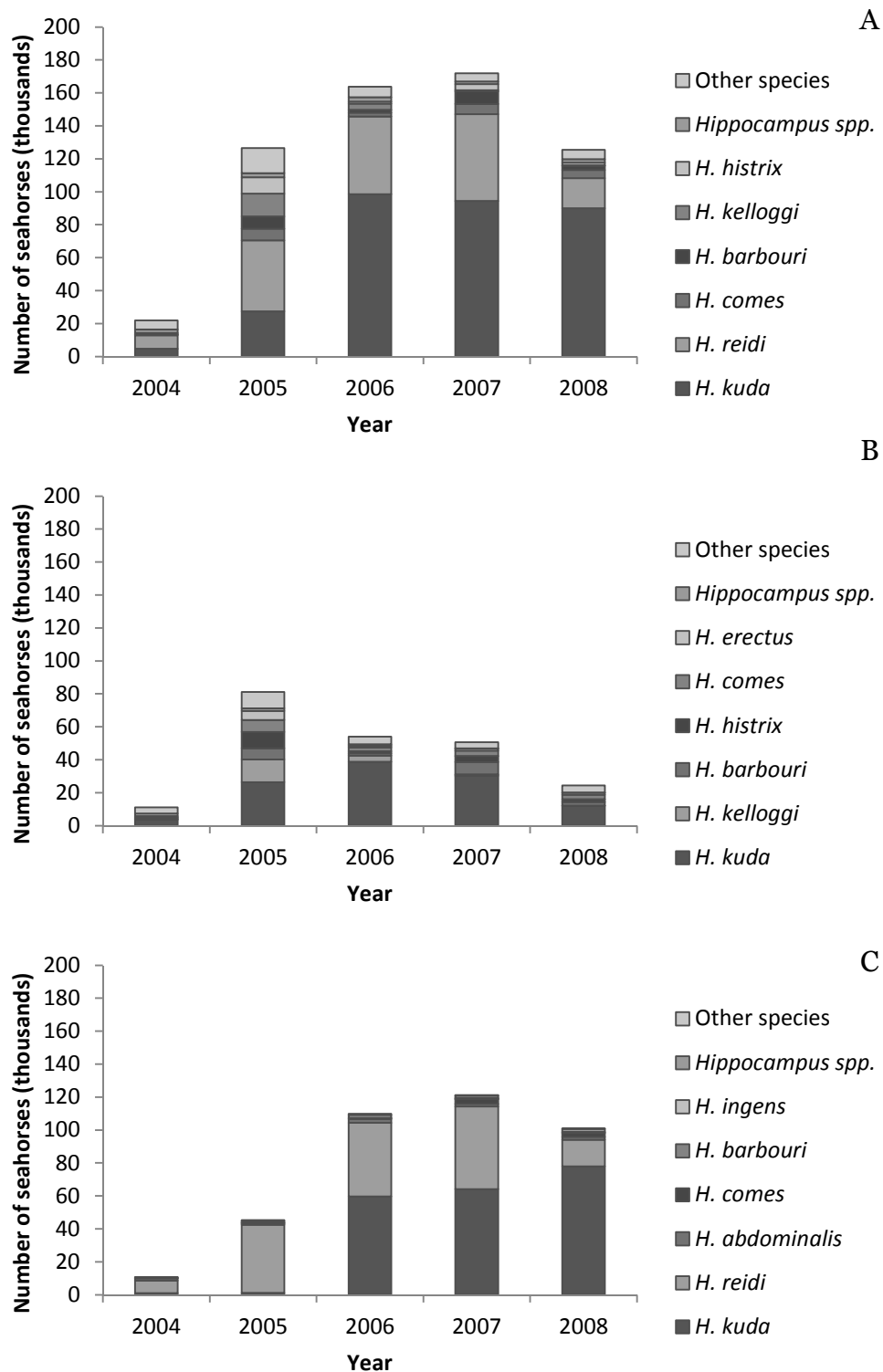


Figure 7. Total volume of all (A) live, (B) live, non-captive-bred, and (C) live captive-bred seahorses, exported by species, as reported in the CITES Trade Database from 2004-2008. Data shows combined export and EFI data. Data for the six species that make up the largest proportion of the trade, as well as all records reported to the genus level (*Hippocampus* spp.) where appropriate, are displayed. All other species grouped into “Other species”. The order of the species in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species Identification

As a rudimentary test of whether species were being identified correctly, the confirmed and suspected distribution of each species was analysed to see whether it overlapped with the country it was reportedly sourced from. This was done for reportedly wild sourced trade only. Of the 562 records of non-captive-bred seahorses, 511 reported source countries that form part of the confirmed or suspected distribution of the species being traded (Lourie *et al.* 2004). There were, however, 51 records where the reported source country was not within the confirmed or suspected distribution of the species being traded. These 51 records represented an estimated volume of 14,300 individuals; the main countries involved were Vietnam, Sri Lanka and the Philippines with approximate volumes of 8,000; 3,500 and 1,000 individuals respectively (Table 8).

Table 8. Countries reported in the CITES Trade Database from 2004-2008 as sources of seahorse species that are not confirmed or suspected to occur in that countries waters (as per Lourie *et al.*, 2004). Confirmed captive-bred records were excluded from this analysis. Species and volumes, in numbers of individuals, are shown. Volumes were estimated from export and EFI data.

Source Country	Species	Volume
Australia	<i>H. barbouri</i>	34
Brazil	<i>H. coronatus</i>	100
	<i>H. kuda</i>	97
Germany	<i>H. reidi</i>	9
Indonesia	<i>H. erectus</i>	227
	<i>H. hippocampus</i>	72
	<i>H. mohnikei</i>	19
	<i>H. zebra</i>	1
Sri Lanka	<i>H. erectus</i>	1
	<i>H. reidi</i>	3,483
Mauritania	<i>H. kuda</i>	87
Mauritius	<i>H. kuda</i>	22
Mexico	<i>H. fuscus</i>	4
Malaysia	<i>H. hippocampus</i>	629
Philippines	<i>H. coronatus</i>	115
	<i>H. erectus</i>	73
	<i>H. guttulatus</i>	10
	<i>H. hippocampus</i>	889
	<i>H. zebra</i>	71
Singapore	<i>H. erectus</i>	28
	<i>H. hippocampus</i>	10
USA	<i>H. abdominalis</i>	96
	<i>H. bargibanti</i>	1
	<i>H. erectus</i>	135
Vietnam	<i>H. erectus</i>	4,590
	<i>H. hippocampus</i>	3,497
Total		14,300

Source Countries

Overall: Although seahorses were reportedly sourced from nearly fifty countries (see Trade Routes, above), just one country – Thailand – made up at least half of all exported volume each year (ranging from 52-80%; $N \approx 3.8$ -6.5 million individuals, per annum) (Figure 8). Smaller volumes were reportedly exported from China, (3-22%; 158,000 – 1.7 million), Guinea (5-9%; $N \approx 300,000$ -860,000 individuals per annum), Senegal (2-6%; $N = 200,000$ -310,000 individuals per annum), Malaysia (0-11%; $N \approx 2,500$ -595,000 individuals per annum) and Vietnam (1-7%; $N \approx 56,000$ -685,000 individuals per annum).

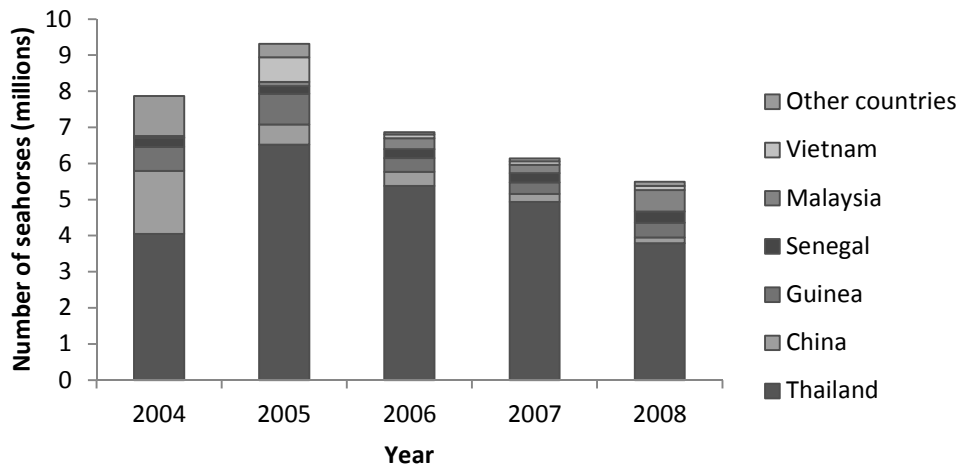


Figure 8. Estimated total volume of exported seahorses reported in the CITES Trade Database from 2004-2008. Volumes were estimated from both export and EFI data. Data for the six countries with largest estimated export volumes are displayed. All other countries grouped into “Other countries”. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Dried: Source countries for dried seahorses were numerous ($N=37$) and varied (all continents except Antarctica - Table 9). Because dried, non-captive individuals dominated the reported international seahorse trade, trends in source country volumes for dried and dried non-captive seahorses reflected those for the overall trade; Thailand comprised over half (52-83%) of all export volumes annually (Figure 8).

Export and EFI data reported seven countries supplying dried, captive-bred seahorses, primarily in 2008. From 2004-2007, the data reported trade of relatively few dried, captive-bred seahorses with New Zealand trading 50 individuals in 2004, mainland China trading 93 individuals in 2005, Germany and New Caledonia trading a total of 10 individuals in 2006, and Australia, Canada and Vietnam trading a total of 185 individuals in 2007. However in 2008, reported trade volumes of dried captive-bred seahorses were much higher. This peak in reported dried, captive-bred individuals was reportedly made up of exports of cultured seahorses from Vietnam ($N \approx 8,000$), Australia ($N \approx 2,600$) and New Caledonia ($N \approx 27$). Other countries also reported to have exported dried, captive-bred seahorses are Canada and Germany.

Live: The majority of live seahorses reportedly came from South East Asian countries (Table 10) such as Vietnam, Sri Lanka and Indonesia, in descending order by volume (Figure 9A). In 2004, these three countries comprised over half of total live exports (58%; $N \approx 13,000$); however, this increased to >90% in subsequent years (91-96%; $N \approx 115,000$ -163,000 individuals per annum). Smaller numbers of live seahorses were also reportedly exported from Australia (1-8%; $N \approx 1,350$ -5,800), Brazil (1-3%; $N \approx 500$ -4,000 individuals per annum), and Mexico (0-1%; $N \approx 0$ -1,300 individuals per annum).

In 2004 and 2005, Indonesia reportedly exported the greatest number of live, non-captive-bred seahorses, comprising 43 and 56% of total volumes, respectively ($N \approx 5,000$ and 45,000 individuals per annum; Figure 9B). From 2006-2008, Vietnam replaced Indonesia as the greatest exporter reported, making up 44-77% of all live, non-captive-bred seahorses each year ($N \approx 10,000$ -41,500 individuals per annum).

From 2004-2005, Sri Lanka dominated total reported exports of live, captive-bred seahorses comprising 63 and 94% of total volumes each year ($N \approx 7,500$ and 42,500 individuals per annum), respectively (Figure 9C). From 2006-2008, Vietnam replaced Sri Lanka as the dominant reported exporter of live, captive-bred individuals – making up 56-79% of the live, captive-bred trade each year ($N \approx 61,500$ -80,000 individuals per annum) (Figure 9C). Across all years, smaller volumes of live, captive-bred seahorses were reportedly exported by (in descending order by volume) Australia, New Zealand, Mexico and Brazil.

Table 9. Trade routes of dried seahorses based on declared export and EFI volumes from 2004-2008 as reported in the CITES Trade Database. Volume levels are denoted by 'X' where X = under 100 kilograms; XX = 100 to 1,000 kilograms; XXX = 1,000 to 10,000 kilograms and XXXX = more than 10,000 kilograms. (i) denotes information was derived from CITES EFI data only, (e) denotes information was derived from export data only and (b) denotes that the information is a mixture of both EFI and export data. ¹ denotes that some portion of these volumes consist of captive-bred individuals.

Source Countries	Consumer Countries (A-M)										
	Australia	Austria	Canada	Czech Republic	France	Hong Kong	Hungary	Japan	Korea, Republic of	Mainland China	Malaysia
Australia									X (e) ¹		
Bahamas											
Bolivia											
Brazil											
Cambodia											
Canada											
Costa Rica							X (i)				
Cote d'Ivoire											
Czech Republic											
Ecuador											
Egypt						XX (e)					
Fiji											
France											
Germany											
Guinea						XXX (b)				XXX (e)	
Hong Kong											
Indonesia											
Japan											
Korea, Republic of											
Lao											
Macau											
Mainland China			X (e)			X (e)		XXX (b)			
Malaysia						XXX (b)					
Mexico											
New Caledonia					X (e) ¹						
New Zealand	X (e)					X (e) ¹					
Peru						XX (i)				XX (e)	
Philippines											
Portugal			X (i)								
Senegal						XXX (b)				XX (e)	
Singapore											
Taiwan											
Thailand	XX (e)					XXXX (b)				XXX (b)	XX (b)
Togo						XX (i)				XX (e)	
United Arab Emirates											
USA											
Vietnam		X (i)		X (i)		X (i) ¹	X (i)				

Source Countries	Consumer Countries (N-Z)											
	New Zealand	Poland	Portugal	Saudi Arabia	Singapore	South Africa	Spain	Switzerland	Thailand	Taiwan	UK	USA
Australia	X (b)1							X (i)1	X (e)1			X (i)
Bahamas												X (e)
Bolivia												X (i)
Brazil												X (i)
Cambodia												X (i)
Canada												X (i)1
Costa Rica												
Cote d'Ivoire												X (i)
Czech Republic	X (i)											
Ecuador												X (i)
Egypt	X (i)											
Fiji	X (i)											
France								X (b)				
Germany								X (b) ¹				
Guinea												
Hong Kong	XX (i)										XX (i)	X (i)
Indonesia	XX (i)	X (i)									XX (i)	
Japan												X (i)
Korea, Republic of												X (i)
Lao												X (i)
Macau												X (i)
Mainland China	XXX (i)	X (i)			X (e)		X (e)				XXX (i)	X (b) ¹
Malaysia	X (i)									XX (e)	X (i)	X (i)
Mexico												X (i)
New Caledonia												X (b) ¹
New Zealand												X (i) ¹
Peru												X (i)
Philippines			X (i)								X (i)	X (i)
Portugal												
Senegal										XX (e)	X (e)	
Singapore											X (i)	
Taiwan	X (i)											
Thailand	X (i)				XXX (b)					XXXX (e)		X (i)
Togo												
United Arab Emirates											X (i)	
USA	X (i)			X (e)		X (e)					X (i)	
Vietnam	XX (i)	X (i)								XXX (e)	X (i)	X (i)1

Table 10. Trade routes of live seahorses based on declared export and EFI volumes from 2004-2008 as reported in the CITES Trade Database. Volume levels are denoted by 'X' where X = under 100 individuals; XX = 100 to 1,000 individuals; XXX = 1,000 to 10,000 individuals and XXXX = more than 10,000 individuals. (i) denotes information was derived from CITES EFI data only, (e) denotes information was derived from export data only and (b) denotes that the information is a mixture of both EFI and export data. 1 denotes that some portion of these volumes consist of captive-bred individuals.

Source Countries	Consumer Countries (A-H)														Hong Kong
	Australia	Austria	Argentina	Barbados	Belgium	Brunei Darussalam	Cameroon	Canada	Czech Republic	Denmark	France	Germany	Guam	Guatemala	
Australia						XX (e) ¹	XX (e) ¹	XX (e) ¹			X (b)	X (i)	XX (e) ¹		X (b) ¹
Brazil			XX (e)					XX (b)				XXX (b)		XX (e)	X (b)
Cuba												X (i)			
Dominican Republic												X (i)			
Guinea															
Haiti															
Hong Kong															
Indonesia		X (i)						XXX (b)	XX (b)	X (i)	XXX (b)	XXX (b)			XX (b)
Ireland															
Japan															
Kuwait															
Malaysia															XXX (e)
Mauritania												X (i)			
Mauritius												X (i)			
Mexico															
New Caledonia											XX (e) ¹				
New Zealand	XX (b) ¹				XX (b) ¹			X (b) ¹							
Peru															
Philippines										X (i)		XXX (i)			
Portugal								XXX (e)							
Senegal											X (e)				
Singapore												XX (i)			
Sri Lanka	XX (e) ¹	XXX (b) ¹	XX (e) ¹		XX (b) ¹			XXX (b) ¹	XX (e) ¹		XXX (b) ¹	XXX (b) ¹			XXX (b) ¹
UK				X (i) ¹				X (e) ¹							
USA												XX (i)			
Vanuatu															
Vietnam		XX (b) ¹			XX (b) ¹			XXXX (b) ¹			XXXX (b) ¹	XXX (b) ¹			XX (b) ¹

Source Countries	Consumer Countries (H-O)														
	Hungary	Ireland	Israel	Italy	Japan	Korea, Republic of	Kuwait	Mainland China	Malaysia	Mexico	Monaco	Namibia	Netherlands	New Zealand	Norway
Australia				XX (b) ¹	XXX (b) ¹	XX (e) ¹		X (e) ¹					XX (b)	X (e)	
Brazil				XX (b)	XX (e)								XX (e) ¹		
Cuba															
Dominican Republic															
Guinea								XX (e)							
Haiti															
Hong Kong															
Indonesia		XX (b)		XXX (b)	XXXX (b)	XXX (b)							XXX (b)	XX (b)	
Ireland															X (e) ¹
Japan											X (e) ¹				
Kuwait															
Malaysia															
Mauritania															
Mauritius															
Mexico															
New Caledonia															
New Zealand		XX (i) ¹			XX (e) ¹										
Peru															
Philippines				XX (i)											
Portugal															
Senegal															
Singapore				XX (i)											
Sri Lanka	XXX (b) ¹	XX (i) ¹	XX (e) ¹	XXX (b) ¹	XX (b) ¹					XX (i) ¹		X (i) ¹	XXXX (b) ¹		XX (e) ¹
UK							X (b) ¹								
USA		X (i) ¹		XX (i)								X (e) ¹	X (i)		
Vanuatu															
Vietnam				XXX (b) ¹	XX (e)			XX (e) ¹	XXX (e) ¹				XXX (b) ¹	XX (e)	X (e) ¹

Consumer Countries (P-Z)																
Source Countries	Poland	Portugal	Romania	Saudi Arabia	Singapore	Spain	Sri Lanka	South Africa	Swaziland	Sweden	Switzerland	Taiwan	UK	Ukraine	United Arab Emirates	USA
Australia					XXX (b) ¹	X (i)					XX (b)1	XX (e) ¹	XXX (b) ¹			XXX (b) ¹
Brazil					XX (b)	XX (b)						X (e)	XX (b)			XXX (b) ¹
Cuba						XX (i)										
Dominican Republic																
Guinea																
Haiti																X (i)
Hong Kong								X (e) ¹								
Indonesia	XXX (e)	XX (i)			XXX (b)	X (i)		XX (b)		X (i)	XX (b)		XX (e)		XX (b)	XXXX (b)
Ireland												X (e) ¹				X (b) ¹
Japan															X (i)1	
Kuwait															X (i)1	
Malaysia												XX (e)				
Mauritania																
Mauritius																
Mexico																XXX (b) ¹
New Caledonia																X (e) ¹
New Zealand												XX (e) ¹	X (b) ¹			XXX (b) ¹
Peru																X (i)
Philippines						X (i)							XX (i)			X (i)
Portugal																
Senegal																
Singapore		X (i)											XX (i)			
Sri Lanka	XX (b) ¹	XX (i) ¹	XX (i) ¹	X (e) ¹	X (e) ¹	XXX (b) ¹		XX (e) ¹	XX (e) ¹	XXX (b) ¹	XXX (b) ¹		XXXX (b) ¹	XX (e) ¹	XX (e) ¹	XXXX (b) ¹
UK																
USA								X (e) ¹					XX (i)			
Vanuatu																X (i)
Vietnam					XXX (b) ¹	XX (e) ¹	XXX (e) ¹				XX (b) ¹	XXX (e) ¹	XXX (b) ¹			XXXXX (b) ¹

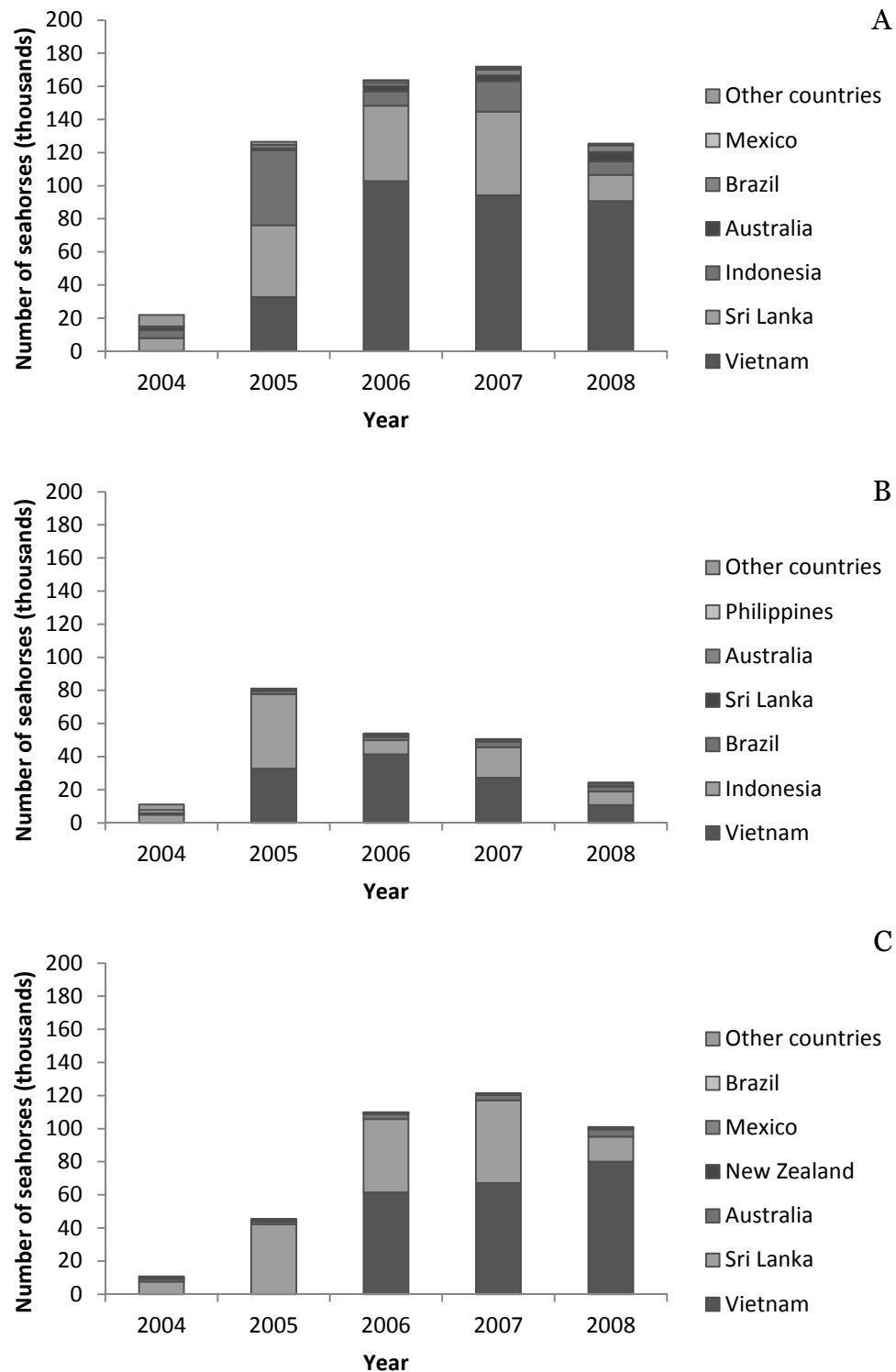


Figure 9. Total estimated volumes of (A) live, (B) live, non-captive-bred and (C) live, captive-bred seahorses reportedly exported by source country as reported in the CITES Trade Database from 2004–2008. Data for the six countries that reported the largest trade are displayed. All other countries grouped into “Other countries”. Data shows combined export and EFI data. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumer Countries

Overall: Export and EFI data suggested Hong Kong SAR was the overall top consumer country of seahorses (dried and live – wild and captive-bred), reportedly importing an average of 57% of the total traded volume (37-75%; $N \approx 2.8 - 4.6$ million individuals per annum) (Figure 10). Smaller consumption volumes were reported for Taiwan (11-23%; $N \approx 625,000 - 2$ million individuals per annum), mainland China (6-12%; $N \approx 340,000 - 1$ million individuals per annum), New Zealand (0-12%; $N \approx 6$ individuals-1 million individuals per annum) and the UK (0-15%; $N \approx 4,700 - 1.2$ million individuals per annum).

