

The catch and trade of seahorses in Vietnam

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Abstract. Catch monitoring and surveys were used to assess the seahorse trade in Vietnam. Despite low daily catch rates, potentially 6.5 t of dried seahorses (~2.2 million seahorses) were taken annually as bycatch by trawlers operating out of five coastal provinces of Vietnam. Individual seahorse catches were collated by a few local buyers, who supplied wholesalers in three major markets: Ho Chi Minh City, Hai Phong City and Da Nang. Domestic consumption was small and most seahorses were exported, generally through unofficial and unregulated channels across the northern border into Guangxi province of China. Overall, the seahorse trade was of low economic value to Vietnam, but may constitute an important source of income to upper level buyers and exporters. Most fishers and buyers surveyed reported that seahorse catch had declined over time. This paper should help in meeting the new CITES requirements – through implementation of an Appendix II listing in 2004 – that all international trade in seahorses must be monitored and managed for sustainability.

Introduction

Seahorses (genus *Hippocampus*) are rarely subject to fisheries management or monitoring, despite an international trade that consumes millions of these fishes, dried for use in traditional medicine (TM) and as curios, and live for display in aquaria (Vincent 1996). Seahorses are caught, directly or indirectly, in fisheries around the world, ranging from small-scale hand collectors to by-catch in commercial shrimp trawlers (Vincent 1996). The trade, therefore, is often diffuse and difficult to track, involving many participants over many regions. Moreover, these fisheries are often considered small-scale, both in terms of catch volumes and economic value, and are rarely of concern to traditional fisheries management bodies. Seahorses are also emblematic of many other species threatened by small-scale fisheries for markets such as traditional medicines, aquarium species, and luxury foods (Wood 1985; Lau and Parry-Jones 1999; Sadovy and Vincent 2002; Pajaro et al. 2004). The high value placed on some of these species, and the fact that value may increase with rarity, provides increased incentives for over-exploitation (Sadovy and

Vincent 2002). These fisheries may also generate high economic value for low volume and contribute much needed income for local communities in developing nations (Pajaro et al. 1997; Sadovy and Vincent 2002).

Official statistics and trade surveys have highlighted an increased pressure on global seahorse populations. The global trade in seahorses increased from the 1980s, in part due to increased demand created by economic growth in Asia, and in part due to increased supply of seahorses from bycatch in the world's growing trawl fisheries (Vincent 1996). Surveys of fishers have suggested that seahorse populations have declined during this time in at least some areas of the world (Vincent 1996). In addition, these fishes are threatened by degradation of their sensitive coral, seagrass and mangrove habitats (Hodgson 1999). In May 2004, in recognition of threats to their conservation status, seahorses were added to Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Signatories to the convention are now compelled to monitor international trade and source countries will need to ensure that exports are non-detrimental to the long-term persistence of wild populations.

Vietnam is reportedly a supplier of dried seahorses, although little is known about the nature and size of the trade, or the status of its seahorse populations. Unregulated (by)catch and export of seahorses was previously reported for Vietnam, though such data rarely showed up in official Customs records of the main dried seahorses importing nations (Vincent 1996). Past surveys suggested most of the trade went unrecorded across the northern border into China (Vincent 1996). A large, and often unregulated, trade of other wildlife across the Vietnam border into China, particularly to the province of Guangxi, has been documented (Li Wenjun et al. 1996; Li Yiming and Li Dianmo 1998).

There are seven species of seahorses known from Vietnam's waters, based on the recently revised morphological and genetic taxonomy of Vietnamese seahorses (Lourie et al. 1999a), which may still not be definitive. As a genus, seahorses live among seagrasses (*Thalassia* spp.) and corals and in estuaries along the coast of Vietnam (Dao Xuan Loc and Hoang Phi 1991). All seahorse species were marketable but here the focus is on the three species that were most widely encountered in trade; *Hippocampus spinosissimus*, *H. trimaculatus* and *H. kuda*. The species now identified as *H. spinosissimus* was previously and incorrectly called *H. histrix* in most publications (e.g. Truong Si Ky and Ton Nu My Nga 1995; Do Huu Hoang et al. 1998). The Red Data Book lists four seahorse species as Vulnerable in Vietnam [*Hippocampus histrix* (may be *H. spinosissimus*), *H. kelloggi*, *H. kuda* and *H. trimaculatus*] (Ministry of Science, Technology, and Environment 1992).