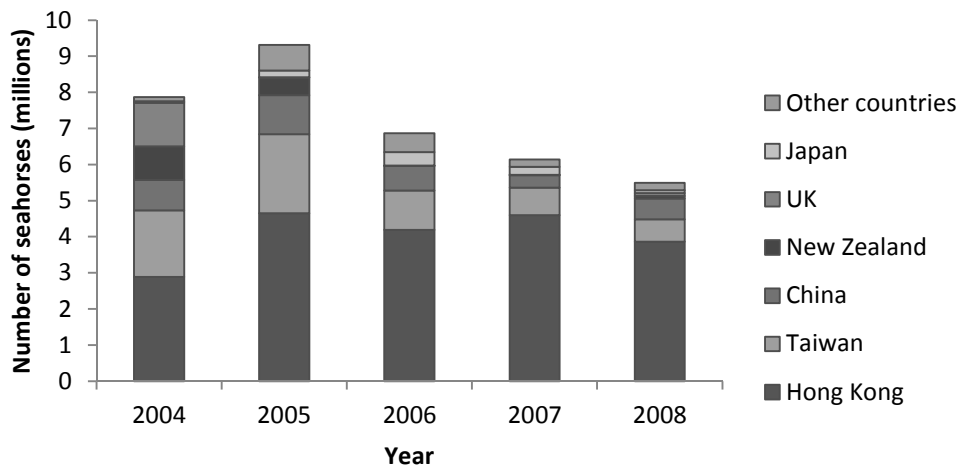


Figure 10. Estimated total volume of seahorses reportedly imported by key consumer countries as reported in the CITES Trade Database from 2004-2008. Volumes were estimated from both export and EFI data. Data for the six countries that report the largest trade are displayed. All other countries grouped into “Other countries”. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Dried: Dried wild seahorses dominated reported trade records from 2004-2008 (Figure 4). Therefore, trends in reported consumer country volumes for all dried versus dried, wild seahorses reflected those discussed previously for trade overall (Figure 10). Although most dried seahorses were consumed in the East, a wide range of consumer countries allegedly consume dried seahorses (Table 9). Hong Kong SAR was the overall top consumer making up 37-77% of total overall dried trade volumes ($N \approx 2.8 - 4.6$ million individuals per annum), with additional substantial volumes reportedly imported by mainland China ($N \approx 240,000 - 1$ million individuals per annum) and Taiwan ($N \approx 625,000 - 2.1$ million individuals per annum).

Based on both export and EFI data, seven countries were reported to have consumed dried, captive-bred seahorses from 2004-2008. Just over ten thousand individuals were reportedly traded in 2008. These relatively large volumes of dried, captive-bred individuals were reportedly consumed primarily by the USA (75%; $N \approx 8,500$). In all other years, reported trade in dry captive-bred seahorses was < 200 individuals per year.

Live: Analyses based on both export and EFI data suggested that live seahorses were consumed primarily by North American and European countries (Figure 11A), although a wide range of other consumer countries were also reported (Table 10). The top reported consumer country was the USA, supposedly consuming one to two thirds of all live seahorses each year (35-68%; $N \approx 7,500 - 110,000$ individuals per annum). Additional notable consumer countries included France (6-13%; $N \approx 1,300 - 16,500$ individuals per annum), Canada (3-9%; $N \approx 1,800 - 12,500$ individuals per annum) and the UK (3-5%; $N \approx 1,000 - 9,000$ individuals per annum).

Based on export and EFI data, Germany was the main reported consumer of live, non-captive-bred seahorses in 2004, importing 30% of total individuals (Figure 11B). In all other years, however, the USA reportedly consumed at least two thirds (66-94%; $N \approx 20,000$ -53,000 individuals per annum) of all live, non-captive-bred seahorses. Japan and Korea were reported to have each imported up to 6% of live, non-captive-bred individuals annually.

Live, captive-bred seahorses were also allegedly primarily consumed by North American or European countries (Figure 11C). Similar to trends for live, wild individuals, the USA reportedly dominated the consumer market for live, captive-bred seahorses in all years making up at least half of such volumes each year (52-60%; $N \approx 6,500$ -63,000 individuals per annum; Figure 11C). Additional notable markets included France (5-16%; $N \approx 924$ -16,000 individuals per annum) and Canada (1-10%; $N \approx 170$ -12,000 individuals per annum) which together supposedly consumed 9-22% of total reported volumes, based on export and EFI data.

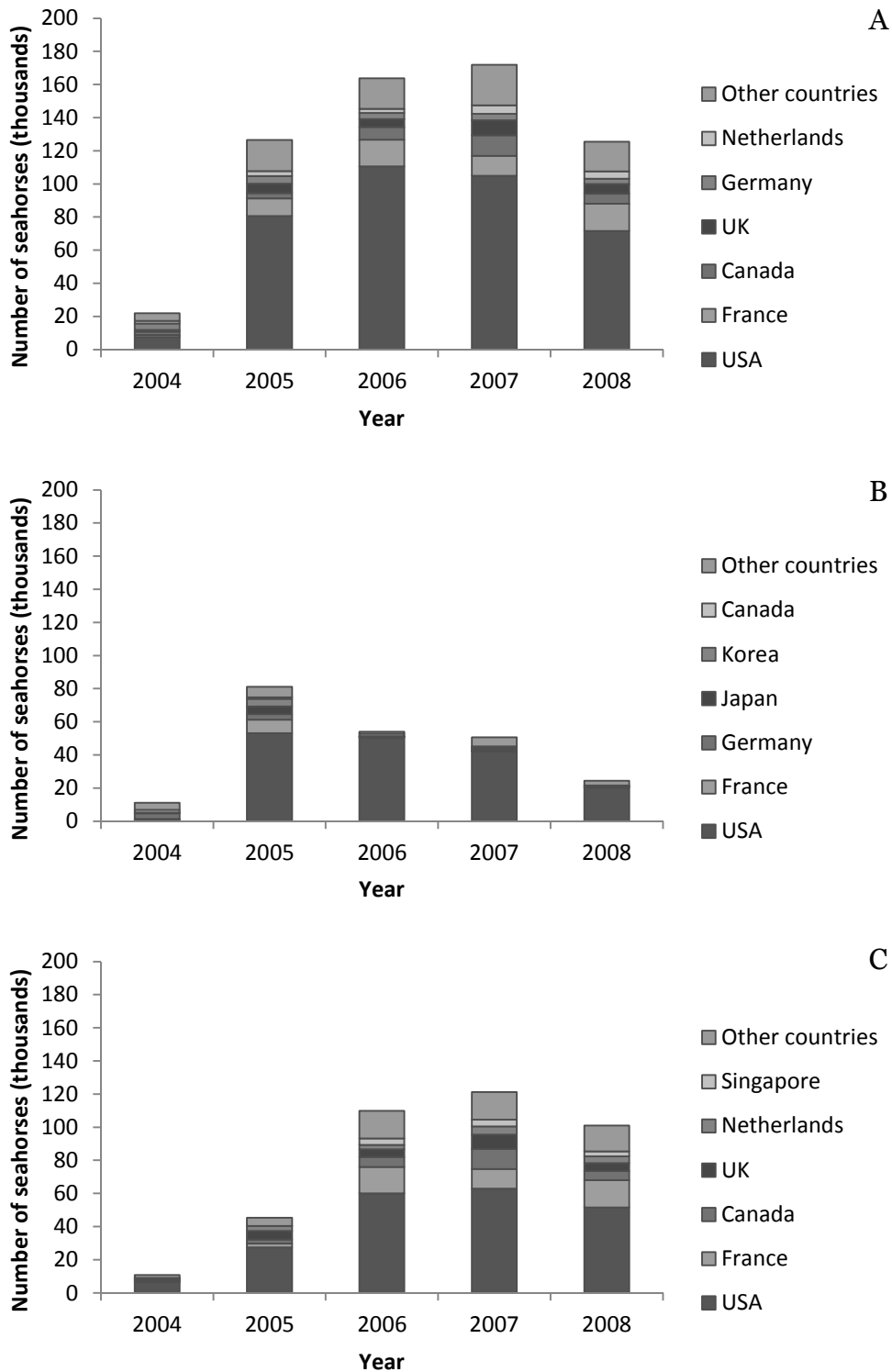


Figure 11. Total estimated volumes of (A) live, (B) live, non-captive-bred and (C) live, captive-bred seahorses reportedly imported by consumer country as reported in the CITES Trade Database from 2004-2008. Data for the six countries that reported the largest trade are displayed. All other countries grouped into “Other countries”. Volumes were estimated from both export and EFI data. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

COMPARISON TO HISTORIC DATA

Species Traded

The overall number of species involved in the international trade of seahorses seems to have remained stable over time, although the actual composition of species reportedly traded has changed. CITES data from 2004-2008 reported a total of 28 seahorse species involved in the overall trade of seahorses, only a slight increase from the 24 previously estimated from historic data (Table 3, *Second surveys*) (Vincent *et al.* 2011a). Species recorded in the CITES data that did not appear in historical records included *H. algiricus*, *H. bargibanti*, *H. denise*, and *H. montebelloensis*. Comparing historic records to CITES data suggested a slight decrease over time in the number of seahorse species reported in the dried trade (from 20 to 18), along with a concurrent change in species composition – four species were added (*H. algiricus*, *H. bargibanti*, *H. breviceps* and *H. zosterae*) while six others were no longer reported (*H. angustus*, *H. borboniensis*, *H. camelopardalis*, *H. mohnikei*, *H. whitei* and *H. zebra*). On the other hand, the number of species traded live supposedly increased post-CITES (from 19 to 27), with CITES data reporting eight species in the live trade for the first time (*H. algiricus*, *H. borboniensis*, *H. denise*, *H. hippocampus*, *H. kelloggi*, *H. montebelloensis*, *H. trimaculatus* and *H. zebra*) (Table 3).

Over both time periods, species reported in the dried trade were primarily Asian (e.g. *H. histrix*, *H. kuda*, *H. kelloggi*, *H. spinosissimus*, *H. trimaculatus*) – with *H. spinosissimus* and *H. trimaculatus* the most commonly reported export species, supposedly originating primarily from Thailand and Vietnam (Vincent *et al.* 2011a). The smooth-bodied, and presumably more valuable, species, *H. kelloggi* and *H. kuda*, that were historically common in TCM markets were also reported in large numbers in the CITES data, albeit in smaller volumes than *H. spinosissimus* and *H. trimaculatus*. *Hippocampus algiricus* was the fourth most traded seahorse in the dry trade in the CITES data but was not reported in the *second surveys*.

Second surveys found the most commonly traded live seahorses were those from the Americas (*H. erectus*, *H. zosterae*, *H. reidi*) and Asia (*H. kuda*). The species composition of the live trade differed slightly in the CITES data, which reported *H. kuda* and *H. reidi* to have dominated the trade along with very small numbers of *H. abdominalis*, *H. spinosissimus*, *H. comes* and *H. ingens*.

Trade Routes

Overall: Similar to the species composition of the trade, the total number of countries involved in the international trade in seahorses seems to have remained stable although the composition of the global contenders has appeared to change over time. The tally of 72 countries reported in the CITES database compares to the historical total of 73 from Project Seahorse trade surveys (*second surveys*) – with a total of 96 countries having been reportedly involved in the seahorse trade at one time or another until 2008.

Source Countries

Comparing sources (Table 5) in the *second survey* and CITES data suggests the overall number of source countries reported in international trade has decreased over time, from 51 to 47, although the involvement of 17 of the 51 source countries recorded during the *second surveys* were for trade of unknown volumes (e.g. Venezuela in Vincent *et al.* 2011b). Our analyses reveal that most of the supposed decrease in source countries from *second surveys* to CITES data is made up of a decrease in the number of sources of dried trade. Historically about 26 countries were recorded to supply the dried trade, compared to only 20 reported in the CITES data. Sources of both live and dried trades and live only trades were more stable: comparing *second survey* to CITES data suggests 15 versus 17 countries supplying both trades, respectively, whereas there does not appear to have been a change in number of source countries for the live trade only (10 countries reported as sources in both time periods).

In addition to the supposed net decrease in the number of source countries involved in the international trade in seahorses, the reported country composition also shifted: 17 previously unrecorded source countries were reported in CITES data, and 21 countries recorded historically were not reported in CITES data. Newly reported source countries were geographically diverse (e.g. Cote d'Ivoire, Haiti, Czech Republic, Canada) but did not contribute substantially to reported overall volumes in the CITES database. The countries that were no longer reported as sources of seahorses were also geographically diverse,

however, only India and Tanzania had traded large numbers (in the tonnes) of seahorses in the past (Vincent *et al.* 2011b).

There have been a grand total of 68 countries ever reported as sources of seahorse trade across the two time periods. Of these, approximately one quarter (28%, N=19/68) are reported to play the same role in the CITES data as they were reported to play historically. Asian countries appear to be the most constant of players – with over half (61%, N=11/18) of the countries without a reported role change hailing from the Asian continent.

But the contrary is, therefore, that 72% (N=49/68) of the countries ever reported as sources of seahorses seem to have changed the role they play as exporters over time. The biggest change in reported data is a purported disappearance of sources – with 31% (N=21/68) of countries ever reported as sources of seahorses not appearing in the CITES database. As mentioned, this is mostly due to a reported decrease in sources for the dried trade – 28% (N=19/68) of countries ever reported as sources for dried trade do not appear as sources at all in the CITES data – with the majority of this change appearing to have taken place in Africa and Asia (of the countries no longer reported as sources, 36 (N=8/22) and 23% (N=5/22) are located in these two regions, respectively). In Africa, the eight countries that were once identified as sources of seahorses but were not reported in the CITES database as exporters were: Gambia, Kenya, Madagascar, Mozambique, Nigeria, the Seychelles, South Africa and Tanzania. In Asia, the five countries no longer reports as sources were: Bangladesh, India, Maldives, Myanmar and Pakistan.

The next most common role change is the supposed appearance of new source countries over time – 25% (N=17/68) of total countries ever reported as sources of seahorses are only found in the CITES database. Of these, over one quarter hail from Europe (29%, N=5/17), and most of these are reported as new sources for the dried trade (four of the seven European countries ever reported as sources of seahorses appear for the first time as sources of dried seahorses in the CITES data). Newly reported European sources of dried seahorses included the Czech Republic, Germany, France and Portugal. Other newly reported sources of dried seahorses include countries in Africa (Cote d'Ivoire and Egypt), Asia (Japan, Lao People's Democratic Republic and Macau), Oceania (New Caledonia and Fiji), North America (Bahamas, Canada and Costa Rica) and South America (Bolivia).

The number of source countries for live seahorses reportedly increased over time from 25 to 27, although seven countries reported during the *second surveys* were for unknown volumes (Table 5). None of the three historically documented African source countries for live seahorses (Egypt, Kenya and Mozambique) were reported in CITES data, resulting in a completely new profile for the live seahorse trade from this continent. The newly reported African source countries were Guinea, Mauritania, Mauritius and Senegal. In Asia, India, Pakistan and Thailand were the only source countries recorded in *second surveys* that were not reported as exporters of live seahorses in CITES data. Newly reported source countries in the region included Hong Kong SAR, Japan and Kuwait. CITES data reported two European sources for live seahorses (Ireland and Portugal) in addition to the UK which was also reported historically. Only two additions were reported in Oceania (New Caledonia and Vanuatu), while Australia and New Zealand were reported in both. In the Americas, the Dominican Republic, Haiti and Peru were reportedly new exporters of live seahorses post-CITES while Belize, Canada, Costa Rica and Ecuador, once historical exporters were no longer reported.

Very few countries have reportedly increased (so gone from dried or live to both – 6% of total, N=4/68), decreased (so gone from both to only dried or live – 3% of total, N=2/68), or switched (so gone from dried to live, or live to dried – 7% of total, N=5/68) their role as sources for seahorses in international trade.

Consumers Countries

The number of consumer countries (Table 6) reportedly involved in the international seahorse trade remained more or less stable, with a small increase from 44 in historical surveys to 47 in CITES data, although nine of the countries reported during *second surveys* were not verified and volumes were unknown (e.g. Vincent *et al.* 2011b). Overall, a grand total of 61 countries were ever reported as consumers of seahorses across the two time periods. Of these about one third (31%, N=19/61) are reported to play the same consumer role in the CITES data as they appeared to play historically. Asian and European countries come across as the most constant of players – with 74% (N=14/19) of the countries without a reported role change hailing from these regions.

But comparing pre- and post-CITES datasets did suggest that 69% (N=42/61) of the countries ever reported as consumers of seahorses seem to have changed their role in the trade over time. Historically 20 countries were supposedly involved in trading both dried and live seahorses compared to 22 in the CITES data; nine were reportedly involved with only the dried trade compared to one in the CITES data; and 15 were reportedly involved in only the live trade compared to the 24 reported in the CITES database. Thus the two dominant observed changes are the purported appearance (28%, N=17/61, especially for live trade – see below) and disappearance (23%, N=14/61, especially for dried trade, see below) of consumers. The 17 consumer countries not found at all in historical records were from Africa (Cameroon, Namibia and Swaziland), Asia (Brunei Darussalam, Israel, Kuwait, Sri Lanka and the UAE), Europe (Czech Republic, Monaco, Norway, Poland, Romania and Ukraine) and the Americas (Barbados, Guam and Guatemala) (Table 6). The 14 consumer countries reported in the *second surveys* that are not found in the CITES data were from Africa (Senegal, Tanzania and Zimbabwe), Asia (India, Indonesia, Jordan, Pakistan and the Philippines) and the Americas (Belize, Costa Rica, Panama, Bolivia, Chile and Uruguay).

Of newly reported consumers, the majority 88% (N=15/17) are reported as consumers of live seahorses only in the CITES data. Asian and European countries are reportedly responsible for most of the observed increase in consumer countries – each representing 29 and 35% of the reported increase, respectively (N=5 and 6 of 17, respectively). And indeed all newly reported consumer countries in Asia are reported as importing live seahorses in the CITES data (100%, N=5/5), whereas in Europe a live-only seahorse trade represents 67% (N=4/6) of newly reported consumer countries in this region. In summary, the 15 new live consumer countries were from Africa (Cameroon, Namibia and Swaziland), Asia (Brunei Darussalam, Israel, Kuwait, Sri Lanka and the United Arab Emirates), Europe (Czech Republic, Monaco, Norway, Poland, Romania and Ukraine) and North America (Barbados, Guam and Guatemala).

Whereas new consumers appear to be consuming mostly live seahorses, the majority (71%, N=10/14) of ‘disappearing’ consumers were historically recorded as consumers of only dried seahorses. Asia was the region with the largest number of countries no longer reported as consumers of seahorses (overall) in the CITES data (N=5/14), two of which appear to have ceased consuming dried, and the other three live, seahorses. African, North and South American countries made up the rest, with three countries each no longer reported as consumers of seahorses. And of these, those in Africa represented losses of dried seahorse consumption only, whereas of those from North and South America, two were historically reported as consumers of dried, and one of live, seahorses for each region. In summary, the nine countries no longer reported as trading in dried seahorses were from Africa (Senegal, Tanzania and Zimbabwe), Asia (Indonesia and Philippines) and the Americas (Belize, Bolivia, Chile and Panama).

Very few countries have reportedly increased (so gone from dried or live to both – 10% of total, N=6/61) or decreased (so gone from both to only dried or live – 10% of total, N=6/61), and none have apparently switched (so gone from dried to live, or live to dried) their role as consumers of seahorses in international trade.

The total number of countries that reportedly consumed dried seahorses decreased from 29 during the *second surveys* to 23 in CITES data, although nine of the countries reported pre-CITES were unconfirmed and volumes were unknown (e.g. Vincent *et al.* 2011b). The majority of the reported decreases occurred in Africa (from four source countries recorded pre-CITES to one reported in CITES data) and the Americas (from eight recorded pre-CITES to two reported post-CITES).

The number of countries that reportedly consumed live seahorses increased from 35 during the *second surveys* to 46 in the CITES data, although six of the countries reported pre-CITES were not verified and volumes were unconfirmed (Table 6; Vincent *et al.* 2011b). The number of reported consumer countries for live seahorses supposedly increased in Africa (from one recorded pre-CITES to four reported in CITES data), Europe (from 14 to 20), North America (from four to six), decreased in South America (from two to one) and stayed the same in Oceania.

Trade Volumes

Overall: The annual volume of traded seahorses reported in the CITES database averaged 7 million individuals (range from 5-9 million), compared to a historical estimated annual average of 19 million seahorses (range from 14-23 million) based on *second surveys* (Vincent *et al.* 2011a).

Dried: The trade in dried, wild animals has consistently dominated the international trade in seahorses – comprising approximately 98% of the total reported trade both historically (Vincent *et al.* 2011a) and in the CITES data. However, more recent data suggested a very small proportion of dried seahorses may be obtained from captive-breeding facilities – although a trade in dried, captive-bred seahorses was not documented during the *second surveys*, CITES data reported trade in just over 11,000 dried, captive-bred individuals from seven source countries between 2004 and 2008. The largest exporters of dry, captive-bred seahorses were Vietnam and Australia with total trades of 8,321 and 2,548 respectively, and with most of this trade occurring in 2008.

Live: The reported trade in live seahorses decreased by approximately half from a historic annual estimate of 300,000 individuals (Vincent *et al.* 2011a) to approximately 120,000 individuals per annum reported in the CITES data. Limited historic data obtained from GMAD for the trade in wild vs. captive-bred seahorses suggested the majority, if not all, of the seahorses were caught wild (Wabnitz, 2010). This is in contrast to more recent CITES data that reported the proportion of supposedly captive-bred seahorses in the live trade to have increased steadily from 36% ($N \approx 45,000/126,000$) in 2005 to 80% ($N \approx 100,000/125,000$) in 2008.

By species: *Second survey* data did not estimate trade volumes of individual species; therefore, we cannot compare to the CITES data.

Source Countries

Dried: *Second surveys* suggested that the top source countries for dried seahorses (presumably mostly wild) were India, Mexico and Thailand (>10 tonnes annually per country) with lesser, albeit still substantial, volumes exported from the Philippines, Tanzania and Vietnam (in tonnes annually per country) (Vincent *et al.* 2011a). CITES data also reported Thailand as a primary source of dried seahorses. However, almost all other historically dominant countries – except Vietnam – were not reported as key sources in CITES data. Newly reported dominant source countries in the CITES database included, in descending order, mainland China (mainly due to reportedly large export volumes in 2004), Guinea, Senegal and Malaysia. Most notably, Guinea, historically recorded to export only small volumes of dried, wild seahorses, was reported in CITES data as one of the top six source countries for such trade. In addition, mainland China, not historically recorded as a source country, supposedly exported large volumes of dried, wild seahorses in 2004 – but it must be noted that volumes estimated for China are very sensitive to the assumptions on units (see Sensitivity Analyses below).

Live: *Second survey* trade data suggested the majority of live seahorses traded globally came from the Philippines and Indonesia with smaller contributions from Australia, Brazil, Sri Lanka and Thailand (Vincent *et al.* 2011a). While CITES data suggested the continued dominance of Southeast Asian countries as sources of live seahorses, the reported country composition varied: Vietnam, previously reported as a negligible source of live seahorses, was the dominant source country in CITES data, along with Sri Lanka and Indonesia. Relatively smaller volumes were reported from Australia and Brazil. Historic data on volumes of wild vs. captive-bred seahorses traded live was not available for comparison to CITES data.

Consumer Countries

Dried: The largest importers of dried seahorses according to *second surveys* were reportedly, in descending order, mainland China, Hong Kong SAR, Taiwan and Singapore (Vincent *et al.* 2011a). While Hong Kong SAR, Taiwan, and mainland China also emerged as dominant consumers post-CITES, increased consumption of dried seahorses in countries such as New Zealand and the UK may indicate a market diversification away from a historically all-Asian composition.

Live: *Second survey* data suggested the majority of live seahorses traded globally were consumed by the USA and Singapore (tens of thousands per year per country; Vincent *et al.* 2011a). Smaller volumes (thousands per year per country), however, were recorded during *second surveys* as imported to Europe (e.g. Belgium, Germany, Italy, Netherlands, the UK), Asia (Thailand, Taiwan, Malaysia, Hong Kong SAR), Australia and Mexico. CITES data, on the other hand, only reported the USA as a significant consumer of live seahorses, with the European Union (France, UK, Germany and Netherlands) and Canada reportedly importing smaller volumes.

RE-EXPORTER TRADE

Species

Just over half of all CITES re-export trade records from 2004-2008 (49%; N=108/220) were reported to the species level; the remaining records reported as the genus *Hippocampus*. Substantially fewer re-export records were provided at the species level for dried seahorse (36%, N=55/154) than for the live seahorse trade (86%, N=57/66). Similar to the trends in species level reporting presented for the direct export trade (see Species Traded), mainland China, Vietnam and Hong Kong SAR were the top three countries, in descending order, with the greatest number of dried seahorse trade re-export records reported to the genus level only (>60% over all years, Figure 12A). Singapore, the USA and Taiwan (in descending order) were the only re-export countries to report their live trade at the genus level (Figure 12B).