We here report on the structure, potential magnitude and significance of the Vietnamese catch and trade of seahorses, in order to guide directions for management, particularly in light of the new CITES requirements.

Methods

Information on the Vietnam seahorse fishery was collected from three sources; (1) biological measurements of a sample of seahorses landed at Cua Be estuary (Khanh Hoa province), (2) informal fishery and trade surveys and (3) catch monitoring. Results from these sources were combined to give an overall picture of the Vietnam seahorse fishery from landings through domestic trade to exports.

Biological measurements

A sample of seahorses, landed as bycatch at Cua Be (located within the larger city of Nha Trang, Khanh Hoa province), were measured (wet) to obtain biological information (Figure 1). The data for *H. spinosissimus* and *H. trimaculatus* were derived from the period June 1995 to May 1996 and thus represented an annual sampling. So few *H. kuda* were landed as bycatch that we extended our measurements from June 1995 to March 1998. Seahorse

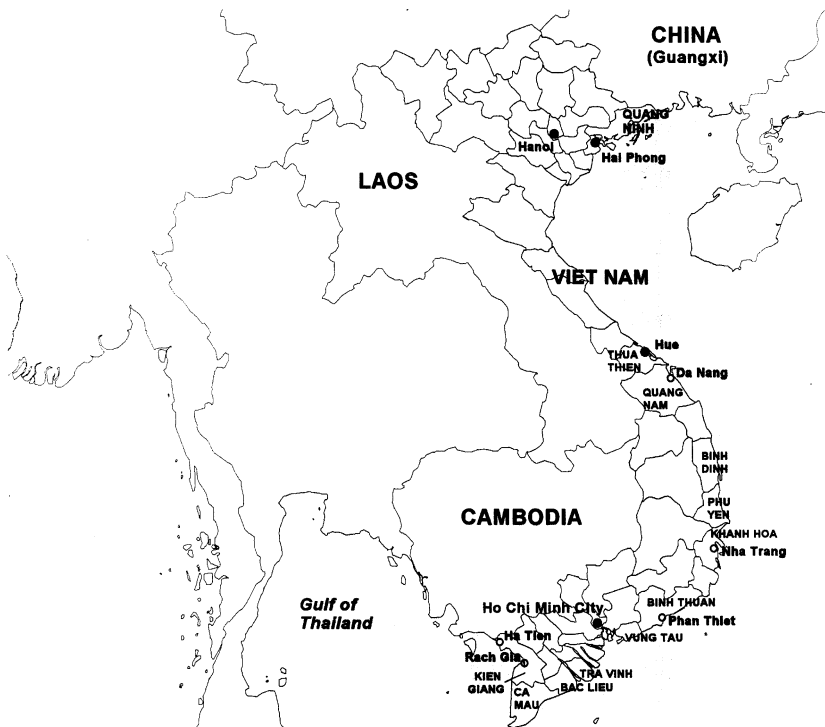


Figure 1. Map of Vietnam showing study locations and sites mentioned in text.

standard length (SL), the total length from the snout tip to where the opercular ridge and mid-line meet to the tail tip, was measured with calipers (Lourie et al. 1999b). Weight (Wt) was measured for freshly caught seahorses.

Fishery and trade surveys

Between 1995 and 1999, two Vietnamese biologists conducted semi-structured, informal interviews with 206 fishers and 95 buyers in a total of 10 provinces (Figure 1), asking about the seahorse species caught, catch locations, trade routes, volumes caught (traded), prices and temporal trends in supply. Additional information was obtained from interviews with fisheries scientists and casual surveys of traditional medicine and marine products shops. Data were supplemented with reports from trade interviews and Customs data from other countries.