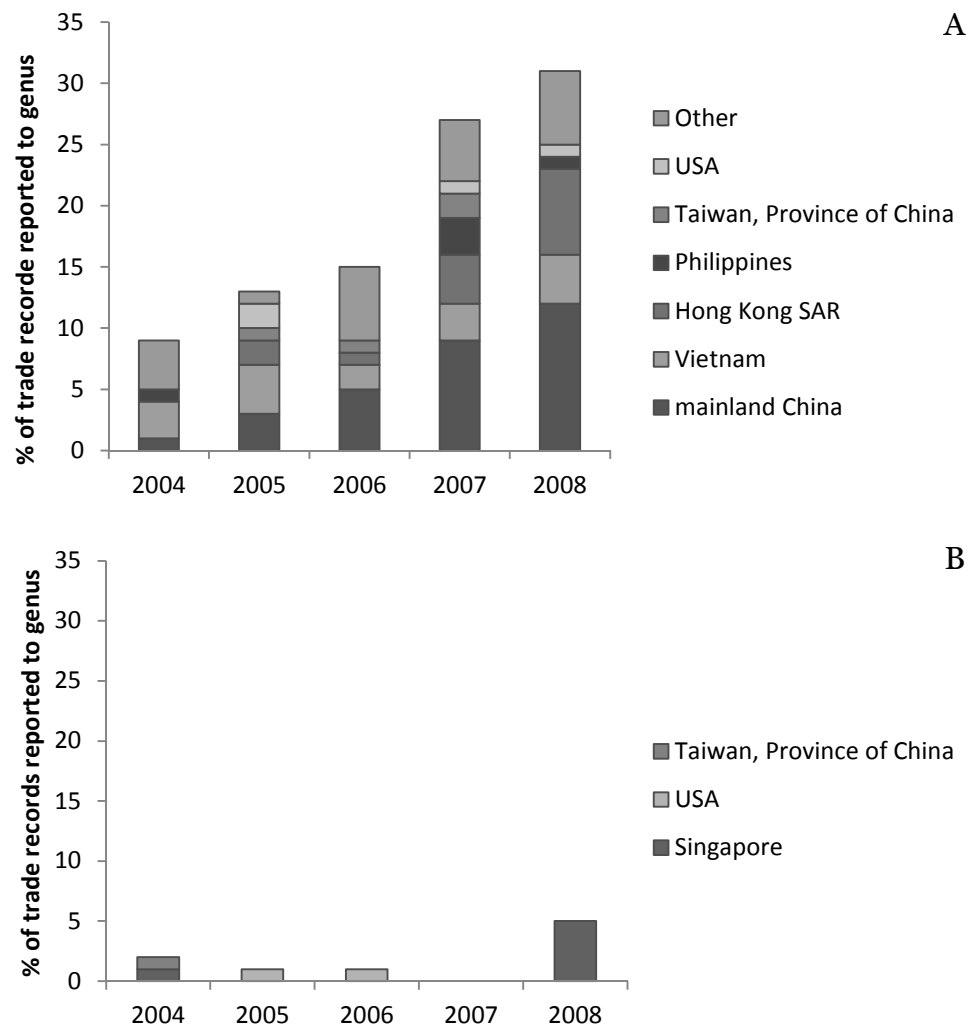


Figure 12. Percentage of re-export trade records from the CITES Trade Database for 2004-2008 reported at the genus level for global trade in (A) dried and (B) live seahorses. In (A), data for the six countries that reported the largest proportion of their trade to the genus level are displayed; all other countries grouped into “Other”. Data is combined export and EFI data. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Eighteen seahorse species (Lourie *et al.* 2004) were reportedly re-exported across all years; two of these (*H. fisheri* and *H. minotaur*) were not reported in the direct export trade (Table 11 versus Table 3). The reported dried re-export trade involved 14 species: 11 were only traded as wild and 3 were re-exported from cultured and wild sources. The live trade reportedly involved 13 species: 9 were reported as only wild, 1 as only captive-bred, and 3 as both wild and captive-bred (Table 11).

Table 11. List of seahorse species reported as re-exports in the CITES Trade Database from 2004-2008 organized by status (dried or live) and source (wild or captive-bred). Purpose of trade and continent/region of origin of species is also listed. Question marks denote uncertainty in the species and/or purpose of trade.

Species	CITES RE-EXPORTS				Continent/Region of Origin
	Dried		Live		
	Wild	Captive-bred	Wild	Captive-bred	
<i>H. abdominalis</i>			X	X	Oceania
<i>H. algericus</i>	X				Africa
<i>H. barbouri</i>	X	X	X		Asia
<i>H. bargibanti</i>	X				Asia
<i>H. borboniensis</i>	X				Africa
<i>H. comes</i>	X		X		Asia
<i>H. erectus</i>			X		North America/Caribbean
<i>H. fisheri</i>	X				North America
<i>H. fuscus</i>	X		X		Indo-Pacific
<i>H. guttulatus</i> (<i>H. ramulosus</i>) ²	X		X		Europe
<i>H. hippocampus</i>	X		X		Europe
<i>H. histrix</i>	X		X		Indo-Pacific
<i>H. kelloggi</i>	X	X	X		Asia
<i>H. kuda</i>	X	X	X	X	Asia
<i>H. minotaur</i>				X	Oceania
<i>H. reidi</i>			X	X	North America/Caribbean
<i>H. spinosissimus</i>	X		X		Asia
<i>H. trimaculatus</i> (<i>H. takakurae</i>) ²	X				Asia
TOTAL	14	3	12	4	

Trade Routes

Based on the CITES data, a total of 24 countries from Asia, Europe, North America and Oceania were reported as re-exporters of dried and live seahorses from 2004-2008 (Table 12). Twenty of these countries (83%) allegedly re-exported dried seahorses, half of which (N=12) were from Asia and the remainder from Europe (N=5) and North America (N=3). Over half of all re-exporter countries supposedly traded live seahorses (58%; N=14); these were countries in Asia (43%; N=6), Europe (29%; N=4), Oceania (14%; N=2) and North America (14%; N=2).

Table 12. Countries reported to have been the source for re-exports in dried and live seahorse species as reported in data from before the listing of seahorses in CITES (1998-2001) (*Second surveys*), and in the CITES Trade Database from 2004-2008 (CITES). ¹ denotes trade of unknown volumes.

Continent	Re-Export Country	Data Sources					
		<i>Second surveys</i>		CITES			
		Dried Seahorses	Live Seahorses	Dried Seahorses		Live Seahorses	
				Wild	Captive-bred	Wild	Captive-bred
Africa	Kenya	X					
	Mali	X					
	Senegal	X					
	South Africa	X ¹					
	Zimbabwe	X					
	Bhutan					X	X
Asia	China, mainland	X	X ¹	X	X		
	Georgia			X			
	Hong Kong SAR	X		X	X		
	Indonesia			X		X	
	Japan	X					
	Korea, Democratic People's Republic	X					
	Lao People's Democratic Republic	X ¹		X			
	Macau	X ¹		X			
	Malaysia	X ¹	X ¹	X		X	
	Philippines			X			
	Singapore	X	X	X		X	X
	Sri Lanka					X	
	Taiwan, Province of China	X		X	X	X	
	Thailand	X	X ¹	X			
	Vietnam	X		X			
Europe	Denmark			X			
	France			X			X
	Germany			X			X
	Netherlands			X			X
	Norway	X					
	UK			X		X	X

Continent	Re-Export Country	Data Sources					
		Second surveys		CITES			
		Dried Seahorses	Live Seahorses	Dried Seahorses		Live Seahorses	
				Wild	Captive-bred	Wild	Captive-bred
Oceania	Australia					X	
	Wallis and Futuna Islands					X	
	Belize	X					
North America	Canada		X ¹	X		X	
	Netherlands Antilles			X			
	USA	X	X	X		X	X
South America	Venezuela	X ¹					
TOTAL		20	6	20	2	11	7

Trade Volumes

Overall

Overall: Based on combined export and EFI data, the reported overall trade in re-exported seahorses from 2004-2008 was estimated at an annual average of 2.8 million individuals, with a range of 687,000 (2004) to 4.3 million (2006) individuals per annum. Temporal patterns showed no distinct trends – reported volumes peaked in 2006, decreased in 2007 and increased again in 2008 (Figure 13).

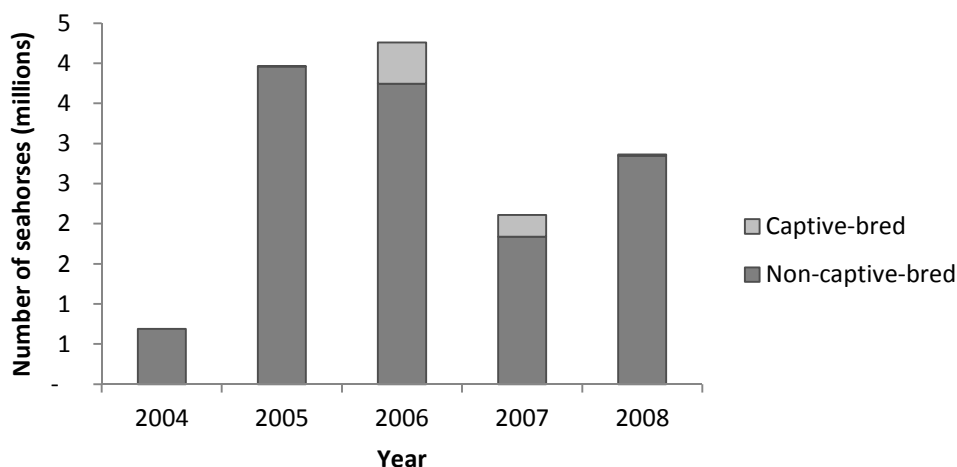


Figure 13. Total reported volumes of dried, captive-bred and non-captive-bred, seahorses re-exported globally from the CITES Trade Database 2004-2008. Data shows combined export and EFI data. The number of live seahorses are included but found in very small numbers. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Dried: Dried seahorses (captive and non-captive-bred) dominated the reported trade, averaging 99.9% of total volumes across all years (99.8-99.9%; N≈680,000 - 4.2 million individuals per annum; Figure 13). The reported re-export trade in dried seahorses was composed primarily of wild individuals, which made up over 90% (80-100%; N≈230,000-2.4 million individuals per annum) of annual dried volumes, where sources were known, across all years.

Live: The number of live seahorses (wild and captive-bred) comprised, on average, 0.1% of the reported total re-exports each year (0.02-0.2%; $N \approx 190$ -6,000 individuals per annum; Figure 14). The live trade appeared to have increased substantially in 2008, from numbers in the hundreds or low thousands to almost 6,000 individuals that year (Figure 14). In addition, the proportion of captive-bred seahorses reported in the live re-export trade increased substantially in 2007 and 2008, when they made up 57% ($N \approx 680$ individuals) and 89% ($N \approx 4,800$ individuals), respectively, of the total number of live seahorses re-exported, where sources were known (Figure 14).

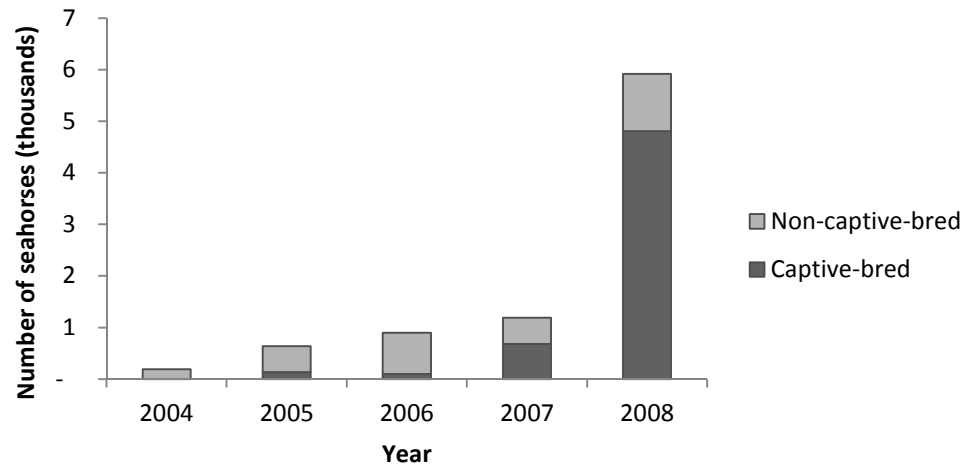


Figure 14. Total reported volumes of live seahorses, captive-bred or wild, re-exported globally from CITES Trade Database 2004-2008. Data shows combined export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

By Species

Overall/Dried: Based on export and EFI data, the two dominant species reported in the overall re-export trade were *H. kuda* (0-65%; $N \approx 0$ -2.7 million) and *H. histrix* (0-48%; $N \approx 0$ -1.9 million) (Figure 15). Temporal patterns revealed the number of species reported as re-exports increased in 2008 – and included *H. trimaculatus* (11%), *H. spinosissimus* (10%) and *H. kelloggi* (8%) (Figure 15). The majority of re-exported seahorses reported in 2004 were identified to the genus level only (99.9%).

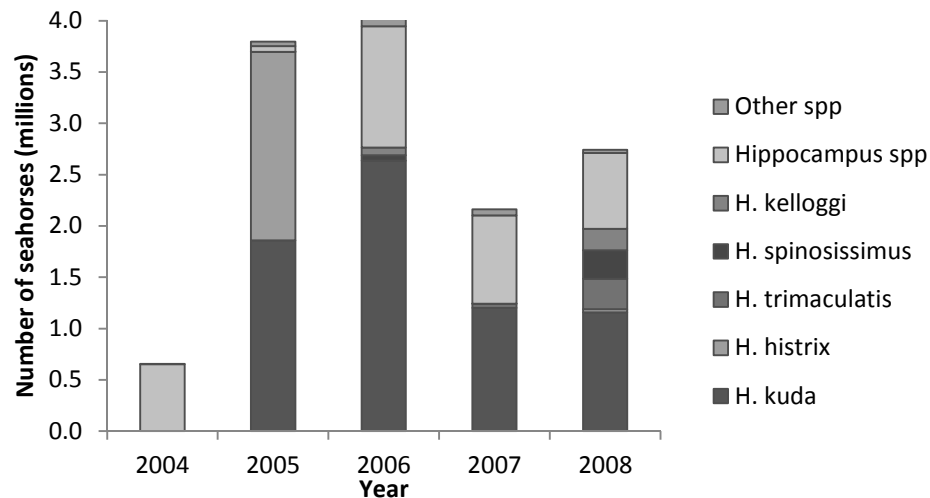


Figure 15. Total number of seahorses reported as being re-exported, by species, in the CITES Trade Database from 2004-2008. Data shows combined export and EFI data. Data for the five species that made up the largest proportion of the trade, as well as all records reported to the genus level (*Hippocampus* spp.) are displayed. All other species grouped into “Other spp”. Data shows combined export and EFI data. The order of the species in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Because dried, and specifically dried, non-captive-bred seahorses comprised the vast majority (95%) of all reported re-exports, the top overall reported species remained the same when examining trends in all dried (wild and captive-bred) and dried, wild species.

Only three dried, captive-bred species were declared in the re-export trade, and only in 2006-2008. These included (in descending order): *H. kuda*, *H. kelloggi* and *H. barbouri*. *Hippocampus kuda* made up 98% ($N \approx 505,000$ individuals) and 100% ($N \approx 267,000$ individuals) of all reported re-exports in 2006 and 2007, respectively. *Hippocampus barbouri* and *H. kelloggi* purportedly contributed approximately 10,000 individuals to the re-export trade in dried, captive-bred seahorses in 2006 and 2008, respectively.

Live: Based on export and EFI data, *H. kuda* dominated the re-export trade of live seahorses in 2006 comprising 82% ($N \approx 750$) of trade in that year (Figure 16A). In 2007, *H. minotaur* comprised the majority of all live re-export volumes (42%; $N \approx 500$) but this finding was based on one trade record only. In 2008, reported re-exported volumes of *H. reidi* increased dramatically, to make up 80% ($N \approx 4,700$ individuals) of total reported re-export volumes of live seahorses.

Hippocampus kuda dominated live, non-captive-bred re-exports from 2005-2008 (54-81%; $N \approx 200$ -650 individuals per annum) (Figure 16B). Examining the live, captive-bred re-export trade suggested that a different species dominated such trade each year from 2005-2008: *H. abdominalis* in 2005, *H. kuda* in 2006, *H. minotaur* in 2007 and *H. reidi* in 2008 (Figure 16C).

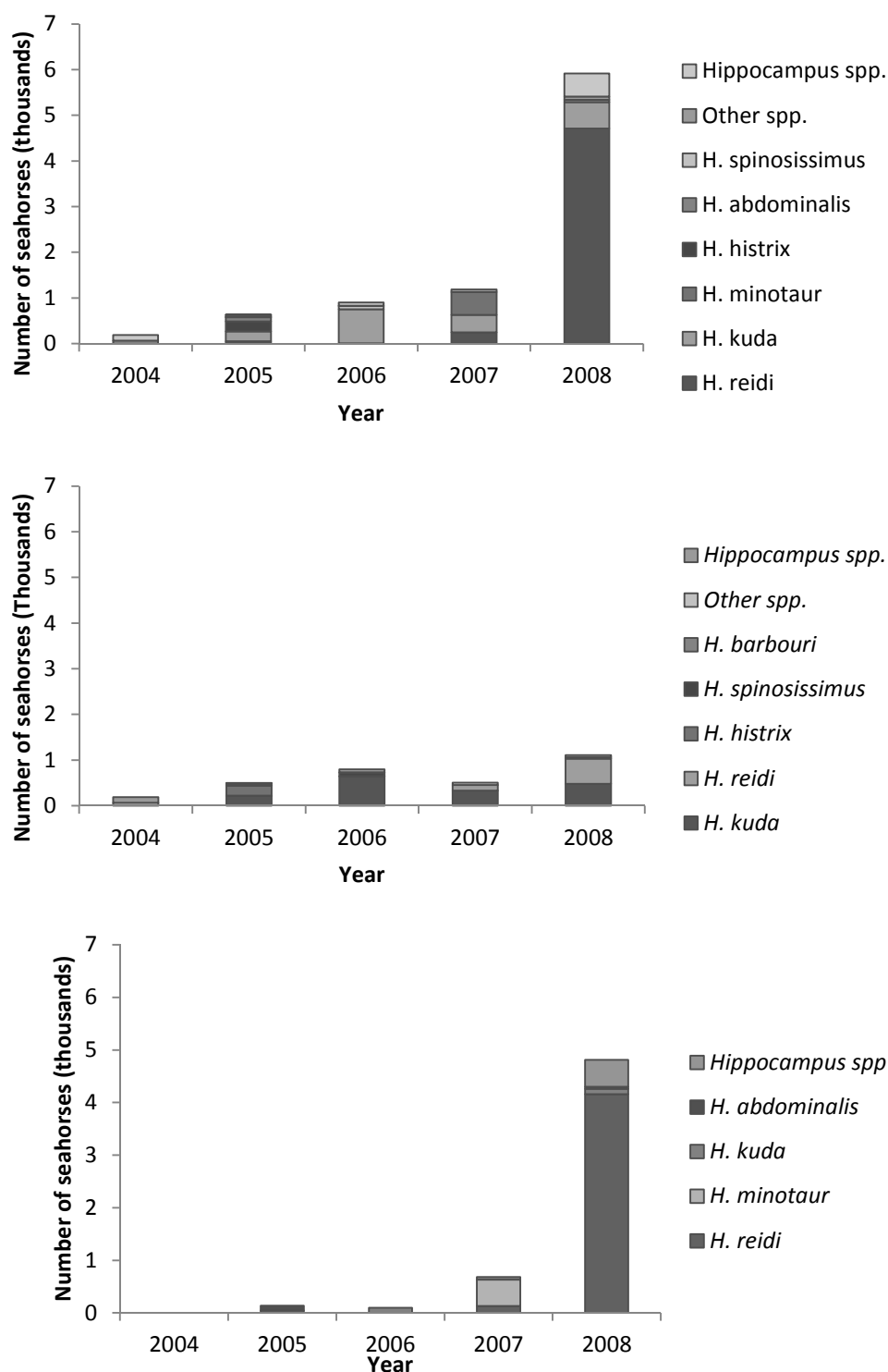


Figure 16. Total number of reported live (A), live non-captive-bred (B), and live captive-bred (C), seahorses re-exported, by species in the CITES Trade Database from 2004-2008. Data shows combined export and EFI data. Data for the six species that made up the largest proportion of the trade, as well as all records reported to the genus level (*Hippocampus* spp.) are displayed. All other species grouped into “Other spp”. Data shows combined export and EFI data. The order of the species in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

By Country

Overall/Dried (Figure 17): Based on export and EFI data, Hong Kong SAR and the Philippines were the top re-exporter countries for all reported international seahorse trade, together making up 73% of re-export volumes each year (54-99%; $N \approx 350,000$ -3.7 million). The Philippines, however, appeared to have only played a major role in the re-export trade in 2004 and 2005, after which Hong Kong SAR alone was the top reported re-exporter (from 2006-2008). Smaller volumes were also reportedly re-exported from mainland China (0-42%; $N \approx 1,000$ -500,000 individuals per annum), Thailand (0-30%; $N \approx 0$ -820,000 individuals), Vietnam (1-10%; $N \approx 1,000$ -325,000 individuals) and Laos (0-9%; $N \approx 700$ -380,000 individuals).

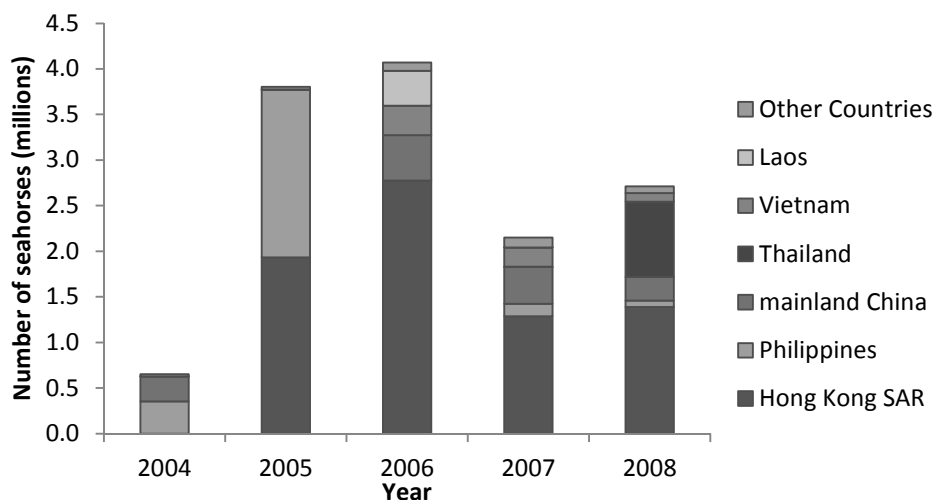


Figure 17. Total number of reported seahorses re-exports by country in the CITES Trade Database from 2004-2008. Data for the six countries with the largest re-exports are displayed; all other countries are grouped into “Other Countries. Data shows combined export and EFI data. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

As previously mentioned, dried seahorses, specifically non-captive-bred, comprised the vast majority of all reported re-export trade; therefore, the top overall re-exporting countries remained the same when examining trends in all dried species, as well as dried species from the wild.

Only four records existed for dried, captive-bred re-exports in the CITES database, for the years 2006-2008. These were supposedly re-exported primarily from Hong Kong SAR (98-100%; $N \approx 10,000$ -500,000 individuals per annum) with one reported shipment from province of Taiwan to Malaysia in 2006 (2%; $N \approx 10,000$ individuals).

Live (Figure 18): A total of 14 countries were reported in CITES data as re-exporters of live (non-captive and captive-bred) seahorses from 2004-2008. Across all years, the majority of live seahorses were reportedly re-exported from the Bhutan (0-76%; $N \approx 0$ -4,500 individuals); this was due to two reported re-exports of live seahorses in 2008 to the USA that originated in Brazil. The next two largest re-exporters of live seahorses were the USA (0-89%; $N \approx 0$ -900 individuals) and Singapore (0-12%; $N \approx 0$ -550 individuals).

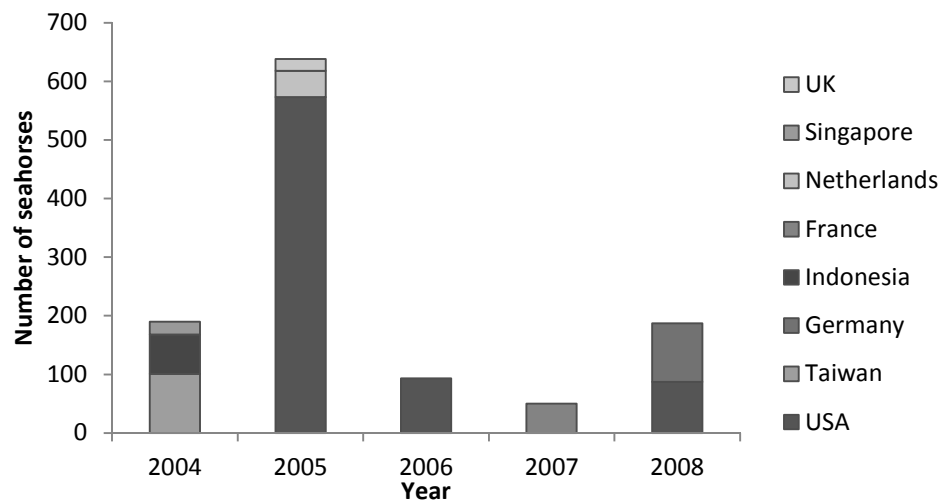


Figure 18. Total number of live seahorses re-exported by country. Data from the CITES Trade Database 2004-2008. Data shows combined export and EFI data. The order of the countries in the key (bottom to top) matches the order of the data in the graph. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Seven countries reported re-exports of captive-bred, live seahorses. The largest reported re-exporter by volume was Bhutan, which supposedly send just over 4000 captive-bred individuals from Brazil to the USA. Other notable re-exporters of live, captive-bred seahorses included the USA and Singapore, which re-exported approximately 790 and 550 individuals respectively between 2004 and 2008.