Surveys were used to produce (a) a qualitative description of the seahorse fishery and trade, (b) quantitative estimates of trade volumes and prices and (c) a description of the perceived temporal trend in seahorse landings. The informal nature of the surveys made it difficult to collect quantitative data rigorously, as not all respondents were asked, or chose to respond, to all questions. Where quantitative data are presented, sample sizes indicating the number of respondents are provided. No attempt was made to address possible sources of error or bias in survey responses, such that data provide only a preliminary description of the Vietnam seahorse trade.

Catch monitoring

The diffuse and unregulated nature of the Vietnam fishery complicated our survey with many small, unregistered vessels operating out of many ports along the coastline of Vietnam. For this study we focused on the bottom trawl 'fishery', consisting of a widespread fleet of differing vessel and net size, but with reportedly common fishing areas, depths, times and target species. At the time of survey, most vessels encountered were engaged in bottom trawling (Do Huu Hoang pers. obs.).

From initial trade and fishery interviews, four main ports for seahorse landings (in four provinces) were identified for direct bycatch monitoring; Phan Thiet (Binh Thuan), Rach Gia (Kien Giang), Ganh Hao (Bac Lieu) and Song Doc (Ca Mau) (Figure 1). Ports were surveyed from 2 to 4 occasions (see Table 1 for exact years for each port) between 1995 and 1999. On each visit, the researchers visited as many trawlers as possible, while vessels were unloading their catch after returning to port. Researchers recorded the number of seahorses taken as bycatch and retained by fishers.

Recorded landings and reported trip durations were used to calculate catch per unit effort (CPUE) (seahorses day⁻¹ boat⁻¹). Mean catch per unit effort

Table 1. Catch per unit effort (CPUE) \pm standard error (seahorses day⁻¹ boat⁻¹), number of boats monitored (n) and reported total provincial fleet size for four provinces in southern Vietnam.

Year	Binh Thuan			Ca Mau			Bac Lieu			Kien Giang		
	CPUE	n	Fleet	CPUE	n	Fleet	CPUE	n	Fleet	CPUE	n	Fleet
1995	0.35 \pm 0.10	94	5370							2.13 \pm 0.15	17	2799
1996	1.08 \pm 0.28	51	5370	0.80 \pm 0.19	15	314	2.50 \pm 0.13	16	355	1.90 \pm 0.10	19	3037
1997				0.33 \pm 0.12	18	400	1.43 \pm 0.33	15	450	2.11 \pm 0.37	19	2962
1998							0.25 \pm 0.15	15	500			3018
1999							1.34 \pm 0.11	12	200	1.76 \pm 0.46	17	

(\bar{C}) for the monitored port was assumed to be representative of the entire province and was extrapolated to estimate total annual bycatch using reported provincial fleet sizes (F) (Vietnam Fishery Service data) and a measure of annual vessel effort (E), taken from Project Seahorse surveys, of 20 days per month \times 10 months per year = 200 days per year. A constant effort was assumed for all provinces and years. Total seahorse bycatch (B) for each province (i) and year (t) was calculated as

$$B_{it} = \bar{C}_{it} \cdot F_{it} \cdot E \quad (1)$$

This calculation resulted in the number of seahorses, which was then converted to kilograms using a value of 350 dried seahorses per kg, an average value obtained in global trade surveys (unpubl. data). Small variations in CPUE may be magnified by the large extrapolation, resulting in highly variable estimates of total catch. So for each extrapolation, a range was calculated using the 95% confidence limits for the observed \bar{C}_{it} , in order to provide an indication of the potential effect of variation in \bar{C} on the total bycatch estimates.

Estimates of catch volumes must be interpreted cautiously due to the large extrapolations involved and the unknown sources of variation. Provincial estimates were based on a fleet size taken from government records and a constant fishing effort from surveys, both of unknown accuracy and variation. Government records were more likely to underestimate fleet sizes as the number of registered vessels at any port was generally less than the actual number operating (Do Huu Hoang pers. obs). Variation in CPUE rates among ports within a province was not quantified and we cannot be certain our monitored ports were representative of the entire province. Confidence limits provided reflect only variation in observed daily catch rates at monitored ports. Catch estimates are meant to assess the potential magnitude of the trade rather than be estimates of the actual annual landings. Due to the high level of uncertainty, we have not attempted to infer temporal trends in catch estimates and individual years are used as replicates to calculate average annual catch for each province.