SENSITIVITY ANALYSES

Our sensitivity analyses have two key outcomes. The results of the first – comparing estimated trade volumes and trade routes based on both export and EFI data to those obtained based on export data only – illustrate the importance of voluntary import data in giving a more complete picture of the international trade in seahorses. The second – which tests the sensitivity of global trade volumes to our assumptions about units – demonstrates the critical importance of having confidence in the units that accompany submitted trade data.

Excluding EFI Records

The estimated total volume of seahorses traded between 2004 and 2008 was reduced by 20% when based on export data only. The largest difference occurred in 2004 (36%) with reductions of between 12 and 18% for all subsequent years (Figure 19). The temporal trend of trade when one considers export data only is comparable to that of combined EFI and export data.

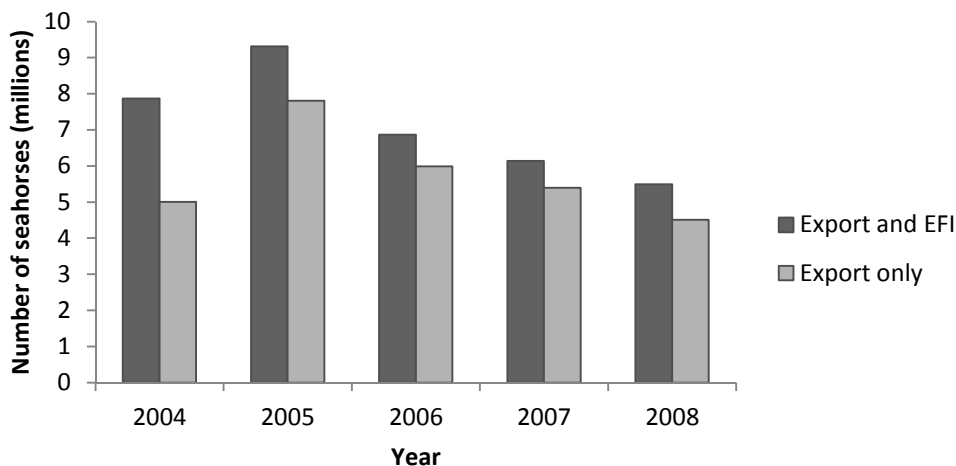


Figure 19. Total estimated volume of seahorses reportedly exported based on export data only (dark grey), and both export and EFI data (light grey) according to the CITES Trade Database for 2004-2008. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

A large number of the documented source countries for the international trade in seahorses were reported by importing countries, and were not reported in available mandated export records. When EFI data was excluded from the analyses, the total number of countries reported to have exported seahorses from 2004-2008 was reduced by nearly half, from 47 to 25. Of those missing from the list, three were from Africa (Cote d'Ivoire, Mauritania and Mauritius), seven from the Americas (Bolivia, Canada, Costa Rica, Cuba, the Dominican Republic, Ecuador and Haiti), nine from Asia (Cambodia, Korea, Kuwait, Lao, Macau, Philippines, Singapore, Taiwan and the United Arab Emirates), one from Europe (Czech Republic), and two from Oceania (Fiji and Vanuatu). These 22 countries were reported by importers as responsible for a total trade between 2004 and 2008 of just over 79,000 individuals, with the majority of this volume reportedly coming from the Philippines and Fiji (each reported to have exported a total of 39,000 and 16,000 individuals, respectively).

The top six sources for seahorses in international trade remained the same when analyses considered export and EFI data versus only mandated export data, but the order and absolute volumes differed (Table 13). When considering only export data, the largest exporter was still Thailand, and the total magnitude of Thailand's trade from 2004-2008 remained at an estimate of approximately 24 million individuals. Vietnam moved up to second largest exporter when considering only exporter data but its total trade reduced from just over- to just under-1 million individuals for the time period studied. Guinea remained as third largest exporter but over 60% of its estimated trade volume came from EFI data (875,000 individuals reported in export records versus 2.6 million individuals reported in both export and EFI records). Over 75% of mainland China's trade was reported by importers, and so excluding EFI data for

this country significantly reduced its total estimated trade volume from a little over 3 million individuals to about 710,000 individuals over the time period.

Table 13. Top six source countries for seahorses in international trade based on total estimated export volumes as reported in the CITES Trade Database for 2004–2008. Table shows estimated volumes when using mandated export data only as well as combined mandated export and voluntary EFI data.

Rank	Export & EFI		Export Only	
	Source	Volume	Source	Volume
1	Thailand	24,686,393	Thailand	24,079,718
2	China	3,063,942	Vietnam	971,197
3	Guinea	2,619,384	Guinea	875,444
4	Senegal	1,274,704	China	710,515
5	Malaysia	1,243,780	Senegal	704,221
6	Vietnam	1,054,982	Malaysia	594,398

Changing the units

As explained in the methods, we had to make some assumptions regarding trade entries in the CITES database that did not have units, and for which units were not subsequently clarified by reporting countries. Based on our extensive experience in seahorse trade, we made the informed assumption that all dry trade records with no units were in kilograms, and all live trade records were in individuals. Applying these assumptions to the CITES data resulted in an estimated annual trade volume from 2004 through 2008 of 7 million individuals. Importantly, and also expectedly, this number was highly sensitive to our unit assumptions. If we instead assumed that all dry trade records with no units were individuals, and all live trade records reported in kilograms were left as kilograms, the total trade volume estimated across all years was 8.5% lower (annual average $N \approx 6.4$ million individuals, range 5.0 million to 8.2 million individuals). Patterns over the years, however, compared with that obtained under our base assumptions (Figure 20).

Applying our base assumptions may have resulted in an overestimation of dried trade volumes, but underestimation of live trade volumes. The difference in overall dried trade volumes when we assumed that dried trade records with no units were in individuals instead of kilograms was almost the same as that for the trade overall (Figure 20). Estimated dried trade volumes across the years were reduced by 0 to 27% (a difference of $N \approx 510,000$ to 790,000 individuals per annum). In this case the total estimated volume of dried trade was estimated a 6.2 million individuals per annum.

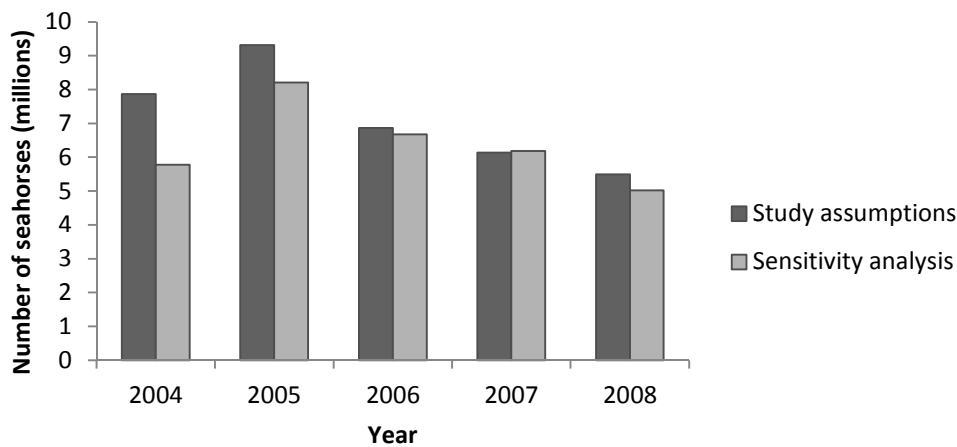


Figure 20. Estimated total volume of seahorses traded internationally per year based on data in the CITES Trade Database from 2004–2008. The grey bars represent the volumes estimated based on assumption that all dry records with no units were kilograms and all live records were individuals regardless of unit. The light bars represent estimated volumes when all dry records with no units were assumed to be individuals and all live records with units reported as kilograms were left as kilograms. Data are combined export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

On the other hand, changing our assumptions about live trade entries resulted in a larger estimate for the overall trade in live seahorses. When we assumed that all live records were in individuals, the total trade in live seahorses for all years was estimated at 609,000 individuals. If, however, we assume the entries reported as kilograms are not in error, and convert these entries to individuals using a conversion factor for live seahorses of 12.5g/seahorse (Vincent and Sadler, 1995; Woods, 2002; Baum *et al.*, 2003; Planas *et al.*, 2008), the total trade in live individuals for all years is estimated to be 22% greater at 148,000 individuals per annum. By year, volumes are estimated to be 157% higher in 2004 ($N \approx 56,000$ individuals), 23% higher in 2005 ($N \approx 155,000$ individuals), 6% higher in 2006 ($N \approx 173,000$ individuals), 35% higher in 2007 ($N \approx 231,000$ individuals) and exactly the same in 2008. Out of the 11 live trade records that have units as kilograms, seven are exports from Malaysia, reported by Malaysia. These records are responsible for 68% (approximately 90,000) of the 132,000 difference that exists when comparing the two sets of assumptions. Other countries that supposedly reported live trade in kilograms are Australia, Guinea, Philippines and Sri Lanka.

REGIONAL AND COUNTRY TRENDS IN DRIED SEAHORSE TRADE

The first report on the international trade in syngnathids revealed a large, economically important trade in seahorses that threatened wild populations (Vincent 1996). Subsequently, further surveys were initiated to assess developments in the trade and explore areas of the world not previously surveyed (Vincent *et al.* 2011a). Results from many of these investigations provided new insights into the scale, complexities and diversity of the global seahorse trade, the findings of which were published in the primary scientific literature (e.g. Baum and Vincent 2005; Martin-Smith 2006; Perry *et al.* 2010).

This section presents a regional and/or country-specific assessment of the trade in **dried** seahorses for a large majority of the regions for which historical data were available from *second surveys*. Here, we sought to compare regional trends in dried seahorse trade that may have been lost in the global overview. While we focused primarily on export trends to highlight potential areas of conservation concern, we have included additional sections for regions/countries that were found to be significant importers of dried seahorses to highlight areas of high consumption. Methods were similar to those for the global analysis: we analysed post-CITES (2004–2008) trade records for dried seahorses for species composition, trade routes and total volumes, using trade data derived from both export and EFI records. These data were then compared to available historical data for the trade in dried seahorses pre-CITES.

NET IMPORTERS/EXPORTERS

Net importers and exporters of dried seahorses from 2004-2008 were numerous and encompassed a wide geographic area (Table 14). Nineteen countries, spanning all continents except Antarctica and South America, were reported in the CITES trade database as net importers of dried seahorses from 2004-2008, while 26 countries were reported as net exporters (Table 14). Countries in Africa and South America were predominantly exporters while those in Europe were mostly reported as having imported dried seahorses. Asia, Oceania and North America had a mix of both net importing and exporting nations over the five year period.

Table 14. Total export and import volumes of dried seahorses as reported in CITES Trade Database from 2004-2008. Net importers of dried seahorses are highlighted in grey. Records where countries were denoted as XX (unknown) were excluded. Volumes are in number of individual seahorses. E = Net Exporter and I = Net Importer.

Continent	Country	Exports	Imports	Net
Africa	Cote d'Ivoire	79	-	E
	Egypt	63,568	-	E
	Guinea	2,618,958	-	E
	Senegal	1,274,682	-	E
	South Africa	-	4	I
	Togo	271,226	-	E
Asia	Cambodia	36	-	E
	Hong Kong SAR	299,228	20,175,983	I
	Indonesia	160,090	-	E
	Japan	2	891,994	I
	Korea, Republic of	169	1,000	I
	Lao People's Democratic Republic	14	-	E
	Macau	17	-	E
	Mainland China	3,063,942	3,531,431	I
	Malaysia	1,242,462	332,814	E
	Philippines	37,278	-	E
	Saudi Arabia	-	1	I
	Singapore	5,204	429,302	I
	Taiwan	1,858	6,514,582	I
	Thailand	24,686,389	33	E
	United Arab Emirates	5,204	-	E
	Vietnam	734,132	-	E
Oceania	Australia	7,215	311,043	I
	Fiji	7,434	-	E
	New Caledonia	69	-	E
	New Zealand	58	1,479,316	I

Continent	Country	Exports	Imports	Net
Europe	Austria	-	6	I
	Czech Republic	371	28	E
	France	4	16	I
	Germany	9	-	E
	Hungary	-	1,463	I
	Poland	-	1,123	I
	Portugal	1,700	-	E
	Spain	-	9,622	I
	Switzerland	-	28	I
	United Kingdom	-	1,282,353	I
North America	Bahamas	4,460	-	E
	Canada	81	16,569	I
	Costa Rica	743	-	E
	Mexico	6,484	-	E
	United States	10,784	89,954	I
South America	Bolivia	16,728	-	E
	Brazil	333	-	E
	Ecuador	137	-	E
	Peru	518,192	-	E

AFRICA

Comparing *second surveys* and CITES trade data revealed Africa as a consistent net exporter of dried seahorses, albeit with temporal differences in the species traded, source countries and volumes exported between the two survey periods. Specifically, the data suggested a shift in source countries from East to West Africa, along with a three-fold increase in the annual volume of dried seahorses exported from Africa. These differences may have been due, at least in part, to the lack of comprehensive surveys conducted throughout the continent pre-CITES (*second surveys*). With the data available we can infer that: 1) Africa has remained a net exporting region for dried seahorses post-CITES; 2) there were six fewer source countries involved in dried exports post-CITES; 3) East African countries were no longer reported as exporters post-CITES; and 4) volumes supposedly exported from West Africa post-CITES were considerably greater than those reported historically.

Africa as a source – CITES data

Overall Export Volumes

The overall export of dried seahorses reportedly originating from African countries averaged approximately 846,000 (N \approx 575,000-1.2 million) seahorses per annum. Reported export volumes in 2004-2005 were approximately double those reported for 2006-2008, with volumes peaking in 2005 at 1.2 million seahorses. The majority of seahorses (99%) were reportedly exported for commercial purposes with smaller volumes for personal and scientific use.

Table 15. Estimated export volumes of dried seahorses from source countries in Africa as reported in the CITES Trade Database for 2004-2008, showing species traded and year of trade. Estimates based on both export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Sources	Species	2004	2005	2006	2007	2008	Total
Cote d'Ivoire	<i>Hippocampus</i> spp.	1				78	79
Egypt	<i>H. hippocampus</i>	62,454					62,454
	<i>Hippocampus</i> spp.	1,115					1,115
Guinea	<i>H. algiricus</i>	658,513	856,431	382,900	254,201	398,885	2,550,929
Senegal	<i>H. algiricus</i>	247,398	205,502	250,409	261,338	310,037	1,274,684
	<i>Hippocampus</i> spp.				59,480	8,550	68,030
Togo	<i>H. algiricus</i>	119,703	151,524				271,227
Total		1,089,183	1,213,457	633,309	575,019	717,550	4,228,518

Species

The vast majority of export trade records from Africa were reported to the species level (83%, N=23/28), and included two out of the nine species known to occur in African waters (Lourie *et al.* 2004): *H. algiricus* and *H. hippocampus* (Table 15). These two species are the only seahorses confirmed to occur in West Africa (Lourie *et al.* 2004).

Hippocampus algiricus comprised the majority of reported African exports post-CITES (90-100%; N≈516,000-1 million individuals per annum), and were apparently exported from three West African countries (Guinea, Senegal and Togo; Table 15). Tens of thousands of *H. hippocampus* were allegedly exported from Egypt in 2004 (6%; N≈62,000 individuals), while seahorses of unknown species comprised less than 1% (N≈1,000 individuals), 10% (N≈59,000 individuals) and 1% (N≈9,000 individuals) of totals in 2004, 2007 and 2008, respectively.

Trade Routes

Based on reported export and EFI data, Guinea ranked as the largest annual exporter of dried seahorses from Africa, averaging 62% of totals from this continent annually (55-71%; N≈254,000-856,000 individuals per annum; Table 15) – in spite of the fact Guinea did not submit its annual report to CITES in 2007 (UNEP-WCMC 2010). Smaller volumes were purportedly exported from Senegal (17-45%; N≈206,000-319,000 individuals per annum), Togo (0-12%; N≈0-152,000 individual per annum), Egypt (0-6%; N≈0-64,000 individuals per annum) and Cote d'Ivoire (<1%; N=0-78 individuals per annum).

Seahorses from Africa were reportedly imported primarily by Hong Kong SAR and mainland China (Table 16). Hong Kong SAR was the top reported importer, consuming on average 74% of total reported volumes (58-98%; N≈500,000-704,000 individuals per annum). Based on reported export and EFI data, additional consumer countries included Taiwan (2%; N≈58,000 individuals), the UK (2% in 2004; N≈17,000 individuals), the USA (<1% of total volumes in 2008; N≈78 individuals), and New Zealand (<1% in 2004; N≈1,000 individuals) (Table 16).

Table 16. Estimated volumes of dried seahorse reportedly sourced in Africa and reported consumer countries as determined from the CITES Trade Database for 2004-2008. Data include both export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumers	2004	2005	2006	2007	2008	Total
Honk Kong	681,375	704,424	499,926	563,866	529,368	2,978,959
Mainland China	389,963	509,033	133,383		141,264	1,173,643
New Zealand	1,115					1,115
Taiwan				11,152	46,840	57,993
UK	16,729					16,729
USA	1				78	79
Total	1,089,183	1,213,457	633,309	575,019	717,550	4,228,518

Hippocampus algiricus, sourced from West Africa (Guinea, Senegal, Togo), were reportedly exported to East Asia (mainland China, Hong Kong SAR and Taiwan) with additional smaller volumes to the UK. *Hippocampus hippocampus* was reportedly exported from Egypt to Hong Kong SAR. Unknown seahorse species were imported to the USA, New Zealand and Hong Kong SAR from Cote d'Ivoire, Egypt and Guinea.

Africa as a source – Comparison to historic export data

Overall Export Volumes

Compared to historical data, volumes of dried seahorses exported from Africa increased approximately two to three-fold after the CITES listing (from approximately 250,000-300,000 individuals per annum pre-CITES, Vincent *et al.* 2011b), to a reported 846,000 seahorses per annum in the CITES database – this even though six fewer countries were reported as exporters in the CITES database than were recorded historically. However, it is unknown whether the *second surveys* which were focused on East Africa missed documenting the existence of an export trade in West Africa. In addition, it is not known whether the historically documented trade from East African countries continued after the CITES listing but was just not reported to CITES.

Species

All reported export trade in dried seahorses from Africa, both pre- and post-CITES, involved seahorses extracted from the wild only. Differences in reported species between data sets reflected variance in the surveyed areas. Specifically, *second surveys* focused on the seahorse trade sourced from Kenya and Tanzania and so recorded species found only in that region (*H. borboniensis*, *H. camelopardalis*, *H. fuscus*, *H. histrix* and *H. kelloggi*) (McPherson and Vincent, 2004). All additional *second survey* information was anecdotal and the species composition unknown (Vincent *et al.* 2011b). The CITES data, however, suggested an export trade almost exclusively from West Africa (with very small volumes from Egypt), with *H. algiricus* dominating exports and with lesser volumes of *H. hippocampus*.

Trade Routes

The number of source countries involved in the dried export trade from Africa purportedly decreased from 11 across the continent during the *second surveys* (Vincent *et al.* 2011b), to five post-CITES. Only Guinea, Senegal and Togo were reportedly involved in exporting dried seahorses both pre- and post-CITES. The absence of Tanzania in the CITES data may have been due to dwindling seahorse populations and/or a lack of convenient transportation between Tanzania and Kenya such that this trade route became economically unfeasible (McPherson and Vincent, 2004). While Guinea was reported historically as source of dried seahorses, reported export volumes appear to have increased ten-fold, from tens of thousands of individuals in 1998-2001 (Vincent *et al.* 2011b), to 100's of thousands in 2004-2008. This may reflect either an emerging export trade or one that had gone undetected historically due to the geographical constraints of the previous surveys.

While African source countries for dried seahorses appeared to have decreased in numbers and shifted geographically over the past decade, consumer markets for African exports reportedly remained stable with East Asian countries (in descending order: Hong Kong SAR, mainland China and Taiwan) dominating the market both pre-CITES (McPherson and Vincent, 2004), and post-CITES. These data reflect the continued dominance of East Asia as the primary consumer region for dried seahorses. Smaller volumes of dried seahorses exported from Africa were also consistently imported into the USA, but only post-CITES. Data also reported small import volumes into the UK (N≈17,000) and New Zealand (N≈1,000).

AUSTRALIA

Imports of dried seahorses into Australia appeared to have increased after the CITES listing, from very few recorded in the *second surveys* (Martin-Smith & Vincent 2006), to hundreds of thousands reported in the CITES data, although nearly all of this post-CITES trade occurred in 2005. Reported exports of dried seahorses from Australia remained low across the two time periods (tens per annum), except for a peak in 2008, when dried export volumes increased to over 5,500 individuals. While Asia was recorded as the primary consuming region of Australian dried seahorses in *second surveys*, New Zealand and the Republic of Korea were reported as the primary and secondary consumers of post-CITES Australian exports, respectively. *Second survey* data consisted only of captive-bred exports of *H. abdominalis* (Martin-Smith and Vincent, 2006), whereas trade in both captive and non-captive-bred individuals was reported to CITES.

Australia as a consumer – CITES data

Overall Import Volumes

Overall reported imports of dried seahorses to Australia totalled just over 311,000 individuals from 2005-2006 although almost 100% of these were imported in 2005 (Table 17). Only two individuals were reportedly imported in 2006 (Table 17). All reported imports of dried seahorses into Australia supposedly consisted of non-captive-bred individuals.

Table 17. Estimated volumes of dried seahorses consumed by Australia as reported in the CITES Trade Database for the years 2004-2008, showing species traded, reported source countries and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Australia as consumer							
Source	Species	2004	2005	2006	2007	2008	Total
New Zealand	<i>Hippocampus</i> spp.			2			2
Thailand	<i>H. kelloggi</i>		8,398				8,398
	<i>H. spinosissimus</i>		225,194				225,194
	<i>H. trimaculatus</i>		77,449				77,449
Total			311,042	2			311,044

Species

In 2005 the majority of dried trade to Australia reportedly consisted of *H. spinosissimus* (72%; N=225,000 individuals) and *H. trimaculatus* (25%; N=77,000 individuals), with a few *H. kelloggi* (3%; N=8,000 individuals) (Table 17). All imports to Australia recorded for 2006 of dried, seahorses were reported to the genus level only. No dried captive-bred individuals were reported as Australian imports.

Trade Routes

CITES data reported the import of dried seahorses to Australia from two source countries: Thailand and New Zealand (in descending order) – the majority of the reported volume was from Thailand (99.6%; N=311,000 individuals), with negligible volumes from New Zealand (N=2 individuals) (Table 17).

Australia as a consumer – Comparison to historic data

Second surveys reported that dried seahorse imports into Australia were variable but generally low, and that seahorses were expensive items (Martin-Smith and Vincent, 2006). Comparing CITES data with historic data, therefore, suggests an increase in import trade volumes of dried seahorses into Australia over time, with CITES data reporting imports in the hundreds of thousands of individuals, although only in 2005.

Australia as a source – CITES data

Overall Export Volumes

Based on CITES export and EFI data, overall reported exports of dried seahorses from Australia averaged 1,400 individuals per annum, with the majority of trade occurring in 2008. From 2004-2007 only 1,700 dried seahorses were reported as exports from Australia; however, in 2008 dried export volumes supposedly increased to approximately 5,500 individuals (Table 18). Roughly one third of all exports of dried seahorses from Australia were confirmed as being captive-bred, with all captive-bred records occurring in 2007 and 2008 ($N \approx 2,500$ of 7,200). All other records did not specify a source and so could have consisted of either wild caught or captive-bred individuals. Across all years, known reported export purposes included: scientific (41%), personal (31%) and commercial trade (20%), with 8% of specimens traded for unknown purposes.

Table 18. Estimated export volumes of dried seahorse from Australia as reported in the CITES Trade Database for the years 2004-2008, showing reported consumer countries, species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumer	Species	Australia as source					Total
		2004	2005	2006	2007	2008	
Korea	<i>H. breviceps</i>					1,000	1,000
New Zealand	<i>H. abdominalis</i>					667	667
	<i>Hippocampus</i> spp.	667	333		667	3,833	5,500
Switzerland	<i>H. abdominalis</i>					15	15
Thailand	<i>H. abdominalis</i>				33		33
United States	<i>Hippocampus</i> spp.			1			1
Total		667	333	1	700	5,515	7,216

Species

Nearly half of all export records related to Australia (45%, $N = 5/11$) were reported as captive-bred specimens of *H. abdominalis* and *H. breviceps*. From 2004-2006 all export trade records of dried seahorses from Australia were reported to the genus level only, while in 2007 the trade of 33 captive-bred individuals were reported as *H. abdominalis*. In 2008, the number of captive-bred *H. abdominalis* and *H. breviceps* exported supposedly increased to approximately 670 and 1,000 specimens that year, respectively (Table 18). In 2008, a further 833 captive-bred specimens were traded but these were only reported to the genus level.

Trade Routes

CITES export and EFI data reported the export of dried seahorses from Australia to five consumer countries (in descending order): New Zealand, the Republic of Korea, Thailand, Switzerland and the USA (Table 18). The majority of overall reported volume across all years was allegedly consumed by New Zealand (85%; $N \approx 6,000$ individuals) and the Republic of Korea (14%; $N \approx 1,000$ individuals – captive-bred only) (Table 18). Over all years, smaller volumes of captive-bred seahorses were reportedly consumed by

Thailand (N≈33 individuals) and Switzerland (N=15 individuals). The USA apparently consumed one dried seahorse from Australia in 2006.

Australia as a source – Comparison to historic data

Overall Export Volumes

Discrepancies between official Australian export data and Hong Kong SAR import volumes for dried seahorses made it difficult to ascertain historic export volumes of dried seahorses (Martin-Smith and Vincent, 2005). *Second surveys* found Australian declared export volumes ranged from 300-600 seahorses per annum, while Hong Kong SAR import records suggested an almost 200-fold increase in the number of dried, captive-bred seahorses recorded from Australia (i.e., 100,000 seahorses per annum). The large discrepancy between these two reported volumes is probably due to misidentification/mistranslation of imports of pipehorses as seahorses into Hong Kong SAR (Martin-Smith and Vincent, 2006). This highlights the need for substantial cross-validation of export and import records to ascertain the accurate level of trade with particular attention to the component that is being sourced from wild populations. Volumes reported to CITES in 2004-2007 were less than historic Australian export levels with average volumes of only a few individuals per year – but this increased to over 5,500 seahorses in 2008.

Australia's pre-CITES export records from *second surveys* reported the trade in captive-bred species only (Hong Kong SAR customs records did not specify the source of the dried seahorses) (Martin-Smith & Vincent, 2006). This differed from CITES data that reported all exports from 2004-2006 as having unconfirmed sources, but with increased volumes of captive-bred seahorses in 2007 (5%; N≈33) and 2008 (46%; N≈2,500).

Species

The two data sets also reportedly differed in species composition of the dried seahorse trade from Australia. *Second survey* data consisted entirely of captive-bred exports of *H. abdominalis* (Martin-Smith and Vincent, 2006), whereas captive-bred individuals of both *H. abdominalis* and *H. breviceps* were reported to CITES in 2007 and 2008.

Trade Routes

Hong Kong SAR and Taiwan were supposedly the largest pre-CITES consumer countries for Australia's dried seahorse exports (Martin-Smith and Vincent, 2006). Post-CITES data reported dominant consumers markets in New Zealand and Korea with negligible consumption by, in descending order, Thailand, Switzerland and the United States.

EAST ASIA

Based on CITES data, dried seahorses exported from East Asia (Cambodia, Hong Kong SAR, Japan, Korea, Lao, Macau, mainland China, Singapore and Taiwan) supposedly increased over four-fold, compared to historical trade estimates, to an average of 4 million individuals per annum from 2004-2008. Primary source countries shifted from Japan (~70%) and mainland China (~30%) exporting the majority of dried seahorses during *second surveys* to mainland China and Hong Kong SAR which together comprised >99% of all export volumes from East Asia reported to CITES. CITES data suggested East Asian dried seahorses were consumed mainly by Japan, New Zealand and the UK. This trend varied from *second surveys* that found the majority of East Asian seahorse exports to be consumed within the region, specifically in Hong Kong SAR and Taiwan.

Mainland China

Reported volumes of dried seahorses imported into mainland China were estimated to be at least an order of magnitude larger pre-CITES than post-CITES, but Thailand was the predominant destination during both survey periods (*second survey* data for mainland China are unpublished). Post-CITES there appears to have been a shift from an almost exclusively Asian source of dried seahorses to one that includes countries in Africa and South America. Post-CITES there also appears to be an increase in the number of species being traded, presumably due to the diversification in source countries.

Volumes of dried, wild seahorses exported from mainland China supposedly increased over 10-fold from pre- to post-CITES, to average approximately 613,000 individuals per annum from 2004-2008. Both data sets found consumer markets for Chinese exports to have a broad geographical range although pre-CITES consumer countries were primarily Asian (Taiwan and Hong Kong SAR) while post-CITES trade was predominantly to New Zealand, the UK and Japan with an increasing volume exported to the USA. *Hippocampus histrix*, *H. kelloggi*, *H. kuda* and *H. trimaculatus* were the only species reported being traded from China with the majority of the trade (2.4 million of 3.1 million individuals) being reported to the genus level.

Mainland China as a consumer – CITES data

Overall Import Volumes

According to data reported to CITES, imports of dried seahorses to mainland China averaged approximately 706,000 individuals per annum with a range of 342,000 to 1.1 million individuals (Table 19). Imports peaked in 2005 with a total volume of approximately 1.1 million individuals. No records were reported as consisting of captive-bred seahorses.

Table 19. Estimated import volumes of dried seahorse into mainland China, as reported in the CITES Trade Database for 2004-2008, showing reported source countries, species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorses took effect in May 2004, all 2004 data represents only a partial year.

Sources	Species	China as consumer					Total
		2004	2005	2006	2007	2008	
Guinea	<i>H. algiricus</i>	283,271	444,796				728,067
Peru	<i>H. ingens</i>	299,377					299,377
Senegal	<i>H. algiricus</i>	52,045		133,383		141,264	326,691
Togo	<i>H. algiricus</i>	54,647	64,238				118,885
Thailand	<i>H. histrix</i>	155,521		11,773			167,294
	<i>H. kelloggi</i>		44,479	117,185	54,432		216,096
	<i>H. kuda</i>		57,543	192,846	105,132	108,865	464,386
	<i>H. spinosissimus</i>		227,683	102,333	95,490	153,966	579,471
	<i>H. trimaculatus</i>		245,723	128,834	87,092	169,518	631,166
Total		844,861	1,084,461	686,353	342,146	573,612	3,531,434

Species

All records of imports of dried seahorses into mainland China reported to CITES from 2004-2008 were reported to the species level with a total of seven species reportedly being traded. *Hippocampus algiricus* made up the largest volumes of dried seahorses imported into mainland China over the time period with the largest volumes in 2004 and 2005 (N≈390,000 and 509,000 individuals respectively; Table 19). Other species imported in large volumes include, in descending order, *H. trimaculatus*, *H. spinosissimus* and *H. kuda* but trade in these species only occurred from 2005 onwards. Smaller but still significant volumes of *Hippocampus histrix* and *H. ingens* were also imported into mainland China.

Trade Routes

Thailand was reportedly the largest and most consistent source of dried seahorses being imported by mainland China with a reported annual average of approximately 420,000 seahorses traded. Guinea was the next largest reported source of dried seahorses but apparently only traded with mainland China in 2004 and 2005 (N≈283,000 and 445,000 individuals, respectively). Other sources for dried seahorses were Peru, Senegal and Togo (Table 19).

Mainland China as a consumer – Comparison to historic data

Overall Import Volumes

Pre-CITES import volumes of dried seahorses were estimated at between 7.4 and 11.2 million individuals annually (Project Seahorse, unpublished data). It must be noted however that these estimates are for total consumption in mainland China and therefore include consumption from domestic sources. However, anecdotal evidence suggests that local seahorse capture is minimal (Project Seahorse, unpublished data). This volume is an order of magnitude larger than the import trade reported to CITES between 2004 and 2008.

Species

Species reportedly being traded pre-CITES include *Hippocampus barbouri*, *H. comes*, *H. histrix*, *H. kuda* and *H. trimaculatus* but the volumes of these species in the trade was not reported (Project Seahorse, unpublished data). Post-CITES, *H. barbouri* and *H. comes* were no longer reported in the trade but *H. algericus*, *H. ingens* and *H. spinosissimus* were newly reported species.

Trade Routes

Pre-CITES source countries for dried seahorses being imported by mainland China were predominantly Asian and fairly extensive. Countries reported pre-CITES included Australia, Hong Kong SAR, India, Indonesia, Japan, Lao, Macau, Malaysia, Myanmar, Philippines, Singapore, Taiwan and Vietnam. The primary sources were reported to be Vietnam, Thailand and Hong Kong SAR. Thailand remained as a primary source post-CITES but no other countries that were reported pre-CITES were recorded in the CITES Trade Database from 2004-2008; the majority of newly reported source countries were African (Guinea, Senegal and Togo) and South American (Peru), which suggests an expansion from previously Asian dominated source markets.

Mainland China as a source – CITES data

Overall Export Volumes

Based on CITES export and EFI data, the overall reported exports of dried seahorses originating from mainland China averaged about 613,000 individuals per annum, and ranged from approximately 158,000 to 1.7 million individuals across the years (Table 20). Non-captive-bred seahorses comprised the majority (99-100%) of all reported exports; the only exception occurred in 2005 when 93 captive-bred individuals were purportedly exported from mainland China to the USA in one shipment. Temporal trends in overall volumes of seahorses reportedly exported from mainland China showed a purported peak of 1.7 individuals in 2004 with steadily decreasing volumes thereafter (Table 20). Across all years, 87% of reported export volumes were supposedly exported for commercial trade and 4% for personal use. No trade purpose was reported for the remaining 9% of export volumes.

Table 20. Estimated export volumes of dried seahorse from mainland China as reported in the CITES Trade Database for 2004-2008, showing reported consumer countries and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumers	Mainland China as source					Total
	2004	2005	2006	2007	2008	
Canada		5,576	9,294			14,870
Hong Kong SAR			1,000			1,000
Japan	41,335	180,044	370,928	221,591	78,097	891,994
New Zealand	798,513	364,684				1,163,197
Poland	1					1
Singapore		892				892
Spain					700	700
UK	904,372			112	70,125	974,608
USA	570	551	4,999	1,104	9,456	16,680
Total	1,744,790	551,747	386,220	222,807	158,378	3,063,942

Species

Just over a third of all CITES export trade entries for dried seahorses from mainland China (35%, N= 26/75) provided data to the species level. Of these, four species (*H. histrix*, *H. kelloggi*, *H. kuda* and *H. trimaculatus*) were reported, all of which have been either confirmed (*H. histrix*, *H. kelloggi*) or suspected (*H. kuda*, *H. trimaculatus*) to occur in the waters of mainland China (Lourie *et al.* 2004).

The species composition of reported dried seahorse exports from mainland China remained more or less constant among years. *Hippocampus kuda* made up the majority of dried records reported to the species level in all years (N≈19,000 – 228,000 individuals), while *H. histrix* and *H. kelloggi* made up the majority of the remainder of trade reported to the species level (Table 21). Trade in *H. trimaculatus* was only reported in 2005 and 2007 and only in very small volumes (N≈6 individuals and N≈137 individuals). Only one trade record was reported for captive-bred individuals (*H. kuda*), which comprised less than 1% (N=93 individuals) of the total export trade volumes for that year (2005).

Table 21. Estimated export volumes of dried seahorse from mainland China as reported in the CITES Trade Database for 2004-2008, showing species traded and year of trade. Data a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Mainland China as source					Total
	2004	2005	2006	2007	2008	
<i>H. histrix</i>	5,450	5,576	23,757	14,454		49,236
<i>H. kelloggi</i>	7,011	5,065	3,861	9,793		25,730
<i>H. kuda</i>	18,587	121,738	228,361	190,813	84,357	643,856
<i>H. trimaculatus</i>		6		137		143
<i>Hippocampus</i> spp.	1,713,742	419,361	130,242	7,610	74,021	2,344,976
Total	1,744,790	551,747	386,220	222,807	158,378	3,063,942

Trade Routes

Based on CITES export and EFI data, dried seahorses from mainland China were apparently exported to other East Asian countries (Hong Kong SAR, Japan and Singapore), North America (Canada and the USA), New Zealand and Europe (Spain, Poland and the UK) (Table 20). The top consumer country shifted over time with the UK allegedly importing the majority of mainland China's dried seahorses in 2004 (52%; N≈904,000 individuals), while New Zealand was reported as the main destination in 2005 (66%; N≈365,000 individuals). In 2006, 2007 and 2008, Japan was reported as the largest importer of Chinese dried seahorses (N≈371,000; 222,000 and 78,000 individuals respectively) (Table 20).

Dried *H. histrix*, *H. kelloggi* and *H. kuda* were apparently exported from mainland China to other East Asian countries (Japan, Hong Kong SAR and Singapore), North America (the USA and Canada) and New Zealand. *Hippocampus trimaculatus* were reportedly exported to Japan and the USA. The export of 93 captive-bred dried seahorses (*H. kuda*) was recorded as exported to the USA in 2005.

Mainland China as a source – Comparison to historic data

Overall Export Volumes

Based on *second surveys* and CITES data, volumes of dried seahorses exported from mainland China have supposedly increased over 10-fold over time (*second survey* data for mainland China are unpublished). Pre-CITES export trade volumes averaged approximately 45,000 dried individuals per annum, compared to the average 613,000 individuals per annum reported in CITES data. No exports of captive-bred seahorses from mainland China were recorded pre-CITES during the *second surveys*, suggesting wild seahorses have made up the majority if not all of the export trade both pre- and post-CITES.

Species

Second surveys did not record export data from mainland China to the species level.

Trade Routes

Both *second surveys* and CITES data found consumer markets for dried seahorses from mainland China to have a broad geographic range encompassing other East Asian countries, North America and the UK. What differed between both data sets was the proportion of trade exported to various countries. *Second survey* consumer country customs records reported Taiwan (78%) and Hong Kong SAR (12%) as the major importers of dried seahorses from mainland China, with only very small volumes exported to non-Asian destinations such as the USA (7%), the UK (<1%) and Canada (<1%). While East Asia appeared to remain a destination for Chinese dried seahorses post-CITES, most such seahorses were supposedly destined for New Zealand and the UK with very few going to Hong Kong SAR and none reported as exported to Taiwan.

Hong Kong SAR

According to CITES data, Hong Kong SAR was a net importer of dried seahorses from 2004-2008 – supposedly importing approximately 4 million dried seahorses annually. While Hong Kong SAR was also a net importer historically, export volumes reported in *second surveys* were much higher (nearly double) those reported in CITES data (*second survey* data for Hong Kong SAR are unpublished). The primary source of dried seahorses imported into Hong Kong SAR, Thailand, appears to have remained the same over time. Reported export volumes of dried seahorses from Hong Kong SAR were more or less similar across the time periods. There were, however, substantial inconsistencies in historic Hong Kong SAR customs data; therefore, export estimates may have been misinterpreted. There were no historic records of the export trade of captive-bred seahorses from Hong Kong SAR – this was similar to post-CITES data, which only reported the trade of non-captive-bred seahorses. Post-CITES, reported dominant consumer countries of dried seahorses from Hong Kong SAR were the USA, the UK and New Zealand. Due to the negligible volumes of seahorses exported from Hong Kong SAR pre-CITES, no historical data for consumer markets were provided.

Hong Kong SAR as a consumer – CITES data

Overall Import Volumes

CITES export and EFI data suggested that the overall volume of dried seahorses imported to Hong Kong SAR averaged just over four million individuals per annum and ranged of approximately 2.9 to 4.7 million individuals across the years (Table 22). Reported volumes were highest from 2005-2007 (N≈4.2-4.7 million individuals per annum), with volumes near or under 4 million individuals in the other two years. The majority of imports were supposedly of non-captive-bred seahorses, but captive-bred individuals were reportedly imported into Hong Kong SAR in 2004 (N≈18,000 individuals) and 2007 (N=71 individuals). Commercial trade was the only reported trade purpose.

Table 22. Estimated import volumes of dried seahorse into Hong Kong SAR, as reported in the CITES Trade Database for 2004-2008, showing reported source countries and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Source	Hong Kong SAR as consumer					Total
	2004	2005	2006	2007	2008	
China			1,000			1,000
Egypt	62,454					62,454
Guinea	375,242	411,636	382,900	313,680	407,435	1,890,892
Malaysia		70,126	300,314	226,918	585,346	1,182,704
New Zealand	50					50
Peru	216,952					216,952
Senegal	178,625	205,502	117,026	250,186	121,933	873,271
Thailand	1,987,134	3,878,289	3,385,319	3,803,266	2,742,240	15,796,247
Togo	65,056	87,286				152,342
Vietnam				71		71
Total	2,885,511	4,652,839	4,186,559	4,594,121	3,856,953	20,175,983

Species

Ten species of seahorse were supposedly imported dry into Hong Kong SAR from 2004-2008. These included (in descending order of volume): *H. trimaculatus*, *H. spinosissimus*, *H. kelloggi*, *H. algiricus*, *H. barbouri*, *H. histrix*, *H. ingens*, *H. kuda*, *H. hippocampus* and *H. comes* (Table 23). *Hippocampus trimaculatus* and *H. spinosissimus* dominated the species-specific records making up at least half of all imported volumes each year (49-66%; N≈1.5-3.1 million individuals per annum).

Table 23. Estimated import volumes of dried seahorse into Hong Kong SAR, as reported in the CITES Trade Database for 2004-2008, showing reported species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Hong Kong SAR as consumer					Total
	2004	2005	2006	2007	2008	
<i>H. algiricus</i>	618,922	704,424	499,926	504,387	520,818	2,848,476
<i>H. barbouri</i>		60,692	287,736	208,050	380,189	936,667
<i>H. comes</i>				18,868	34,277	53,145
<i>H. hippocampus</i>	62,454					62,454
<i>H. histrix</i>	5,288	25,879	116,221	81,757	58,725	287,869
<i>H. ingens</i>	216,952					216,952
<i>H. kelloggi</i>	349,435	734,588	731,095	835,288	804,790	3,455,196
<i>H. kuda</i>	28,989	50,700	13,579	71		93,339
<i>H. spinosissimus</i>	777,916	1,498,631	1,246,656	1,366,407	930,249	5,819,860
<i>H. trimaculatus</i>	697,667	1,567,807	1,291,347	1,519,813	948,476	6,025,110
<i>Hippocampus</i> spp.	127,888	10,118		59,480	179,431	376,917
Total	2,885,511	4,652,839	4,186,559	4,594,121	3,856,953	20,175,983

Trade Routes

CITES export and EFI data reported the import of dried seahorses to Hong Kong SAR from ten source countries (in descending order): Thailand, Guinea, Malaysia, Senegal, Peru, Togo, Egypt, mainland China, Vietnam, and New Zealand (Table 22). The vast majority of dried seahorse exports to Hong Kong SAR were allegedly sourced from Thailand (69-83%; $N \approx 2.0$ -3.9 million individuals) with smaller amounts from Guinea (7-13%; $N \approx 314,000$ -412,000 individuals) and Malaysia (0-15%; $N \approx 0$ -585,000 individuals; Table 22).

Hong Kong SAR as a consumer – Comparison to historic data

Second surveys found dried seahorse imports to Hong Kong SAR (approximately 10 million individuals per annum) to be approximately double volumes reported in CITES data suggesting a decrease in the volumes of imports into Hong Kong SAR over time. As was reported in the CITES data, the majority (66%) of dried seahorses were historically sourced from Thailand. Other sources varied pre-CITES, with the Philippines (12%) and other Asian countries (18%) making up the majority of exporting countries to Hong Kong SAR in *second surveys*. CITES data, on the other hand, reported a wide variety of source countries from all over the world (i.e., Africa, Asia, South America, Oceania).

Hong Kong SAR as a source – CITES data

Overall Export Volumes

Information concerning the exports of dried seahorses from Hong Kong SAR in the CITES data from 2004-2008 was contained in EFI data only. These data suggested the overall volume of dried, wild seahorses exported to other countries from Hong Kong SAR purportedly averaged just fewer than 60,000 individuals per annum (Table 24). Reported volumes were highest in 2004 and 2005 ($N \approx 256,000$ and $N \approx 40,000$ individuals respectively) with volumes at or under 3,000 individuals in all other years. The export of captive-bred seahorses was not reported.

Table 24. Estimated export volumes of dried seahorse from Hong Kong SAR, as reported in the CITES Trade Database for 2004-2008, showing reported consumer countries and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumers	Hong Kong SAR as source					Total
	2004	2005	2006	2007	2008	
New Zealand	73,978	39,405				113,383
UK	182,071					182,071
USA	28	211	384	60	3,091	3,774
Total	256,076	39,616	384	60	3,091	299,228

Species

All CITES records for Hong Kong SAR seahorse exports from 2004-2008 were reported to the genus level.

Trade Routes

CITES EFI data reported the export of dried, wild seahorses from Hong Kong SAR to three consumer countries (in descending order): the UK (0-71% $N \approx 0-182,000$ individuals), New Zealand (0-99%, $N \approx 0-74,000$ individuals) and the USA (0-100%, $N \approx 3,000$ individuals) (Table 24).

Hong Kong SAR as a source – Comparison to historic data

Overall Export Volumes

Second surveys found dried seahorse exports from Hong Kong SAR to be far less than those reported to CITES – which may suggest an increase in the export trade but for 2004 and 2005 only. However, it should be noted that there were substantial inconsistencies in historic Hong Kong SAR customs data between import and re-exports records (Project Seahorse, unpublished data). Pre-CITES export volumes from Hong Kong SAR were limited (1-2 kg or 370-750 individuals per annum), as most of the recorded movement of seahorses out of Hong Kong SAR consisted of re-exports from other areas (Project Seahorse, unpublished data). There were no historical records of the export of captive-bred dried seahorses from Hong Kong SAR, similar to post-CITES data which also did not report trade in captive-bred individuals.

Species

Second surveys did not record species-level export data for dried seahorses from Hong Kong SAR.

Trade Routes

Due to the negligible volumes of seahorses reportedly exported from Hong Kong SAR pre-CITES, no data for consumer markets were provided. Historically, it seemed the majority of seahorses being sent elsewhere from Hong Kong SAR were re-exports of seahorses imported from other areas (Project Seahorse, unpublished data).

Japan

The CITES data report Japan as a consumer of dried, non-captive-bred seahorses – numbering in the hundreds of thousands of individuals per annum. Japan's trade appears to have emerged after the CITES listing as historical records suggested only small amounts of dried seahorses were consumed by Japan pre-CITES (*second survey* data for Japan are unpublished).

Japan as a consumer – CITES data

Overall Import Volumes

CITES export and EFI data suggested that the overall volume of dried seahorses imported to Japan averaged just over 178,000 individuals per annum, and ranged approximately 41,000 to 371,000 individuals over time (Table 25). Reported import volumes were highest from 2005-2007 (N≈180,000 to 371,000 individuals per annum), with smaller volumes of dried seahorses being imported into Japan in the other years (N<78,000 individuals per year). The trade of captive-bred seahorses into Japan was not reported, and commercial trade was the only reported trade purposes.

Table 25. Estimated import volumes of dried seahorse into Japan, as reported in the CITES Trade Database for 2004-2008, showing reported species traded and year of trade. Data are a combination of export and EFI data. All imports were reportedly sourced from mainland China. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Japan as consumer					Total
	2004	2005	2006	2007	2008	
<i>H. histrix</i>	5,450		14,463	14,454		34,366
<i>H. kelloggi</i>	7,011	4,173		9,476		20,660
<i>H. kuda</i>	18,587	121,506	227,361	190,813	78,097	636,364
<i>H. trimaculatus</i>		6				6
<i>Hippocampus</i> spp.	10,286	54,359	129,104	6,848		200,598
Total	41,335	180,044	370,928	221,591	78,097	891,994

Species

Four species of dried seahorses were supposedly imported to Japan from 2004-2008. These included (in descending order): *H. kuda*, *H. histrix*, *H. kelloggi* and *H. trimaculatus* (Table 25). *Hippocampus kuda* made up the majority of imports to Japan in all years (45-100%; N≈19,000-227,000 individuals).

Trade Routes

All imports to Japan reported in the CITES database supposedly originated in mainland China.

Japan as a consumer – Comparison to historic data

The volume of dried seahorses consumed in Japan could not be estimated from *second surveys* but was likely to be small (Project Seahorse, unpublished data). This differs from the volumes of dried seahorses reportedly consumed by Japan in the CITES data which averaged 178,000 individuals per annum.

Japan as a source – CITES data

In 2004, the USA purportedly imported just two dried, wild seahorses (species unknown) from Japan for personal use. This was the only CITES record for the export of dried seahorses from Japan.

Japan as a source – Comparison to historic data

Second surveys indicated periodic exports of dried seahorses (species unknown) from Japan to Hong Kong SAR (N≈400-4,400 individuals per annum) and mainland China (N≈270-930 individuals per annum) from 1996-2002 (Project Seahorse, unpublished data). Import records from mainland China reflected Japanese export records. It is uncertain, however, whether seahorses exported to Hong Kong SAR from Japan originated in Japanese waters or were re-exported through Japan; Hong Kong SAR did not record imports of seahorses from Japan, but reported re-export of seahorses that were listed as originating from Japan (Project Seahorse, unpublished data). CITES data suggested a very limited export trade from Japan, therefore, it is likely that the export of seahorses from Japan has historically been, and continues to be, very small in scope.

The Republic of Korea

CITES trade data report trade in dried seahorses to and from The Republic of Korea at smaller volumes than recorded historically, and supported historical data which found The Republic of Korea to be a minor exporter of dried seahorses (*second survey* data for Korea are unpublished).

The Republic of Korea as a consumer - CITES data

In 2008, Australia purportedly exported 1,000 dried, captive-bred seahorses (*H. breviceps*) to the Republic of Korea for commercial trade purposes. This was the only record in the CITES data for the imports of dried seahorses to the Republic of Korea.