Results

Description of seahorse fishery from surveys and biological monitoring

Three main species were identified by the authors in the bycatch of Vietnamese trawlers at Cua Be; *Hippocampus spinosissimus* ($n = 552$, $SL \pm sd = 128.3 \pm 26.7$ mm, $Wt \pm sd = 6.8 \pm 4.2$ g), *H. trimaculatus* ($n = 606$, $SL \pm sd = 133.3 \pm 19.8$ mm, $Wt \pm sd = 6.5 \pm 4.1$ g) and *H. kuda* ($n = 65$, $SL \pm sd = 131.0 \pm 25.6$ mm, $Wt \pm sd = 6.5 \pm 4.0$ g). Pregnant males of all three species were caught during all months, indicating year round breeding for the species, although any given individual may have bred for only part of each year.

The vast majority of landed seahorses was reportedly obtained as bycatch by trawlers targeting shrimp and demersal fish in inshore waters (less than 30–50 m deep) at night, according to interviews with fishers. Peak catch was reportedly between January and September. Trawl fishers in most ports in southern and central Vietnam, operating in the South China Sea or Gulf of Thailand, identified *H. trimaculatus* as the most commonly caught seahorse, followed by *H. spinosissimus*. Biological monitoring at Cua Be estuary, however, encountered relatively equal numbers of the two species (*H. trimaculatus* = 606; *H. spinosissimus* = 552). Only fishers based in Ha Tien (Kien Giang province) reported catching large numbers of *H. kuda*, mainly near the border with Cambodia. Few seahorses were reported in bycatch of trawlers operating in the Gulf of Tonkin in northern Vietnam. A small number of seahorses, mostly *H. kuda*, were hand-caught by swimmers or divers, often adolescents out to collect anything of value in estuaries, such as near Cua Be.

Catch monitoring rates and volumes

Despite low individual CPUE rates, the total fishery may have landed tonnes of seahorses annually in southern and central Vietnam. Individual trawlers caught on average <1 to slightly more than 2 seahorses per day (Table 1). Catch rates were highest for trawlers in the most southern provinces of Bac Lieu and Kien Giang, though still only at 1–2 seahorses per day (Table 1). However, given the large fleets reportedly operating, particularly for Kien Giang and Binh Thuan, there was potential to land large volumes of seahorses annually (Table 2). Overall provincial averages (and 95% CI), calculated from annual estimates of bycatch, were summed to produce an estimate of average total catch. Monitoring in four provinces suggested a combined average annual bycatch of 5900 kg (3227–8559 kg) (Table 2). In addition, earlier catch monitoring recorded annual bycatch of 500–600 kg in Khanh Hoa province (Vincent 1996), resulting in the estimated total bycatch of 6.5 t, or 2,275,000 individuals per year for five provinces.

Table 2. Mean annual seahorse bycatch and 95% confidence intervals (kg dried weight) for four provinces in southern Vietnam, and the provincial average and 95% confidence intervals calculated for all years monitored.

Year	Binh Thuan		Ca Mau		Bac Lieu		Kien Giang	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
1995	1074	483–1665					3407	2930–3884
1996	3314	1647–4981	144	76–211	507	455–559	3297	2947–3648
1997			75	21–130	368	204–532	3575	2362–4787
1998					71	0–154		
1999					153	138–178	3035	1478–4593
Provincial	2194	0–4389	110	41–179	275	79–441	3329	3107–3550

Data were extrapolated from CPUE rates observed in catch monitoring to the total provincial fleet.