The Republic of Korea as a consumer - Comparison to historic data

Although official government records were lacking for the Republic of Korea, *second surveys* estimated historic consumption levels of dried seahorses at hundreds of kilograms annually, an estimate substantially greater (10-100 fold) than that reported in the CITES data. This suggests a decrease in the consumption of dried seahorses in the Republic of Korea. No historical data were available for trade routes or species for this country.

The Republic of Korea as a source - CITES data

In 2007, the USA purportedly imported 169 dried, wild seahorses (species unknown) from the Republic of Korea for commercial trade purposes. This was the only record in the CITES data for the export of dried seahorses from the Republic of Korea.

The Republic of Korea as a source - Comparison to historic data

Second survey export volumes suggested that the Republic of Korea was not a significant exporter of dried seahorses pre-CITES (Project Seahorse, unpublished data). The only known export was for 28 dried seahorses sent from the Republic Korea to the USA in 1996, as recorded by the US Fish and Wildlife Service. CITES records suggested the export of seahorses from the Republic of Korea continued to be sporadic and negligible relative to other countries in the region, such as mainland China and Hong Kong SAR.

Singapore

Singapore is reported as a significant consumer of dried seahorses both pre- and post-CITES – although consumption volumes were higher historically than those recorded in the CITES data (*second survey* data for Singapore are unpublished). *Hippocampus trimaculatus* was the main species recorded from Singapore in the CITES data, and the majority of dried trade into this country was reported as coming from Thailand. Historically recorded imports from India did not appear in the CITES data. The recorded export of dried seahorses from Singapore, was substantially greater historically than that reported to CITES – exports of tens to hundreds of dried seahorses were recorded in *second surveys* (mostly to Hong Kong SAR), versus a single record of 14 seahorses (to the UK) in the CITES data.

Singapore as a consumer - CITES data

Overall Import Volumes

CITES export and EFI data suggested the overall volume of dried seahorses imported to Singapore averaged around 86,000 individuals per annum with a range of approximately 19,000 to 272,000 individuals (Table 26). Reported volumes were highest in 2005 (N≈272,000 individuals per annum), with substantially smaller volumes in all other years (N<65,000 individuals per year). Captive-bred seahorses were not reportedly consumed by Singapore and commercial trade was the only reported trade purposes.

Table 26. Estimated import volumes of dried seahorse into Singapore, as reported in the CITES Trade Database for 2004-2008, showing reported source countries, species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Source	Species	Singapore as consumer					Total
		2004	2005	2006	2007	2008	
China	<i>H. kelloggi</i>		892				892
Thailand	<i>H. kelloggi</i>		10,575	3,110	7,776	3,110	24,572
	<i>H. spinosissimus</i>	13,403	76,516	7,776	13,997	7,776	119,468
	<i>H. trimaculatus</i>	19,362	90,202	7,776	15,552	7,776	140,669
	<i>Hippocampus</i> spp.	31,540	93,499			18,663	143,701
Total		64,305	271,685	18,663	37,325	37,325	429,303

Species

Three species of dried seahorses were reported in the CITES data as having been imported to Singapore from 2004-2008. These included (in descending order): *H. trimaculatus*, *H. spinosissimus* and *H. kelloggi* (Table 26). *Hippocampus trimaculatus* made up the majority of reported imports to Singapore in all years (26-71%; $N \approx 7,800$ -90,000 individuals).

Trade Routes

CITES export and EFI data reported the vast majority of dried seahorse imports into Singapore were sourced from Thailand (99.7-100%; $N \approx 19,000$ -271,000 individuals), with very small volumes from mainland China in 2005 ($N \approx 892$ individuals) (Table 26).

Singapore as a consumer - Comparison to historic data

Similar to the trend suggested by the CITES data, Singapore was an important consumer of dried seahorses historically (Project Seahorse, unpublished data); however, dried seahorse volumes imported to Singapore apparently decreased by approximately 20-fold over time from 1.7 million individuals per annum during *second surveys* to approximately 86,000 individuals per annum post-CITES.

Trade routes also shifted over time with the Indian official government historically recording significant exports of dried syngnathids (seahorses and pipefish combined) to Singapore. In more recent years, however, Thailand dominated as a source market with no trade reported from India in the CITES data.

Singapore as a source - CITES data

In 2004, the UK reported one import of 5,204 dried *H. trimaculatus* from Singapore. This was the only trade record for the export of dried seahorses from Singapore in the CITES data. No trade purpose was provided.

Singapore as a source - Comparison to historic data

Inconsistencies in export volumes between the two survey periods suggest either a decrease in the number of dried seahorses exported from Singapore over time, or inaccurate trade records. *Second survey* seahorse export volumes from Singapore were substantially greater than those reported to CITES. Pre-CITES estimates ranged from 75,000-743,000 dried seahorses per annum, with most shipments destined for Hong Kong SAR. Hong Kong SAR customs data recorded imports from Singapore that reflected the lower end of the range recorded by Singapore (mean $\approx 125,000$ individuals); however, their records appeared incomplete (Project Seahorse, unpublished data). Historical records also indicated that smaller, but consistent volumes of dried seahorses from Singapore were imported by Taiwan (37,000 individuals) and mainland China (37,000 individuals).

Taiwan, Province of China

Taiwan is reported as an important consumer of dried seahorses both pre- and post-CITES, although trade volumes appear to have changed over time with larger volumes reportedly traded pre-CITES. The primary source of dried seahorses to Taiwan pre-CITES, Thailand, has appeared to have remained the primary source post-CITES, but the composition of the other players seems to have changed slightly over time. As with Singapore, the historical records suggested greater exports from Taiwan than the single export records reported to CITES. *Second survey* data for Taiwan are unpublished.

Taiwan, Province of China as a consumer - CITES data

Overall Import Volumes

CITES export data suggested the overall volume of dried seahorses imported to Taiwan purportedly averaged just over 1.3 million individuals per annum with a range of approximately 627,000 to 2.2 million individuals (Table 27). Reported import volumes peaked in 2005 (N≈2.2 million individuals), and decreased each year thereafter with the smallest volumes reported in 2008 (N≈627,000 individuals). Captive-bred seahorses were not reportedly consumed by Taiwan and commercial trade was the only reported trade purpose.

Table 27. Estimated import volumes of dried seahorse into Taiwan, as reported in the CITES Trade Database for 2004-2008, showing reported source countries and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Taiwan, Province of China as consumer						
Source	2004	2005	2006	2007	2008	Total
Malaysia		47,170				47,170
Senegal				11,152	46,840	57,993
Thailand	1,844,893	1,490,174	1,090,445	752,970	580,591	5,759,072
Vietnam		650,350				650,350
Total	1,844,893	2,187,693	1,090,445	764,123	627,431	6,514,584

Species

Seven species of dried seahorses were supposedly imported to Taiwan from 2004-2008. These included (in descending order): *H. trimaculatus*, *H. spinosissimus*, *H. kelloggi*, *H. histrix*, *H. kuda*, *H. algiricus* and *H. comes* (Table 28). *Hippocampus spinosissimus* made up the majority of imports in 2004 (33%; N≈611,000 individuals), *H. kelloggi* in 2005 (50%; N≈1.1 million) and *H. spinosissimus* in 2008 (33%; N≈205,000 individuals). *Hippocampus trimaculatus* made up the majority of imports to Taiwan in 2006 and 2007 (40-41%; N≈316,000-432,000 individuals).

Table 28. Estimated import volumes of dried seahorse into Taiwan, as reported in the CITES Trade Database for 2004–2008, showing reported species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Taiwan, Province of China as consumer					Total
	2004	2005	2006	2007	2008	
<i>H. algericus</i>				11,152	46,840	57,993
<i>H. comes</i>	31					31
<i>H. histrix</i>	155,866	87,418	96,911	73,344	48,442	461,981
<i>H. kelloggi</i>	389,353	1,087,771	174,364	111,198	124,684	1,887,370
<i>H. kuda</i>	46,513	44,323				90,837
<i>H. spinosissimus</i>	610,543	471,829	387,247	252,255	205,288	1,927,162
<i>H. trimaculatus</i>	529,616	496,351	431,922	316,174	202,177	1,976,241
<i>Hippocampus</i> spp.	112,970					112,970
Total	1,844,893	2,187,693	1,090,445	764,123	627,431	6,514,584

Trade Routes

CITES export and EFI data reported the import of dried seahorses to Taiwan from four source countries (in descending order): Thailand, Vietnam, Senegal and Malaysia. The vast majority of reported seahorse exports were sourced from Thailand (68–100%; $N \approx 753,000$ –1.8 million individuals) with moderate volumes from Vietnam in 2005 (30%; $N \approx 650,000$ individuals; Table 27).

Taiwan, Province of China as a consumer - Comparison to historic data

Second surveys import volumes to Taiwan were three times greater than those reported to CITES suggesting a decrease in dried seahorse exports into Taiwan over time. According to *second surveys*, approximately 4 million individual dried seahorses were imported to Taiwan annually between 1983 and 2004. *Second surveys* found that trade routes were similar over time with Taiwan having obtained 67% of its purported dried seahorse imports from Thailand, a comparable result to that deduced from the CITES data. The other players appear to have changed over time, however, with the Philippines being an important source for dried seahorses into Taiwan pre-CITES (12%), but other source countries (i.e., Vietnam, Senegal and Malaysia) emerging as important sources post-CITES.

Taiwan, Province of China as a source - CITES data

In 2004, New Zealand imported 1,860 dried seahorses (species unknown) from Taiwan. This was the only trade record for the export of dried seahorses from Taiwan from 2004–2008 reported in the CITES data. No trade purpose was provided.

Taiwan, Province of China as a source - Comparison to historic data

Second surveys reported export volumes from Taiwan that were substantially greater (over 30-fold) than those reported to CITES, suggesting a decrease in dried seahorse exports from Taiwan over time. According to customs records, 36,000–68,700 dried seahorses per annum were exported from Taiwan from 1995–1998. In addition, USA and Hong Kong SAR customs data showed imports of 2,000 individual seahorses in 1997 and 744,000 individuals in 2000, respectively. These records suggest alternate historical trade routes than those revealed in the CITES data.

SOUTH EAST ASIA

Indonesia

Volumes of dried seahorses exported annually from Indonesia pre- and post-CITES were irregular and ranged from hundreds to hundreds of thousands of animals per annum depending on the source of data

(*second survey* data for Indonesia are unpublished). Consumers of dried Indonesian seahorse exports varied substantially over time with Asian countries (e.g. Hong Kong SAR, the Republic of Korea, mainland China, Taiwan, Singapore and Malaysia) dominating in the *second surveys* and only non-Asian countries (e.g. Poland, New Zealand and the UK) being reported in the CITES data – suggesting a potential shift from Asian to western countries. *Hippocampus kuda* and *H. barbouri* made up the majority of species exported from Indonesia post-CITES. It is worth noting that all CITES data for exports from Indonesia were from EFI data only. Indonesia was not reported in the CITES database to have imported any dried seahorses from 2004–2008.

Indonesia as a source - CITES data

Overall Export Volumes

Based on EFI data only, the overall volume of dried seahorses exported from Indonesia averaged approximately 6,400 individuals per annum with a range of 0 to 59,000 individuals (Table 29). There were no records of dried seahorse exports from Indonesia in 2006 and 2007 but reported volumes ranged from approximately 50,000 to 59,000 individuals for all other years. The export of captive-bred seahorses was not reported. Trade purposes were only reported in a third of all entries (N=3/9) – of these, personal use (99% of the volume) and commercial trade (<1% of the volume) were reported.

Table 29. Estimated export volumes of dried seahorse from Indonesia, as reported in the CITES Trade Database for 2004–2008, showing reported consumer countries, species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumer	Species	Indonesia as source					Total
		2004	2005	2006	2007	2008	
New Zealand	<i>Hippocampus</i> spp.		50,000			50,000	100,000
Poland	<i>H. barbouri</i>					890	890
	<i>Hippocampus</i> spp.					200	200
UK	<i>H. barbouri</i>	17,500					17,500
	<i>H. kuda</i>	19,000					19,000
	<i>H. spinosissimus</i>	1,000					1,000
	<i>H. trimaculatus</i>	1,500					1,500
	<i>Hippocampus</i> spp.	20,000					20,000
Total		59,000	50,000			51,090	160,090

Species

Over half (56%, N= 5/9) of all CITES trade entries relating to Indonesia as a source country provided data to the species level. Of these, four species (*H. barbouri*, *H. kuda*, *H. spinosissimus* and *H. trimaculatus*) were reported, all of which have been confirmed to occur in Indonesian waters (Lourie *et al.* 2004). In 2004, all four species were apparently exported, with *H. kuda* (32%; N≈19,000 individuals) and *H. barbouri* (30%; N≈17,500 individuals) making up the majority of the reported export trade (Table 29). The other species-level information was for 2008 when 890 individuals of *H. barbouri* were reported to be exported to Poland. All data were derived from EFI records only and no species were reported as captive-bred.

Trade Routes

CITES EFI data reported three countries as importers of dried, wild seahorses from Indonesia (in descending order): New Zealand, the UK and Poland (Table 29). In 2004 all dried seahorses from Indonesia were reportedly imported by the UK (N≈59,000 individuals), and in 2005 by New Zealand (N≈50,000 individuals) (Table 29). There were no records of dried seahorse exports from Indonesia in 2006 or 2007. Such exports were recorded again in 2008, 98% of which (N≈50,000 individuals) were

allegedly imported by New Zealand with smaller volumes to Poland (2%; N≈1,000 individuals). No export data were reported by Indonesia; therefore analyses were entirely dependent on EFI data from consumer countries for all years.

Indonesia as a source - Comparison to historic data

Overall Export Volumes

Historical estimates of dried seahorse exports from Indonesia determined from *second surveys* were contradictory and did not allow us to ascertain temporal trends. Individual exporters and upper level traders estimated historic average export volumes of approximately 1,000 individuals per annum (Project Seahorse, unpublished data). However, these estimates were contradicted by those obtained from a seahorse importer in Singapore that estimated imports from Indonesia of up to 100,000 individuals in one month. Given that the CITES data reported export volumes of approximately 32,000 individuals per year, the real value is most probably somewhere between what internal and external traders estimated.

Species

Second surveys did not record export data from Indonesia to the species level.

Trade Routes

According to exporters interviewed during the *second surveys*, dried seahorses from Indonesia were shipped to other Asian countries (e.g. Hong Kong SAR, the Republic of Korea, mainland China, Taiwan, Singapore and Malaysia) in unknown amounts (Project Seahorse, unpublished data). This differed from CITES data, which revealed the exports of dried seahorses to non-Asian consumer countries only (i.e., Poland, New Zealand and the UK). These results suggest a possible expansion over time of consumer countries for dried seahorses beyond the traditionally dominant Asian countries.

Malaysia

CITES data support historical data from *second surveys*; both data sets suggested Malaysia as a net exporter of dried seahorses, but with an apparent doubling in the export of dried, wild seahorses over the two time periods (to hundreds of thousands of individuals per annum). Asian countries (Hong Kong SAR, Taiwan, Thailand, Singapore and mainland China) played a predominant role as consumers during both survey periods. Additional countries (New Zealand, the UK and the USA), however, were reported to CITES as importers suggesting a geographic expansion over time. *Hippocampus barbouri* made up the majority of known species purportedly exported post-CITES; no captive-bred seahorses were exported.

Malaysia as a source - CITES data

Overall Export Volumes

Based on CITES export and EFI data, the overall volume of dried, wild seahorses allegedly exported from Malaysia averaged approximately 248,000 individuals per annum, with a range of 2,500 to 595,000 individuals over the five years (Table 30). Temporal trends from 2004-2008 indicated an increase in the reported export volume from 2004-2006 followed by a 30% drop in reported volume in 2007. In 2008, export volumes increased to the highest reported levels over the five year period (N≈595,000 individuals). The export of captive-bred seahorses was not reported in the CITES data. Trade purposes were recorded for 90% of all entries (N=18/20), and included commercial trade (99%) and personal use (1%).

Table 30. Estimated export volumes of dried seahorse from Malaysia, as reported in the CITES Trade Database for 2004-2008, showing consumer countries, species traded and year of trade. Data a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumers	Species	Malaysia as source					Total
		2004	2005	2006	2007	2008	
Hong Kong SAR	<i>H. barbouri</i>		60,692	287,736	208,050	380,189	936,667
	<i>H. comes</i>				18,868	34,277	53,145
	<i>H. kuda</i>			12,579			12,579
	<i>Hippocampus</i> spp.		9,434			170,881	180,314
New Zealand	<i>H. hippocampus</i>					629	629
	<i>Hippocampus</i> spp.	2,516				6,299	8,814
Taiwan	<i>H. kelloggi</i>		47,170				47,170
UK	<i>Hippocampus</i> spp.					3,145	3,145
USA	<i>Hippocampus</i> spp.			2			2
Total		2,516	117,296	300,316	226,918	595,418	1,242,464

Species

More than half (57%) of all CITES export trade entries for dried seahorses relating to Malaysia ($N \approx 12/21$) provided data to the species level. Of these, four species (*H. barbouri*, *H. comes*, *H. kelloggi* and *H. kuda*) were reported, all of which have been confirmed to occur in Malaysian waters (Lourie *et al.* 2004). One species, *H. hippocampus*, was also reported as being exported from Malaysia but is not known to occur in the region. *Hippocampus barbouri* constituted the majority of known species purportedly exported comprising 52 to 96% ($N \approx 61,000$ to 380,000 individuals) of trade from 2005 to 2008 (Table 30). Smaller volumes of *H. kelloggi* in 2005 (40%; $N \approx 47,000$ individuals per annum), *H. comes* in 2008 (6%; $N \approx 34,000$ individuals) and *H. kuda* in 2006 (4%; $N \approx 13,000$ individuals per annum) were also supposedly exported.

Trade Routes

Analysis of reported CITES export and EFI data revealed the export of dried, wild seahorses from Malaysia to five consumer countries (in descending order): Hong Kong SAR, Taiwan, New Zealand, the UK and the USA (Table 30). The minimal exports reported in 2004 were supposedly consumed by New Zealand ($N \approx 2,500$, <1% of total volumes reported from Malaysia). In all other years, Hong Kong SAR was reported to consume an average of 90% of dried seahorse exports from Malaysia (52-96%; $N \approx 70,000$ -585,000 individuals per annum; Table 30). Smaller volumes of seahorses were reportedly also exported to Taiwan in 2005 (40%; $N \approx 47,000$), the UK in 2008 (1%; $N \approx 3,000$) and the USA in 2006 (<1%; $N \approx 2$ individuals).

Malaysia a source - Comparison to historic data

Overall Export Volumes

Estimates of dried seahorses exported from Malaysia derived from *second surveys* were not sufficient to allow for the extrapolation to overall export volumes (Perry *et al.* 2010); however, Taiwanese and Hong Kong SAR government records showed average imports of 12,000-300,000 individuals and 20,000-100,000 individuals per annum from 1997-1998 and 2003-2004, respectively. Estimates from CITES data (248,000 individuals per annum) were substantially higher than both of these pre-CITES estimates (1997-1998 - 4-fold greater; 2003-2004 - approximately double), which may suggest a continued and growing export trade in dried seahorses originating from Malaysia. In addition, the lack of captive-bred species in historic and CITES records implies a reliance on Malaysia's wild populations to fulfil market demands.

Species

Second surveys did not record species-level volume data from Malaysia; however, all six seahorse species that were known to occur in Malaysian waters (*H. barbouri* – the most common species in TCM; *H. comes* – TCM and curio; *H. histrix* – curio; *H. kuda* – TCM, *H. spinosissimus* – TCM, local TM, and curio; and *H. trimaculatus* – TCM and curio) were historically traded within the country (Perry *et al.* 2010). These data along with CITES records suggest the continued reliance on the extraction of *H. barbouri* from the wild to fulfil TCM trade markets.

Trade Routes

Unlike CITES data that suggested a broad geographic range in countries importing dried seahorses from Malaysia, *second surveys* only recorded Asian countries (Hong Kong SAR, Taiwan, Thailand, Singapore and mainland China) as consumers of Malaysia's dried seahorses (Perry *et al.* 2010). While CITES records revealed the continued importance of Asian countries (Hong Kong SAR and Taiwan) as primary consumers of Malaysian seahorses, the inclusion of additional countries (New Zealand, the UK and the USA) suggests a geographic expansion of dried seahorse consumers over time. Regardless, both historic customs and more recent CITES records highlighted the dominant importance of Hong Kong SAR, specifically, as a major consumer country of dried, Malaysian seahorses (Perry *et al.* 2010). While Taiwan was recorded as a dominant importer of Malaysian dried seahorses in the past (from 1996-1998; 75,000-100,000 individuals per annum), its reported trade imports from Malaysia post-CITES were substantially less, with 47,000 individuals reportedly imported in 2005 only.

Philippines

The number of dried seahorses supposedly exported from the Philippines decreased almost 30-fold between the two survey periods (from *second surveys* to CITES data) from hundreds of thousands to tens of thousands of individuals per annum, and finally to zero after 2005 (the *second survey* data for the Philippines are unpublished). This trend is not unexpected given the national ban on seahorse capture enacted in the Philippines in 2004 (Philippine Department of Agriculture, 1998). The Philippine's dried seahorses were historically exported to other Asian nations (mainland China, Hong Kong SAR, Singapore, and Taiwan), with only small volumes to Europe, the USA, Japan and Malaysia. This differed from the CITES data, which only reported the consumption of Philippine dried seahorses by three non-Asian countries (Portugal, the UK and the USA).

Philippines as a source - CITES data

Overall Export Volumes

Based on EFI data only (there were no export records from the Philippines in the CITES data), the overall volume of dried, seahorses exported from the Philippines ranged from 36,000 individuals in 2004 to just over 2,000 individuals in 2005 (Table 31). Thus, reported export volumes apparently decreased nine-fold from 2004 to 2005, and dropped to nil in subsequent years (2006-2008). The export of captive-bred seahorses was not reported. Only half of all records (N=4/8) reported trade purposes; seahorses were reportedly exported for commercial trade only.

Table 31. Estimated export volumes of dried seahorse from the Philippines, as reported in the CITES Trade Database for 2004-2008, showing consumer countries, species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumer	Species	Philippines as source					Total
		2004	2005	2006	2007	2008	
Portugal	<i>H. hippocampus</i>		849				849
UK	<i>H. barbouri</i>	12,739					12,739
	<i>H. kuda</i>	4,246					4,246
USA	<i>H. histrix</i>	19,108	425				19,533
	<i>Hippocampus</i> spp.		761				761
Total		36,093	2,035				38,128

Species

Almost all CITES records for dried seahorses related to the Philippines (86%, N=6/7) were reported to the species level and none were reported as captive-bred. Three of the nine species confirmed in Filipino waters were reportedly exported in 2004 and 2005: *H. barbouri*, *H. histrix* and *H. kuda* (Table 31). *Hippocampus hippocampus* was also supposedly exported, but this species is neither confirmed nor suspected in or near Filipino waters, and is instead found in Africa and Europe (Lourie *et al.* 2004). This record was, therefore, likely identified incorrectly.

In 2004, exports of dried seahorses from the Philippines were dominated by *H. histrix* (53%; N≈19,000 individuals) while *H. barbouri* (35%; N≈13,000 individuals) and *H. kuda* (12%; N≈4,000 individuals) made up the remaining volumes (Table 31). In 2005, *H. histrix* supposedly made up 20% (N≈425) of all volumes with *H. hippocampus* purportedly comprising 42% (N≈849 individuals) of the total annual export trade from the Philippines for that year.

Trade Routes

Analysis of reported CITES EFI data revealed the supposed import of dried seahorses from the Philippines to three consumer countries (in descending order): the USA, the UK and Portugal (Table 31). The USA dominated as a consumer in 2004 and 2005, consuming 53 and 58% of the dried seahorses reported from the Philippines in each year, respectively (N≈19,00 and 1,200 individuals). The UK made up 47% of reported volumes in 2004 (N≈17,000 individuals), while Portugal comprised 42% (N≈849 individuals) of total reported export volumes in 2005 (Table 31)

Philippines as a source - Comparison to historic data

Overall Export Volumes

Comparing export volumes reported in the CITES data to those determined from *second surveys* suggested an almost 30-fold decrease in dried seahorse exports from the Philippines over time – from 245,000-365,000 to an estimated average of 19,000 individuals per annum. Volumes supposedly dropped to zero after 2006. This noteworthy decrease and the subsequent reported cessation of all export trade of seahorses from the Philippines from 2006 onwards was not unexpected given the national ban on seahorse capture enacted in the Philippines in 2004. However, the US supposedly imported over 300,000 dried, wild seahorses in 2005 which could be in conflict with the ban, or could have been trade of stockpiled seahorses, caught before the ban was enacted.

Species

Second surveys did not record export data from the Philippines to the species level.

Trade Routes

Comparing pre- and post-CITES export data for the Philippines suggest the cessation of the historic trade of Filipino dried seahorses to Asian consumer countries. *Second surveys* found dried seahorses from the Philippines to be most commonly exported to mainland China, Hong Kong SAR, Singapore, and Taiwan, with only small volumes for the curio trade exported to Europe, the USA, Japan and Malaysia – whereas no exports to Asian countries were reported in the CITES data. These CITES data only reported the export of smaller volumes of dried seahorses from the Philippines to smaller markets in three non-Asian countries (Portugal, the UK and the USA).

Thailand

Second surveys (Perry *et al.* 2010) and CITES trade data both reported Thailand as a net exporter of dried seahorses, and indeed one of the largest sources for international trade. The CITES data suggested, however, a potential increase in export volumes from Thailand since the *second surveys*, from an average export volume of 2.1-4.2 million dried individuals per annum pre-CITES to an annual average of almost 5 million individuals post-CITES. Hong Kong SAR and Taiwan were reported as prominent importers of dried seahorses from Thailand in both data sets, but non-Asian countries such as Australia, New Zealand and the USA reportedly emerged as new, albeit secondary, consumers in the CITES data. *Hippocampus spinosissimus*, *H. trimaculatus* and *H. kelloggi* made up the majority of dried seahorse exports post-CITES.

Thailand as a source - CITES data

Overall Export Volumes

Based on CITES export and EFI data, the export of dried, wild seahorses reportedly originating from Thailand ranged from 3.8 to 6.5 million individuals per annum with an average of 4.9 million across all years (Table 32). Reported export volumes increased from 2004 to 2005, but decreased thereafter. The export of captive-bred seahorses was not reported and over 99% of all reported trade for dried seahorses from Thailand was for the purpose of commercial trade.

Table 32. Estimated export volumes of dried seahorse from Thailand, as reported in the CITES Trade Database for 2004-2008, showing consumer countries, and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumers	Thailand as source					Total
	2004	2005	2006	2007	2008	
Australia		311,042				311,042
China	155,521	575,428	552,970	342,146	432,348	2,058,414
Hong Kong SAR	1,987,134	3,878,289	3,385,319	3,803,266	2,742,240	15,796,247
Malaysia			332,815			332,815
New Zealand	311					311
Singapore	64,305	270,793	18,663	37,325	37,325	428,411
Taiwan	1,844,893	1,490,174	1,090,445	752,970	580,591	5,759,072
USA	80			1		81
Grand Total	4,052,243	6,525,726	5,380,212	4,935,709	3,792,504	24,686,393

Species

Almost all CITES records related to Thailand were reported to the species level (90%, N=85/94). These records contained all species previously confirmed to occur (*H. comes*, *H. kelloggi*, *H. kuda*, *H. spinosissimus* and *H. trimaculatus*), and one suspected to occur (*H. histrix*), in Thai waters (Lourie *et al.* 2004; Table 33).

Table 33. Estimated export volumes of dried seahorse from Thailand, as reported in the CITES Trade Database for 2004-2008, showing species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Thailand as source					Total
	2004	2005	2006	2007	2008	
<i>H. comes</i>	31					31
<i>H. histrix</i>	316,675	113,297	224,905	155,101	107,166	917,145
<i>H. kelloggi</i>	738,788	1,188,292	1,171,944	1,008,694	932,585	5,040,303
<i>H. kuda</i>	75,502	152,566	192,846	105,132	108,865	634,911
<i>H. spinosissimus</i>	1,401,862	2,499,854	1,837,325	1,728,149	1,297,278	8,764,468
<i>H. trimaculatus</i>	1,246,645	2,477,533	1,953,191	1,938,631	1,327,947	8,943,949
<i>Hippocampus</i> spp.	272,739	94,184		1	18,663	385,586
Grand Total	4,052,243	6,525,726	5,380,212	4,935,709	3,792,504	24,686,393

Hippocampus trimaculatus and *H. spinosissimus* dominated reported CITES exports from 2004-2008 (Table 33). In 2004 and 2005, *H. spinosissimus* was the dominant reported species (35%; $N \approx 1.4$ million individuals in 2004, 38%; $N \approx 2.5$ million individuals in 2005); while from 2006-2008 *H. trimaculatus* was reported to be exported in the largest numbers (36-39%; $N \approx 1.3$ -2.0 million individuals per annum). Consistent and substantial volumes of *H. kelloggi* (18-25%; $N \approx 739,000$ -1.2 million individuals per annum), along with smaller numbers of *H. histrix* (2-8%; $N \approx 107,000$ -317,000 individuals per annum) and *H. kuda* (2-4%; $N \approx 76,000$ -193,000 individuals per annum) were also purportedly exported from Thailand across all years.

Trade Routes

Analysis of CITES export and EFI data revealed the purported export of dried, seahorses from Thailand to eight consumer countries (in descending order): Hong Kong SAR, Taiwan, mainland China, Singapore, Malaysia, Australia, New Zealand and the USA (Table 32). Across all years, Thai seahorse exports were supposedly mostly destined for Asian countries (95-100%; $N \approx 3.8$ -6.2 million individuals per annum). Hong Kong SAR apparently dominated overall across all years (49-77%; $N \approx 2.0$ -3.9 million individuals per annum), with Taiwan (15-45%; $N \approx 581,000$ -1.8 million individuals per annum), mainland China (4-11%; $N \approx 156,000$ -575,000 individuals per annum), Singapore (1-4%; $N \approx 19,000$ -271,000 individuals per annum) and Malaysia (0-6%; $N \approx 0$ -333,000 individuals per annum) rounding off the top five importers. Non-Asian nations made up the remaining reported consumer countries: Australia (0-5%; $N \approx 0$ -311,000 individuals per annum), New Zealand ($N \approx 0$ -311 individuals per annum), and the USA ($N \approx 0$ -80 individuals per annum).

Thailand as a source - Comparison to historic data

Overall Export Volumes

Comparison of historical *second survey* data (Perry *et al.* 2010) and CITES trade data for dried seahorse exports from Thailand suggested a potential increase in purported export volumes over the two time periods. *Second surveys* estimated average export volumes of 2.1-4.2 million individuals per annum – the volume estimate depended on whether source or consumer country data were used (Perry *et al.* 2010). The export of dried seahorses from Thailand estimated from CITES data (4.9 million) is more than double the lower estimated average annual exports pre-CITES, but comparable to the higher end of the estimate. Thus dried seahorse exports from Thailand may have increased or remained stable over time. The lack of captive-bred species in both *second surveys* and CITES data suggested a complete reliance on wild populations to fulfil market demands for both time periods.

Species

Second surveys did not record export data from Thailand to the species level.

Trade Routes

According to *second surveys*, dried seahorses were historically exported from Thailand to East Asian countries (Hong Kong SAR, Taiwan, mainland China, Singapore, Japan and the Republic of Korea) (Perry *et al.* 2010). Of these, both *second surveys* and CITES trade data reported Hong Kong SAR and Taiwan as the dominant importing countries of Thai dried seahorses; but the CITES data did not contain records of imports by Japan and the Republic of Korea. In addition, Australia, New Zealand, Malaysia and the USA reportedly emerged as new, albeit secondary, consumers of Thai dried seahorses from 2004-2008.

Vietnam

Second surveys (Giles *et al.* 2006) and CITES export records both documented Vietnam as a net exporter of dried seahorses. Overall recorded volumes of dried seahorse exports from Vietnam decreased by five to ten-fold over the two survey periods, depending on the source of *second survey* data used to make the comparison. Taiwan was the only dominant consumer country recorded in both data sets, with Hong Kong SAR and mainland China appearing to have played reduced roles over time, and additional consumer markets for Vietnamese dried seahorses having emerged in Europe, New Zealand and the USA. An export trade in captive-bred dried seahorses from Vietnam appears to have emerged in 2007 and 2008.

Vietnam as a source - CITES data

Overall Export Volumes

Based on CITES export and EFI data, the overall export of dried seahorses reportedly originating from Vietnam ranged from approximately 890 to 655,000 individuals per annum – averaging 147,000 individuals across the five year period (Table 34). Reported export volumes increased dramatically from 2004-2005 at which point volumes reached a peak of 655,000 individuals. But in 2006, reported exports of dried seahorses from Vietnam decreased substantially to less than 900 dried seahorses, with exports remaining in the thousands in 2007 and tens of thousands in 2008 (N≈2,300 in 2007 and approximately 20,000 in 2008). Only one trade record was reported by Vietnam to CITES – in 2005 – which made up 99% (N≈655,000 individuals) of the volume of dried seahorses from Vietnam reported for that year, and 89% of all dry seahorses sourced from Vietnam across the entire 2004-2008 time period. This record was not reported with a unit and so was assumed to be kilograms, and thus may be an overestimate if our assumption was wrong. The volume should, therefore, be substantiated with Vietnamese trade authorities to verify its accuracy.

Table 34. Estimated export volumes of dried seahorse from Vietnam, as reported in the CITES Trade Database for 2004-2008, showing consumer countries and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumers	Vietnam as source					Total
	2004	2005	2006	2007	2008	
Austria				6		6
Czech Republic				28		28
Hong Kong SAR				71		71
Hungary			350			350
New Zealand	45,804	2,797		1,748	5,245	55,594
Poland	14	18				32
Taiwan		650,350				650,350
UK	10,490					10,490
USA	86	1,625	541	471	14,492	17,215
Total	56,394	654,790	891	2,324	19,737	734,135

Captive-bred seahorses were only apparently exported from Vietnam in 2007 and 2008, making up 3% (N≈71 individuals) and 42% (N≈8,250 individuals) of the total reported export volumes, respectively. Over 84% of all reported trade in dried seahorses from Vietnam was for commercial trade.

Species

Only 14% of entries (N=6/42) in the CITES database related to Vietnam were reported to the species level, and none in 2004 and 2006. The records reporting species contained three species previously confirmed to occur in Vietnamese waters (*H. kelloggi*, *H. kuda* and *H. trimaculatus*) (Table 35). *Hippocampus hippocampus* was also supposedly exported but this species is not confirmed nor suspected in or near Vietnamese waters and is normally found in Africa and Europe (Lourie *et al.* 2004); therefore, this record is most likely incorrectly identified.

Table 35. Estimated export volumes of dried seahorse from Vietnam, as reported in the CITES Trade Database for 2004-2008, showing species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Species	Vietnam as source					Total
	2004	2005	2006	2007	2008	
<i>H. hippocampus</i>					3,497	3,497
<i>H. kelloggi</i>		650,350				650,350
<i>H. kuda</i>				71	8,250	8,321
<i>H. trimaculatus</i>				14	23	37
<i>Hippocampus</i> spp.	56,394	4,440	891	2,239	7,967	71,931
Total	56,394	654,790	891	2,324	19,737	734,135

In 2005, *H. kelloggi* dominated the reported export trade of dried seahorses from Vietnam, and comprised 99% of all trade volume in that year (N≈650,000 individuals) (Table 35). In 2007 and 2008, *H. kuda* was the main reported export species, comprising 3% (N≈71 individuals) and 57% (N≈8,250 individuals) of total trade in those years, respectively. *Hippocampus trimaculatus* reportedly made up 1% (N≈14 individuals) and <1% (N≈23 individuals) of exported dried seahorses from Vietnam in 2007 and 2008, respectively. The two CITES entries reporting the trade in dried, captive-bred seahorses were supposedly made up entirely of *H. kuda*.

Trade Routes

CITES data reported the export in dried, wild seahorses from Vietnam to two East Asian countries (in descending order: Taiwan and Hong Kong SAR), New Zealand, the USA, and five European countries (in descending order: the UK, Hungary, Poland, the Czech Republic and Austria; Table 34). Dried seahorses were reportedly exported from Vietnam predominantly to the New Zealand in 2004 and 2007 (81% and 75%; N≈46,000 and 1,700 individuals, respectively), Taiwan in 2005 (99%; N≈655,000 individuals) and the USA in 2006 and 2008 (61 and 73%; N≈540 and 14,000 individuals, respectively).

Captive-bred *H. kuda* were reportedly exported to Hong Kong SAR (N≈71 individuals) and the USA (N≈8,250 individuals) in 2007 and 2008, respectively.

Vietnam as a source - Comparison to historic data

Overall Export Volumes

Second survey annual export volumes of dried seahorses from Vietnam (540,000–610,000 individuals per annum) calculated from exporters' information were considerably lower (approximately two-fold) than volumes calculated from buyers' information (820,000-1.6 million individuals per annum) (Giles *et al.*, 2006). Both estimates, however, were substantially greater than CITES export volumes (which averaged approximately 147,000 individuals per annum); this suggests that the trade in dried seahorses from Vietnam may have decreased over the two survey periods.

Species

Second surveys did not record export data from Vietnam to the species level.

Trade Routes

Taiwan appeared to have remained a dominant consumer of Vietnamese dried seahorses over time, based on *second surveys* and CITES data, with Hong Kong SAR playing a diminished role post-CITES (Vincent *et al.* 2011a). Mainland China, once a primary consumer (Giles *et al.*, 2006), was no longer reported as an importer of Vietnamese dried seahorses in the CITES data. A diversification of consumer markets to New Zealand, the USA and Europe (UK, Hungary, Czech Republic and Poland) were also evident from the CITES data.

LATIN AMERICA

Based on *second surveys* (Baum and Vincent 2005; Vincent *et al.* 2011b) and CITES data, all Latin American countries were net exporters of dried seahorses. Seahorses were exported mainly from Ecuador, Mexico and Peru pre-CITES, and Bolivia, Mexico and Peru post-CITES. Mexico and Peru together made up 89% and 96% of total export volumes of dried seahorses from Latin America pre- and post-CITES, respectively. While incidences of export trade were consistent, volumes were erratic ranging from several to hundreds of thousands year to year. Historic source countries that were noticeably absent in CITES records included Honduras (once the main source – 16,000-100,000 individuals per annum), Belize (12,000 individuals per annum) and Nicaragua (volumes unknown). Overall, volumes exported from Latin America appeared to have decreased over time and importing countries shifted from primarily East Asian countries (mainland China, Hong Kong SAR and Taiwan) pre-CITES to also include Hungary and the USA post-CITES. Taiwan was no longer reported as consuming seahorses sourced from Latin American countries post-CITES.

Costa Rica

Costa Rica as a source - CITES data

The CITES data reported that in 2005, Hungary purportedly imported 743 dried, wild seahorses (species unknown) from Costa Rica. This was the only record of dried seahorse trade involving Costa Rica from 2004-2008. No trade purpose was provided.

Costa Rica as a source - Comparison to historic data

Historical data from *second surveys* corroborated CITES data suggesting a continued but very limited export trade in dried seahorses from Costa Rica, likely for curios (Baum and Vincent 2005). According to interviews and official records obtained during *second surveys*, Costa Rica exported from 20 to 1,000 individual seahorses per annum for the curio trade (Baum and Vincent 2005). While reported export volumes appeared to have remained low over time, consumer countries supposedly shifted with dried seahorses being exported historically to the USA and Nicaragua (Baum and Vincent 2005), but in CITES data to Hungary only.

Ecuador

Ecuador as a source - CITES data

The USA reported imports of one and 136 dried, wild seahorses (species unknown), in 2004 and 2008, respectively, from Ecuador for commercial trade purposes. These were the only trade records for dried seahorses from Ecuador in the CITES database from 2004-2008.

Ecuador as a source - Comparison to historic data

Second survey export volumes from Ecuador were substantially greater than those reported to CITES in 2008 (i.e. exports in the 10s of thousands - Baum and Vincent 2005). Based on exporter and government records, Ecuador exported 34,000-110,000 dried seahorses per annum from 1994-1997. The USA remained a consistent importer over both survey periods albeit in much smaller volumes in the CITES

data. Taiwan and Hong Kong SAR, however, once known to import dried seahorses from Ecuador (Baum and Vincent 2005), supposedly no longer played a consumer role with respect to Ecuador post-CITES.

Mexico

Dried seahorse export volumes from Mexico supposedly decreased by 2-16 times from pre-CITES data, collected from 1990-2001 (Baum and Vincent 2005), to the data reported to CITES from 2004-2008. While Mexico was recorded as a consistent net exporter of dried seahorses during both time periods, export volumes were extremely erratic, ranging from tens to millions of individuals per annum. While mainland China consumed the largest number of dried Mexican seahorses historically (Baum and Vincent 2005), the USA emerged in the CITES data as the only consumer of Mexican dried seahorses.

Mexico as a source - CITES data

Overall Export Volumes

The overall export of dried, seahorses reportedly originating from Mexico averaged approximately 1,300 seahorses per annum with a range of 8-2,800 individuals across all years (Table 36). Only EFI data was provided to CITES with respect to Mexico. The majority of reported imports from Mexico occurred in 2005 (2,800 individuals) with reported volumes falling below 2,000 individuals in all other years. The export of dried captive-bred seahorses from Mexico was not reported. The majority of dried Mexican seahorses (99%) were supposedly imported for the purpose of commercial trade, with smaller volumes (1%) traded for personal use.

Table 36. Estimated export volumes of dried seahorse from Mexico, as reported in the CITES Trade Database for 2004-2008, showing consumer countries, species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumer	Species	Mexico as source					Total
		2004	2005	2006	2007	2008	
USA	<i>H. fuscus</i>					4	4
	<i>H. ingens</i>			570	899		1,469
	<i>H. reidi</i>			570	105		675
	<i>Hippocampus</i> spp.	1,472	2,862			4	4,338
Total		1,472	2,862	1,140	1,004	8	6,485

Species

Over a third of all CITES entries related to Mexico (43%, N=6/14) were reported to the species level. Only two of the four species confirmed to occur in Mexican waters were reportedly exported: *H. ingens* and *H. reidi* (Table 36). *Hippocampus fuscus* was also reportedly exported in 2008; however, this species is neither confirmed nor suspected in or near Mexican waters and is instead normally found in the Red and Arabian seas (Lourie *et al.* 2004). This shipment was, therefore, most likely erroneous due to misidentification or mislabelling. *Hippocampus ingens* and *H. reidi* were reportedly exported in equally small volumes in 2006 (N≈570 individuals for each species); however, the former apparently made up over three quarters of reported exports (90%; N≈900 individuals) in 2007 (Table 36).

Trade Routes

The CITES data from 2004-2008 only reported the USA as a consumer country for dried Mexican seahorses.

Mexico as a source - Comparison to historic data

Overall Export Volumes

Second surveys (Baum and Vincent 2005) revealed historical dried seahorse exports from Mexico to be substantially greater than the more recent estimates obtained from the CITES data. Both sets of data confirmed Mexico as a consistent exporter of dried seahorses, albeit one with extremely erratic annual export volumes (from tens to millions). Recorded dried seahorse exports from Mexico varied greatly from 1990 and 2001, ranging in volume from 2,500-2.1 million individuals per annum (Baum and Vincent 2005) while trade volumes reported in the CITES records were significantly less, ranging in volume from eight to 2,800 individuals per annum. Similar to CITES records, the export in captive-bred individuals was not reported historically.

Species

Second surveys did not record species-level export volumes from Mexico; however, both *H. ingens* and *H. reidi* were collected historically from Mexico for both the dried and live trades (Baum and Vincent 2005), and both were supposedly exported post-CITES. *Hippocampus erectus* was observed during the *second surveys*, but was not reported to CITES from 2004-2008.

Trade Routes

Based on *second surveys* and CITES data, the USA appeared to remain the one consistent consumer country of Mexican dried seahorses, although mainland China historically consumed the largest number (Baum and Vincent 2005). Volumes imported by the USA supposedly reduced between the two survey periods, from approx. 12,000 individuals to 1,300 individuals in the CITES data per annum. Mainland China was the dominant importer of dried seahorses from Mexico during the *second surveys*, having consumed an estimated 2.1 million individuals in 2000 (Baum and Vincent 2005). Smaller volumes of dried Mexican seahorses were also imported by Australia (300 individuals) and Hong Kong SAR (40,000 individuals) in 1999, and by Hong Kong SAR only (6,500 individuals) in 2000 (Baum and Vincent 2005).

Peru

The export volume estimates for dried seahorses originating from Peru were consistent over the two time periods studied, such that Peru emerged as a constant net exporter over time. However, volumes varied greatly from thousands to hundreds of thousands per annum (Baum and Vincent 2005). Hong Kong SAR and mainland China appeared to be the only consistent consumer countries of dried seahorses from Peru across the two time periods, with the USA having emerged as the only importer for the year 2005 through 2008.

Peru as a source - CITES data

Overall Export Volumes

CITES data reported that the overall export in dried seahorses originating from Peru averaged 104,000 seahorses per annum, with a range of 30-516,000 individuals across all years (Table 37). Only consumer country EFI data was provided to CITES. Peak reported trade volumes involving Peru occurred in 2004 (N≈516,000 individuals) with relatively few seahorses reportedly exported in subsequent years (N≈30-1,100 individuals across 2005-2008). The export of captive-bred dried seahorses from Peru was not reported in CITES data. The majority of seahorses were supposedly exported for the purpose of commercial trade (99%) with smaller volumes for personal use (1%).

Table 37. Estimated export volumes of dried seahorse from Peru, as reported in the CITES Trade Database for 2004-2008, showing consumer countries, species traded and year of trade. Data are a combination of export and EFI data. As the CITES listing of seahorse species took effect in May 2004, all 2004 data represents only a partial year.

Consumer	Species	Peru as source					Total
		2004	2005	2006	2007	2008	
China	<i>H. ingens</i>	299,377					299,377
Hong Kong SAR	<i>H. ingens</i>	216,952					216,952
USA	<i>Hippocampus</i> spp.	1	285	1,134	30	415	1,865
Total		516,330	285	1,134	30	415	518,193

Species

Only a quarter of all entries related to Peru (25%, N=2/8) were reported to the species level. *Hippocampus ingens*, the one species confirmed to occur in Peruvian waters (Lourie *et al.* 2004), was reportedly exported from Peru in 2004, making up the vast majority of exports that year (99%; N≈516,000 individuals) (Table 37). Dried seahorse exports from Peru were only reported to the genus level in the other years, but could be assumed to be *H. ingens*.

Trade Routes

All trade route analyses for Peru were based on consumer country EFI data only. Dried seahorses reported to be from Peru were supposedly exported to three countries from 2004-2008: mainland China, Hong Kong SAR and the USA (Table 37). Reported data suggested the vast majority of dried seahorses sourced from Peru in 2004 were imported into East Asia (99%; N≈516,000 million), with smaller numbers supposedly imported into the USA (<1%; N=1). The USA was seemingly the only consumer of Peruvian dried seahorses from 2005-2008 (N≈30-1,100 individuals).

Peru as a source - Comparison to historic data

Overall Export Volumes

Second survey export estimates for dried seahorses from Peru were similar to those reported to CITES both in volume and variability – they ranged greatly from the thousands (1,200) to hundreds of thousands (524,000 individuals) of seahorses per annum (Baum and Vincent 2005). There were no historic records of the export in dried, captive-bred seahorses from Peru; similar to the more recent post-CITES data.

Species

Second surveys did not record export volumes from Peru to the species level; however, both *H. ingens* and *H. reidi* were collected historically for the dried and live trades (Baum and Vincent 2005) but only *H. ingens* was reportedly exported dried from Peru post-CITES. *Hippocampus erectus* was also observed in trade during the *second surveys* but was not reported to CITES from 2004-2008.

Trade Routes

Based on *second surveys* and CITES data, Hong Kong SAR and mainland China appeared to be the only consistent consumer countries of Peruvian dried seahorses across the two study periods, although CITES data suggested imports by Hong Kong SAR and mainland China in 2004 only. Additional historic consumer countries not reported to CITES included Canada (280-22,500 individuals per annum) and Chile; although volumes imported by Chile were unknown (Baum & Vincent 2005). The USA, which allegedly imported all Peruvian dried seahorses from 2005-2008, was not recorded historically to import dried seahorses from Peru (Baum & Vincent 2005).

DISCUSSION

SUMMARY

The CITES database gives us an unparalleled tool to investigate the trade in seahorses, as indicated in this, the first analysis of CITES data for any marine fish of commercial importance. Its breadth of geographic coverage allows many new insights into the species, volumes, and trade routes of seahorses in trade. That said, the database is also subject to the vagaries of any database that relies on compliance from contributors with limited capacity and unlimited demands on their resources. It is full of discrepancies, uncertainties and confusions that relate to species identification, units of measure, mismatches between export and import data and much more. Nonetheless, the relatively new availability of longitudinal data from the 175 signatory nations to CITES begins to round out the story of seahorse trade, especially once married to the trade surveys on the ground and national/regional official data.

Millions of seahorses were certainly traded internationally in each of the five years after the CITES listing was implemented, from 2004-2008. The CITES database shows more species in trade and lower volumes of trade than had been estimated prior to the CITES listing but the evident gaps mean that we cannot yet deduce where the correct estimate lies. As in pre-CITES years, CITES records show that most seahorses were sold dried, apparently for traditional medicine. Asian countries were both the main exporters and importers for seahorses over time, with Thailand as the primary source for seahorses in dried trade, and Hong Kong SAR, Taiwan and mainland China as the major consumers. The inferences we were forced to make from CITES data suggested substantial new exports from Guinea and mainland China, and substantial new imports to New Zealand and the UK. We are, however, concerned that the latter three findings may derive more from record keeping issues rather than from actual trade volumes.