Unknown volumes of seahorses were caught incidentally in other southern and central provinces. Direct catch monitoring was conducted in only 5 of 23 coastal provinces. Fishers, however, reported bycatch and trade of seahorses in Quang Nam ($n = 8$), Phu Yen ($n = 12$), Thua Thien ($n = 11$), and Vung Tau provinces ($n = 2$), albeit in lower numbers (CPUE = 0.13–0.88 seahorses day⁻¹ boat⁻¹). Buyers in Da Nang (Quang Nam province) also cited the province of Binh Dinh as a source of seahorses. Fishers ($n = 2$) in the southern province of Tra Vinh gave questionably high bycatch rates (50 seahorses day⁻¹ boat¹), but reported no trade in seahorses.

Trade routes from surveys

Dried seahorses caught in southern and central Vietnam were sent to three major markets within Vietnam; Ho Chi Minh City (HCMC), Hai Phong City and Da Nang, primarily for export to China (Table 3). The trade was generally concentrated through a small number of upper level buyers, who purchased from lower level local buyers or directly from fishers, and in turn supplied exporters. The main buyers in Khanh Hoa and Binh Thuan sent seahorses to all three markets, as well as possibly exporting directly to China. Most seahorses caught in Kien Giang and neighbouring Bac Lieu and Ca Mau, apparently went through one of three upper level buyers in Kien Giang, before being sent to Ho Chi Minh City. Buyers in Kien Giang, however, cited increased instances of agents from Ho Chi Minh coming to buy directly from fishers. Some seahorses from Bac Lieu and Ca Mau were also sent to buyers in Vung Tau province or directly to exporters in Ho Chi Minh or Hai Phong. Buyers in Vung Tau and reportedly those in Binh Dinh sent seahorses to Da Nang.

Few exporters ($n = 6$) were located during surveys, but those interviewed listed mainland China as the main destination for their dried seahorses. Buyers in Bac Lieu also stated they sold to Taiwanese operating out of Da

Table 3. Dried Seahorse trade routes, trade volumes and number of respondents (*n*) from surveys of (a) upper level buyers in main source provinces surveyed and (b) exporters located.

Source	Destinations					Annual Volume (kg)	<i>n</i>
	China	HCMC	Haiphong	Da Nang	Vung Tau		
(a) Buyers							
Binh Thuan		x		x		240-1000	5
Khanh Hoa	x	x	x	x		458	4
Kien Giang						1500-3000	3
Vung Tau				x		150-200	4
Bac Lieu ^a		x	x		x	200-400	3
Ca Mau ^a		x	x		x	50-100	1
Binh Dinh				x		?	?
Total						2348-4658	
(b) Exporters							
Ho Chi Minh City	x					400-550	2
Haiphong	x					240-300	3
Da Nang	x		x			900	1
Total						1540 - 1750	

Volumes were taken from most recent survey available between 1995 and 1999.

^aExcluded from calculation of total volume traded, as they sent unknown volumes of dried seahorses to Kien Giang and Vung Tau.

Nang, and Taiwan Customs listed limited imports from Vietnam; 121 ± 111 kg per year between 1990 and 2002 (Republic of China (Taiwan) Statistics). Reciprocally, survey participants in China ($n = 12$) cited Vietnam as the major source for dried seahorses in interviews conducted in 1999 and 2000 (Project Seahorse, unpubl. data). Importers in Hong Kong and Taiwan also cited Vietnam as a source of dried seahorses in trade surveys conducted in those areas (Vincent 1996), though Vietnam was not listed in official Customs data for Hong Kong. Most seahorses sent to China were reportedly traded across the border at Mong Cai into Guangxi province or transferred to Chinese fishing vessels at sea. The trade reportedly began in 1988 but only became legal following the normalization of relations between China and Vietnam in 1991. Most trade remained 'unofficial' in that it was conducted among individual enterprises rather than through Government companies.