CITES RECORDS

The CITES Appendix II listing for seahorse species provides a wonderful opportunity to gather information on trade in these highly cryptic marine fishes, as we will outline below. Given how terribly difficult it is to monitor their wild populations – most seahorses are still listed as Data Deficient on the IUCN Red List of Threatened Species (26/38 species that have been assessed; www.redlist.org) – we desperately need fisheries and trade data to allow inferences as to the status of the species, globally and regionally. The CITES database provides such trade data, albeit without offering effort data to allow for direct inferences on population dynamics. In many ways, the CITES database provides a portal into the necessary and more detailed catch- and trade-per-unit-effort analysis. The analyses in this report confirm that many CITES records are inaccurate and problematic, but also confirm the utility and value of gathering such information.

Despite the value of CITES database for seahorses, we have noted problems with species identification, volume metrics, and mismatches between export and EFI data. The frequency with which Parties reported trade in seahorses only to the genus level – totalling 23% of the records from 2004-2008 (and proportionally more in the dried trade) – was hugely problematic. Parties to CITES are obliged under Article VIII, paragraph 6(b), to identify specimens to the species level (<http://www.cites.org/eng/disc/text.php>), not least because non-detriment findings apply only to the species. Although Parties reported most trade at the species level by 2006-2008, there were numerous oddities in the names assigned.

- Some species were not found in the waters of the Party reporting the export. This is particularly easy to detect for Parties that are only range states for one or two species. For example all trade from West African countries should consist of *H. algiricus*. In total, we found that 10% of trade records (for specimens not captive-bred) reported export of species that were not native to those Parties, representing just over 1% of overall volume. Some such records are, however, legitimate, particularly the export of the Caribbean seahorse, *H. reidi*, from Sri Lanka where it is cultured.
- Some species names, particularly *H. kuda*, were highly overused and likely incorporated a variety of Indo-Pacific species, including *H. comes* and *H. fuscus* (B. Giles, Project Seahorse, unpublished data).
- Our trade experience indicates that, in contrast to many Parties' reporting, very large shipments are unlikely to comprise only one species. For example, we would be surprised if the dried

seahorses in a single 5,041 kg shipment, representing approximately 1.9 million individuals, were actually all *H. trimaculatus* as reported.

Identification problems also troubled pre-CITES trade surveys. There is clearly a critical need to build capacity with respect to seahorse species identification.

The reliability of the records in the CITES database is entirely dependent on the accuracy with which CITES Parties report these data, and our sensitivity analyses suggest that volumes may suffer inaccuracies. Comparing mandated export records with those voluntarily submitted by importing Parties suggested that under-reporting is a big problem with CITES data for seahorse trade at least. If voluntary EFI data had been omitted from our analyses, a very different view of the seahorse trade would have emerged, with estimated trade volumes lower, and key players and species missing from the picture. An observed lack of consistency between export and EFI data means that reliance on the former alone might result in underestimation of global trade of seahorses and other Appendix II species.

Even those records that were submitted could be highly problematic, especially where they lacked units of measure. Where units are blank, CITES assumes that “*the figure represents the total number of specimens*” (UNEP-WCMC 2004). We did our best to clarify directly with exporting nations but, where that failed, we assumed that entries for dried trade without units were measured in kilograms. With the CITES database, kilograms were the only metric used for any dried trade entries that did have with a unit measure. Moreover, in all our extensive experience with the seahorse trade since 1993, all shipments of dried seahorses have been by weight (e.g. Vincent *et al.* 2011b); neither exporters nor importers counts out tens of thousands of animals. We are, however, mindful that our assumption of a kg metric in the dried trade – at about 370 seahorses per kg – had implications for trade estimates that should generate caution. In contrast, we assumed that live trade entries without units represented individuals as any kg metric would have necessarily included the bag of water used for shipping.

The critical need for export records to include units of measure is exemplified by records from mainland China. About 32 of 73 entries related to China in the CITES database from 2004-2008 (both export and EFI) were submitted without units. Applying our base assumptions as outlined in the methods, *prior* to seeking unit clarification from Parties, resulted in an estimate of 19.8 million individuals exported from mainland China over this time period, almost 100 times larger than estimated historically. Such a large volume was highly suspect given the small seahorse populations found in Chinese waters (Vincent 1996; UNEP-WCMC 2012). We consequently sought clarification from importers on EFI entries related to mainland China, with the result that the estimated export volume was reduced 25%, to just over 15 million individuals. The majority of this residual volume consisted of two entries reported by mainland China as derivatives, with volumes of 12,000 and 18,000 (no units), which translated into approximately 4.5 and 6.7 million seahorses if we applied our base assumption of 370 seahorse per kg. After several requests, the Chinese CITES Authorities clarified that the metric for these entries was individual capsules, each containing 1.4 mg ground dried seahorse. The result was that six and nine individual specimens, respectively, had been used, a very long way from our first deduction of 4.5 and 6.7 million seahorses. After this correction, mainland China’s estimated exports were further reduced 80% to just over 3 million individuals. There were still six EFI records of exports from mainland China for which we have not yet managed to clarify the units. If our assumption that the units were kilograms is wrong, then we are still overestimating China’s exports by as much as 2 million individuals if the units were actually individuals, and even more if some of them were shipments of capsules.

Data should be submitted according to protocols outlined in “A Guide for Interpreting Outputs from the CITES Trade Database” (UNEP-WCMC 2004), but previous research suggests Parties commonly depart from the CITES guidelines in ways other than those we uncovered in our analyses: they may not make it clear whether the data provided are from actual specimens traded as oppose to the quantity for which the permits/certificates were issued; they may exclude data on seized or confiscated specimens; omit the purpose, term and/or source of the specimens being traded; and/or they may make untimely or incomplete submissions of data (Blundell & Masica 2005; Nijman & Shepherd 2010; UNEP-WCMC 2010).

SPECIES IN TRADE

All 24 species recorded as being traded historically were also found in the CITES database, suggesting that a total of 28 species are of some commercial value (past or present).

Dried trade

Although 18 species were reportedly traded dried in the CITES data, four Asian species dominated the trade. Among all the seahorses identified to species level, *H. trimaculatus* and *H. spinosissimus* continued to dominate TCM markets (as per Vincent 1996), comprising 50% (about 17.7 million individuals) of overall dried trade volumes from 2004-2008. The other two Asian species, *H. kelloggi* and *H. kuda*, together comprised 21% (about 7.4 million individuals) of overall trade volumes for the same time period. West African *H. algiricus* was also traded dried in large numbers, making up 11% (4.1 million individuals) of overall dried trade volumes from 2004-2008. The other 13 species made up the remaining 18% (6.4 million individuals) of the dried trade. We cannot compare dried volumes by species to pre-CITES trade as *second survey* data did not distinguish among species.

Six species previously recorded in dried trade (albeit infrequently for many) did not appear in CITES records: *H. angustus*, *H. borboniensis*, *H. camelopardalis*, *H. mohnikei*, *H. whitei* and *H. zebra*. All were, however, reported as traded live in CITES data (four as wild, and all but *H. zebra* are also apparently traded captive-bred). The difference may lie as much in record keeping as in any real change: these species were found primarily through trade surveys but may not have been detected or tracked among the large volumes in commercial dried trade. The absence of the two East African species (*H. borboniensis* and *H. camelopardalis*) will be directly related to the lack of reported trade from this region.

Four seahorse species were newly reported in the dried trade: *H. algiricus*, *H. bargibanti*, *H. breviceps*, and *H. zosterae*. *Hippocampus algiricus* will always have been the dominant seahorse traded from West Africa even when it was not identified by name. Reports of the other three species are odd as they are so small that any dried trade is most unlikely unless for curios. Capture and trade in *H. breviceps*, an Australian endemic, is tightly regulated and indeed the records all refer to captive-bred specimens. There are only three records for dried *H. zosterae* in any case, one of which was for just two individuals. The single entry of *H. bargibanti* is likely erroneous as this tiny seahorse species (max height < 2.5cm) is most unlikely to be traded dried.

Live trade

As with the dried trade, the live trade reported to CITES was focused on a few species. Two species, *H. kuda* and *H. reidi*, together comprised 79% of total live trade volumes, with the other 25 species making up 21% of the total trade. Historic surveys had cited *H. erectus* and *H. zosterae* (with *H. reidi*) as the most common species in the live trade but the first two of these made up only 3% of the reported trade post-CITES.

Eight new species were reported as traded live in the CITES data: *H. algiricus*, *H. borboniensis*, *H. denise*, *H. hippocampus*, *H. kelloggi*, *H. montebelloensis*, *H. trimaculatus* and *H. zebra*. Seven of these were reported as coming from the wild, and so may represent new pressures on wild populations. Two may well have been traded before they were formally identified (*H. denise* and *H. montebelloensis* were described in 2003 and 2001 respectively, after the *second surveys*). As with the dried trade, newly reported species could signify a diversification in species traded due to geographic expansion in order to meet demand, an increased ability to source species, better identification of species being traded or an increased scarcity of previously sourced species. Two of the species were reported as captive-bred which may indicate an improvement in husbandry techniques for these species. Alternately, any of these entries could simply reflect erroneous species identification.

GLOBAL VOLUMES

CITES data indicated lower volumes of dried and live exports than those deduced from historic, pre-CITES trade surveys, with the probability that inferred changes in dried trade resulted from underreporting while changes in the live trade represented real declines in export.

According to the CITES data, Parties exported about 7 (5-9) million seahorses annually, the overwhelming majority of which were reportedly extracted from the wild. Such figures are lower than the estimates from pre-CITES trade surveys, of about 19 million seahorses annually (range 14-23 million). The dried trade reportedly continued to dominate overall seahorse trade volumes, comprising approximately 99% of totals from 2004-2008. This suggests extraction of seahorses continues to be geared primarily towards meeting the demands of the TCM and other medicinal markets, as pre-CITES (Vincent 1996).

The difference between pre- and post-CITES data may arise from underreporting and/or it may be real. Underreporting is a very real phenomenon for exports of many species listed under CITES Appendix II (e.g. turtles, tortoises, frogs: Cheung & Dudgeon 2006; Goh & O'Riordan 2007; Nijman & Shepherd, 2010) but some of the drop may have also arisen from domestic legislation. Both India and the Philippines (historically totalling about 4.5 million seahorses annually, combined) banned seahorse capture (and thus trade) at about the time the CITES listing came into effect (Indian Ministry of Environments and Forests 2001; Philippine Department of Agriculture 1998), although some imports were still recorded from the Philippines in 2004 and 2008. CITES data also show no records of exports from Tanzania, which historically traded seahorses in large numbers (McPherson & Vincent 2004) – but we have too little information to guess why. Although there were new export records from geographically diverse Parties without a previous history of seahorse trade (e.g. Canada, Cote d'Ivoire, Czech Republic, Haiti), they contributed little to overall volumes in the CITES database and some (e.g. the landlocked Czech Republic) are clearly spurious. In general, it would be surprising if there were a reduction in global demand given the persistent consumption of seahorses for TCM in Asian countries and increasing TM consumption in countries such as Canada, France, Germany and the USA (Robinson and Zhang 2011). It is, however, possible that demand outstrips supply, especially with lack of recorded exports from some Parties.

CITES data suggested that exports of live seahorses from 2004-2008 (120,000 per annum, range 22,000 to 172,000) were rather lower than the pre-CITES inferred annual average export of approximately 300,000 individuals. An initial increasing trend in the CITES data from 2004 to 2007 may represent a greater compliance with reporting, while the lower numbers in 2008 were apparently mainly due to reductions in reported exports from Sri Lanka. In all cases, however, the absolute levels were much lower than those deduced from pre-CITES trade surveys. Again, this may be an artefact or reporting issue or it may be real. The latter is perhaps more probable in the live than dried trade, given how much more difficult it is to trade live animals surreptitiously, with their need for fast movement by airplane.

TRADE BY PARTY

The post-CITES trade in seahorses remained global and complex, with many countries trading many seahorses. The CITES data showed that many source countries supplied dried seahorses to fewer consumer nations (37 versus 21). In contrast, fewer source countries supplied live seahorses to more consumer nations (26 versus 40). Many source countries were Asian (15 for dried, 9 for live), with roughly equal portions of the remaining coming from the other regions. And many consumer countries were also located in Asia (9 for dried, 13 for live), but many were also European (9 for dried, 20 for live).

Although the overall number of countries that played a role in the international trade of seahorses had apparently remained relatively stable over time, the actual composition of the reported players had changed. CITES data suggested that the number of source and consumer nations of dried seahorses might have declined. Possible reasons could include difficulty in accessing supplies in some waters, permitting restrictions that deterred trade, and/or a diversion of trade into illicit channels. The latter would be easier for dried than live seahorses because of the exacting requirements of living animals. Indeed CITES data hinted at an increase in the number of countries importing live seahorses. Possible explanations include better record keeping under CITES regulations (an apparent increase), advances in seahorse husbandry (making it more feasible to include seahorses in aquarium displays) and/or an increase in captive breeding post-CITES which supplied seahorses more readily at tolerable prices. The last of these is highly probable, given the role of the live seahorse culture in Sri Lanka.

Exporters

From a conservation point of view, what really matters is understanding extraction by region. We particularly need to emphasise the need for Thailand, Vietnam and Guinea to make excellent non-detriment findings, given the sheer scale of their exports.

CITES data show that Thailand purportedly remained the key source country for seahorses, with annual export volumes in the millions of individuals. All data indicate that Thailand has long exported a great many wild seahorses for the dried trade (Perry *et al.* 2010), suggesting a significant pressure on these populations. CITES data appear to substantiate narrative reports that wild populations were declining in the late 1990s. The records show more exports post-CITES than had been inferred from trade surveys, but the subsequent decline in trade volumes from 2004-2008 suggests a need to evaluate the population status of these seahorses. Either international demand declined (leading to more discards of the seahorse bycatch or, perhaps, more domestic consumption), CPUE declined, or effort declined (through reduced trawling). Either of the first two would be worrying in conservation terms.

Seahorse trade from Vietnam, although still large, appears to have decreased from pre-CITES levels. Although there was a large discrepancy in the estimated pre-CITES volumes depending on which data were used (exporters vs. buyers), both estimates resulted in larger volumes than those reported post-CITES (Giles *et al.* 2006). The majority of trade from Vietnam occurred in 2005 with declines thereafter, a trend that could be explained by declines in either demand or supply, or reporting inaccuracies. The latter explanation must be considered as our estimate of Vietnamese exports in 2005 was largely based on a single record, where units were unknown, not clarified and therefore assumed to be in kilograms.

Reportedly large volumes of dried seahorse exports from West African, particularly from Guinea, may reflect trade that has greatly increased over time or is newly revealed. Although Guinea was reported as a source for seahorses pre-CITES the volumes calculated from the CITES data are ten-fold higher. It is unclear whether this is evidence for an emerging trade or whether this large trade had simply been underreported in earlier years, as *second surveys* focused on East Africa. The apparent decline in exports from Guinea from 2004-2008, could be explained by underreporting, as data for this Party in 2006, 2007 and 2008 was almost exclusively EFI.

Few historically dominant source countries for dried seahorses – except Thailand and Vietnam – reported much trade in the CITES records. *Second surveys* reported India and Mexico as top source countries for dried seahorses, followed by the Philippines and Tanzania. None of these Parties reported seahorse exports from 2004-2008, although voluntary import records included mentions of Mexico and the Philippines as sources. India and the Philippines have banned the extraction of wild seahorses (the latter as an automatic consequence of the CITES listing surprisingly) but we have encountered reports of illegal trade from both countries post-CITES (Nishan Perrera, Project Seahorse, pers. comm., O'Donnell *et al.* 2010). CITES EFI records show a trade from Mexico at one-tenth of levels estimated from trade surveys (Baum & Vincent 2005). Since seahorses in Mexico continued to be captured in unceasing shrimp trawl fisheries (Foster & Vincent, 2010), the reported decline in trade volumes either indicates fewer seahorses per trawl, more seahorse discards, a new domestic market for seahorses, or underreporting. We have too little information to guess why Tanzania, once a known source (McPherson & Vincent 2004), did not record dried seahorse exports in the CITES data.

In the CITES database, four Parties (Guinea, Malaysia, Senegal and China) reported dried exports far greater than had previously been inferred. For the first three Parties, our best estimate is that either there were real increases in trade post-CITES and/or previous reports underestimated trade in these countries. The case of mainland China is rather surprising. CITES records hinted that mainland China, historically a large destination for seahorses, might be exporting substantial numbers of seahorses. However, no narrative information supports this inference, and we think it most likely that totals may have become inflated by our general inferences that all shipments without units were in kg (see above). One other possibility is that China's apparent exports were actually re-exports of specimens extracted by other Parties; mainland China reportedly made up as much as 42% (depending on the year) of re-export trade in the CITES data from 2004-2008.

The CITES database showed that Southeast Asian countries declared most of the trade in live seahorses. Vietnam which was previously reported as a negligible source for live animals emerged as a dominant

player in the CITES data, along with historically important sources Sri Lanka and Indonesia. Australia and Brazil appeared to have maintained their export volumes. Historically important Philippines does not appear to play an on-going role, presumably because it was hard to circumvent the trade ban with live animals. West African declarations of live seahorse exports may reflect trade that is either new or newly revealed. In Asia, India, Pakistan and Thailand were the only source countries recorded in *second surveys* that were not reported as exporters of live seahorses in CITES data.

Many Parties that reported exports of live seahorses for the first time – e.g. Hong Kong SAR, Japan, Kuwait, Ireland, and New Caledonia – were shipping captive-bred live seahorses. Other countries, however, provided their first reports for live seahorse exports from wild populations: Dominican Republic, Haiti and Peru. In contrast, Belize, Canada, Costa Rica and Ecuador submitted no export records for live seahorses despite being historically involved in seahorse trade.

Importers

The CITES data emphasise that most seahorses are sold dried, primarily to Asia. The *second surveys* showed that most seahorses were exported to/imported by mainland China, Hong Kong SAR, Taiwan and Singapore (in that order). CITES data indicated that most dried exports from 2004-2008 went/came to Hong Kong SAR, Taiwan and mainland China from 2004-2008. That said, CITES data suggested consumer markets for dried seahorses (and presumably for TCM) in Europe, Oceania and North America (Robinson & Zhang, 2011).

For live seahorses, CITES data showed that most went to the USA from 2004-2008, although many captive-bred individuals also went to other countries (France, Canada, and UK). *Second survey* data had similarly suggested that the majority of live seahorses traded globally went to the USA, but had also highlighted Singapore as a major consumer, a finding that did not emerge from the CITES data.

WILD VS CAPTIVE-BRED

Our CITES database analyses support previous findings that captive breeding operations contribute little to dried trade (just over 1% of overall volumes), even while playing an important role in live trade. A review of seahorse aquaculture operations found that only one of the 13 commercial facilities surveyed supplied seahorses to the TM trade; all supplied the live trade (Koldewey & Martin-Smith 2010). It is clear that the many seahorse aquaculture ventures launched over the past two decades (Koldewey & Martin-Smith 2010) have made no real difference to the number of wild of seahorses in the dried trade. This is unlikely to change, because the vast majority of dried seahorses are sourced very cheaply in shrimp trawl bycatch in developing countries (Baum & Vincent 2005; Giles *et al.* 2006; Meeuwig *et al.* 2006) where there is very little cost to extracting the dead animals from the net.

CITES data indicated an increasing reliance on captive-breeding operations to supply the live trade in seahorses; the percent of such trade that was reported as captive-bred doubled from 2005-2008. No such data were available pre-CITES, although the most live seahorses in trade were believed to be wild-caught (Perera *et al.* in prep). In CITES data, about half the species reported to be traded live were also reported as captive-bred. That said, only three species were reported as captive-bred only, with the remainder fully or partially sourced from wild populations. CITES records show notable exports of live, captive-bred seahorses from Sri Lanka (for *H. reidi*) and Vietnam (for *H. kuda*). In the former case, an entrepreneur seized the opportunity to avoid CITES documentation by culturing a Caribbean species of seahorse which – because it was an exotic for Sri Lanka – could be exported (once it reached F2 generation) without challenges as to its captive provenance, and thus without requiring Sri Lanka to make non-detriment findings. In both Sri Lanka and Vietnam, captive exports were probably facilitated by improvements in seahorse husbandry and captive breeding, a preference for cultured seahorses because they present fewer husbandry challenges (Vincent & Koldewey 2006), and the favourable circumstances dictated by a CITES Appendix II listing (which dictate much easier paperwork for F2 captive-bred specimens than wild animals).

It is unclear how the expansion of captive breeding for live seahorses will affect wild populations – there are often issues with continued extraction of wild animals by the aquaculture venture and with consumer preference for wild individuals – but the overall number of captive-bred exports (in live trade) appears to have increased since the trade surveys. Previous CITES listings for corals and giant clams (Wabnitz *et al.*

2003), sturgeons and paddlefish (Raymakers 2002), were linked with increases in captive breeding programs without an associated decreased impact on wild populations.

CONSERVATION IMPLICATIONS

Our analyses of CITES data – especially in the context of trade survey findings – indicate a dynamic trade environment with some Parties beginning to export seahorses and others ceasing to export seahorses or changing the nature of their seahorse exports. So how do these changes reflect the health of seahorse populations in the wild, taking into account great uncertainties about reliability and comprehensiveness of CITES records?

It is evident that four Asian species (*H. kelloggi*, *H. kuda*, *H. spinosissimus*, and *H. trimaculatus*) are bearing the brunt of the international trade in seahorses, with the pressure probably arising more from (a) geographic location (Southeast Asia, with its proximity to key East Asian markets) and (b) vulnerability to certain gear (especially trawls), than from any particular desire for those species. Although TM does express a preference for larger, smoother specimens, such a bias seems not to have diminished trade in the very thorny *H. spinosissimus*. These four Asian species are all listed as Vulnerable on the IUCN Red List of Threatened Species (IUCN 2012). It is also obvious that considerable pressure is being applied to *H. algericus*, also listed as Vulnerable on IUCN Red List of Threatened Species (IUCN 2012). This latter trade may well reflect growing Chinese commercial interests in West Africa (Kaczynski *et al.* 2000; Tull 2006). New trade surveys indicating geographic expansions of sourcing in Senegal, a major exporter, suggest that the steady export volumes may be coming at a cost to wild populations (West 2012).

The on-going domination of the dried trade probably explains the concentration on a few species; the diversity of seahorse forms is of little interest in TM consumption but holds interest in the aquarium trade. The apparent dearth of discretion by species in the TM trade makes it all the more worrying that most dried seahorses were wild caught, while the smaller aquarium trade moved considerably towards cultured sources. The TM trade will consume most species that are available, not least in the growing pre-packaged medicine market.

Any management measure to reduce pressure on wild populations of seahorses will have to involve restrictions on nonselective gear in time and space. Huge pressures from trawling and other forms of non-selective fishing may be at the heart of any threat to most seahorse species in most regions. It is not a coincidence that Thailand and Vietnam have both very large dried seahorse exports and very large trawl fisheries. Such gears and methods will continue to catch and kill seahorses whatever the TM demand for these animals. Any form of export quota under CITES would, in the absence of restrictions on such gear, only lead to more discards, trade moving underground, or a growing domestic market. Such indirect pressure is as problematic in West Africa as in Southeast Asia, given that *H. algericus* is also largely obtained in bycatch (West 2012). It is stunning to realise that catches of only 1-2 seahorses a night per trawl can cumulatively become, through very heavy fishing pressure, exports of millions of seahorses annually (e.g. Giles *et al.* 2006). Any adjustments in demand will not, per se, relieve bycatch pressure on seahorses.

The evolution of the live trade into a market largely supplied by cultured specimens, mainly from farming one exotic species in Sri Lanka (thus avoiding certain CITES paperwork), says a lot about the potential influence of a CITES Appendix II listing on the market --- and thus on wild populations. The challenge now is to discern the impacts on species and regions (and on the fishers) no longer as heavily involved in supplying the aquarium trade for seahorses. It is also to anticipate and mitigate the risks of such movement of live exotic specimens around the world, not least to the culture facility itself in Sri Lanka (which has six native seahorse species).

NEXT STEPS

There is a great need to improve data accuracy and thus increase the utility of the CITES database in tracking the international trade in threatened species, and in providing informed conservation policy choices. The many gaps, discrepancies, oddities and contradictions in the CITES database mean that we face serious challenges in understanding what CITES trade data represent about wild populations. The following are some of the ways that CITES data might become more valuable:

- Automate record validation to help eliminate common sources of reporting discrepancies. For example, entries would be automatically refused if the Party was not a range state for the particular species entered or if the entry lacked specified units.
- Build capacity through hard copy, e-materials, trainings and games to (i) improve species identification, (ii) emphasise the value of accuracy in volumes and units, and (iii) encourage promptness. Records often arrive several years late, greatly modifying global analyses.
- Promote submission of records on export of derivatives/pre-package medicines (with clear indication of their seahorse content) to the CITES database. This is a hugely growing aspect of TM and needs careful consideration, not least as seahorse species and size are no longer visible to consumers or practitioners.
- Provide incentives for the most accurate entries and the entries that best matched any available EFI data.
- Undertake field sampling to cross-validate CITES data with respect to species, volumes and routes. This could be done by using citizen science and/or professional research for a subset of populations, fisheries and trades.

It is important to realise that even perfect CITES data would leave many questions unanswered. For all Parties, there is a great need to understand any domestic consumption of seahorses (which is sometimes very large) and the additional pressure it may apply. Indonesia is a particular case in point, with a large domestic market for seahorses in its traditional *jamu* medicine (Vincent 1996), as well as a significant export of pre-packaged *jamu* products.

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