Domestic consumption from surveys

Small numbers of seahorses were consumed in Vietnam as traditional medicines, to cure general health problems and impotence and as an aphrodisiac. Seahorses and their derived products were sold through Traditional Chinese Medicine (TCM) outlets in Hanoi, Ho Chi Minh City and Quang Ninh City, and in the dry marine product market in Ninh Trang. Seahorses were also sold domestically as tonics, reportedly in order to assist the kidneys and invigorate general health (which often means the same thing in TCM), increase sexual potency and cure rheumatism and lumbago. Seahorses for tonic purposes were either sold fermented in alcohol in commercially prepared, ready-made tonics, or live for incorporation into alcohol-based tonics at home. The shops surveyed reported small annual sales, combined for a total annual domestic consumption of only 103–121 kg (Table 4). While more markets and shops may sell seahorses in Vietnam, surveys indicated that most seahorses landed were exported rather than consumed domestically.

Table 4. Domestic sales of dried seahorses based on surveys of retailers located in four major markets, showing estimated number of shops selling dried seahorses reported average sales per shop and calculated total annual sales for the city.

City	Shops (n)	Sales per shop (kg per annum)	Total Annual Sales (kg)
Ho Chi Minh City	25–30	0.5–1	12.5–30
Hanoi	11	0.4–0.5	4.4–5.5
Quang Ninh City	8	2	16
Nha Trang	28	2.5	70
Total			103–121

Export volumes from surveys

The vast majority of seahorses traded were reportedly exported. Total trade volume within Vietnam can therefore serve as an estimate of annual exports. While trade initially went through a large number of lower buyers, it was generally concentrated through a few upper level buyers in each province. Therefore, the total annual volume of the dried seahorse trade was estimated from the reported volumes of the upper level buyers identified in the source provinces who sent seahorses to exporters. Upper level buyers located in Kien Giang, Vung Tau, Khanh Hoa and Binh Thuan reported no trade amongst themselves so their volumes can be considered independent and may be summed (Table 3). Trade from Bac Lieu and Ca Mau was excluded from the total to avoid duplication, as an unknown portion may have gone to the buyers in Kien Giang and Vung Tau, though some went directly to exporters. For each province, we used the buyers' volumes from the most recent year. Annual values were not compared as the number of buyers surveyed varied among years, either because of changes in trade participation or in sampling effectiveness.

Upper level buyers ($n = 20$) sent an estimated 2348–4658 kg of dried seahorses each year to the main exporting centres (Table 3). Buyers in Kien Giang and Binh Thuan reported the largest volumes (Table 3), consistent with the provinces' respective estimated bycatch volumes (Table 2). The total volume traded by interviewed buyers was of a similar magnitude as the estimated total annual bycatch in the five provinces monitored (3700–9100 kg).

Annual export volumes (1540–1750 kg) calculated from exporters' information ($n = 6$) were considerably lower than volumes calculated from buyers' information (Table 3), probably because we didn't locate all exporters.

Economic values from surveys

Seahorses from Vietnam were considered high quality by TCM practitioners in other Asian countries because of their smoothness (Vincent 1996). Prices paid to fishers depended on size and type but were generally low and apparently declined during the study period (Table 5), for unknown reasons. Overall, trawl fishers were not particularly interested in seahorses, as the small catches contributed less than 5% of the trawlers' annual income, according to surveys, though divers targeting seahorses reported earning up to 35% of their annual income from seahorses.

On average, primary buyer maximum sell prices were 27% higher (range 0–100%) than the maximum prices (per kg) paid to fishers for the same area and year (Table 5). The reported prices paid to buyers at Ganh Hao Port in 1998 and 1999 were suspect as they were below the reported price paid to fishers. The decline in fisher sell price was mirrored in buyer sell price. The decline was most apparent in Rach Gia Port (Kien Giang) and Ganh Hao (Bac Lieu), the sites with the longest monitoring periods (Table 5). Upper level buyers who

Table 5. Sell and purchase prices (VND1000) for dried seahorses reported by fishers, primary buyers and upper level buyers in surveys conducted around Vietnam (1995–1999).

Province	Location	Year	Fishers		Primary buyers		Major buyers		Size Class (cm)	
			Sell price (per SH)	Purchase Price (per SH)	Sell price (per kg)	Purchase Price (per SH)	Sell price (per kg)	Sell price by size Class (per kg)		
Kien Giang	Ha Tien	1996						1400; 1600	8–15; > 15	
		1997					500–1200	500–800; 1100–1500	small; large	
		1998		0.5–1.5		0.5–1.5	500–1300	500–800; 1100–1500	small; large	
	Rach Gia	1999	0.5–2	0.5–1.5	175–700	0.5–1.5	500–1400	1100–1200; 1400	6–10; 10–12	
		1995	4–7		1200–1300		1400–1450	1470		
		1996	3–7		1200–1400		1450–1600	1550		
		1997	2–3		700–1100		1000–1200	1200–1400		
		1999			625–1000	1–2	1000–1300	1300–1500		
		1996			1000–1200	2–3	1500–1700			
Bac Lieu	Ganh Hao	1995						300–700		
		1996	1.5–3		700–800	0.5	1100–1200	1300		
		1997	0.5–1.5		175–525	0.5–1	350–700	300–500; 670–750; 900–1200	5–6; 6–11; 12–15	
	Song Doc	1998	0.5–1.5		175–525		175–700	900–1300		
		1999	0.5–2		175–700	1–2	175–700	900–1300, 1400	unknown; 9–11	
		1996	2–5		1000–1200		1200–1300	900–1250		
		1997	0.5–1.0		175–350	0.5–1.5				
		Khanh Hoa	1996						1650–1800	
			HCMC	1996	5–7		1750		800–1200	
1996	2–3				700–950		1400			
Binh Thuan	Phan Thiet	1995	3–10		1200–1500		1450–1550			
		1996	2–8		100–1300		1350–1500			
	1997	2–3		400–950						

Table 5. Continued.

Province	Location	Year	Fishers		Primary buyers		Major buyers		
			Sell price (per SH)	Purchase Price (per SH)	Sell price (per kg)	Purchase Price (per SH)	Sell price (per kg)	Sell price by size Class (per kg)	Size Class (cm)
Quang Nam	Da Nang	1995						1600; 2500; 3200	< 15; 15-20; > 20
Hanoi		1995						2200-2300	
Range		All Years	0.5-1		100-500			175-1500	
		1995-96	1.5-10		100-1500			800-1700	
		1997-99	0.5-3		175-1100			175-1600	

For upper level buyers, sale prices were sometimes given by size class.

Table 6. Seahorse products for sale in Vietnam located during trade surveys, with description and retail prices with year located.

Product	Description (no. seahorses)	VND1000	US\$	Year
<i>Bô Than Tinh</i>	<i>H. sp.</i> (2); small	80	7.30	1995
<i>Ruou hai ma</i>	<i>H. trimaculatus</i> (1)& ginseng	28	2.50	1996
Seahorse tonics	<i>H. sp.</i> (4); 90–115 mm	22.5	1.73	1998
	<i>H. sp.</i> (2); 135–170 mm	35	2.69	1998
	<i>H. sp.</i> (2); >170 mm	85	6.75	1998
Live seahorses	<i>H. kuda</i> (2); 150 mm	40	3.57	1996
	<i>H. kuda</i> (2)	40–50	3.08–3.85	1998
Dead seahorses	<i>H. kuda</i> (2)	20–25	1.79–2.23	1996
	<i>H. kuda</i> (2)	25–35	1.92–2.69	1998

Exchange rates for one US\$ were VND11,000 in 1996 and VND13,000 in 1998.

sold to exporters in main centres reported receiving similar prices to the primary buyers, though with a wide range in price based on size (Table 5).

Although seahorses were of low value to fishers, they collectively provided sufficient income to make purchase by higher-level buyers worthwhile. Using the average annual catch of seahorses (6500 kg) and the range of reported value per kg paid to upper level buyers (VND300–1500 kg⁻¹), the total value of the seahorse trade may have been as much as VND2–10 billion (US\$170,000–962,000) per year. The range of reported values excludes the largest, rarely encountered, size class > 15 cm, for which upper level buyers were reportedly paid VND300,000–1,600,000 kg⁻¹ (US\$26–148 kg⁻¹).

At the domestic retail level, individual seahorses sold in elixirs or live for tonics fetched considerably higher values than paid to fishers. Retail prices for seahorse products ranged between VND 20,000 and 85,000 (Table 6). Species identified were *H. trimaculatus* and *H. kuda*, suggesting local sources, though identification was not possible for some products.

Temporal trends in catch from surveys

Fishers were asked to describe and quantify temporal changes in the number of seahorses landed. The majority of fishers who responded ($n = 122$ of 143) reported that seahorse catches had declined over the last 2–5 years. A small number reported stable catches ($n = 14$), while only fishers in Ganh Hao (Bac Lieu) reported an increase in catch ($n = 7$). Most of those reporting a decline ($n = 89$ of 122) estimated a 30–60% decrease in seahorse catch in 2–5 years. Buyers also reported decreases in seahorse availability ($n = 21$ of 27) in most regions, with the exception being Ganh Hao (Bac Lieu) where buyers reported increased ($n = 2$) or stable supplies ($n = 1$). During surveys in 1996, we encountered buyers in Da Nang who had ceased trading seahorses when supplies were unable to meet demand from Taiwan. The majority of fishers ($n = 89$ of 102) and buyers ($n = 16$ of 19) reported no change in the size of seahorses caught.

Discussion

Low seahorse bycatch rates in southern and central Vietnam, magnified by large fishing effort, supported a commercial export of dried seahorses. This trade went unrecorded and unregulated through unofficial channels into China. Although no fisheries-independent data existed, fishers and buyers reported a decline in seahorse catch rates during the 1990s. The apparently large seahorse trade stresses the need for monitoring and evaluation of sample seahorse populations, fisheries and trades in order to meet CITES responsibilities for sustainable exports.

Individual bycatch rates for seahorses were low, with catch restricted primarily to the southern and central portions of Vietnam. On a daily basis only a few seahorses, predominately *H. spinosissimus* and *H. trimaculatus*, were taken in near shore trawl fisheries, with low numbers potentially reflecting the low density and patchy distribution observed for many seahorse species (Foster and Vincent 2004). Seahorse landings showed geographic variation, on a broad scale, with most landed in the southern and central provinces and reportedly few from the northern provinces. Whether this reflects a variation in seahorse abundance/distribution or a variation in fishing method is unknown.

Despite small individual catches, our estimates suggest that total landings and exports of dried seahorses may have measured tonnes annually (even without comprehensive surveys), albeit based on a large extrapolation to a total fishing effort value of unknown accuracy. The relative agreement in magnitude between estimates from catch monitoring and trade surveys provided some level of cross-validation. Moreover, our estimate was consistent with records of trade from neighbouring countries. Customs data from Taiwan and Hong Kong, for instance, document tonnes of dried seahorses originating from Thailand, the vast majority of which were taken as bycatch in trawlers (Vincent 1996). Vietnam's estimated seahorse bycatch would place it in the top five for global production of dried seahorses, with Thailand, Philippines, India, and Indonesia, according to trade surveys conducted (Project Seahorse, unpubl. data).

Exporting seahorses was a relatively new activity for Vietnam, probably arising from a coincidence between increased supply and opening of markets in the 1980s and 1990s. Total fishery production from Vietnam increased 250% from 1980 to 2001 (FAO statistics) as a result of fleet expansion and gear improvements mostly inshore (Ministry of Fisheries 1996). This increased trawling effort will have led to increased seahorse bycatch. Around the same time, normalization of relations between China and Vietnam in the late 1980s and early 1990s, opened an export market for dried seahorses and other marine products (Li Yiming and Li Dinamo 1998). Most exports from Vietnam reportedly went to China, although the absence of Vietnam as a source country in official Chinese Customs data supports the conviction that most trade was unofficial and unreported. Guangxi province, cited as the main entry point to

China, is known to engage in substantial unregulated trade in wildlife from Vietnam (Li Wenjun et al. 1996; Li Yiming and Li Dinamo 1998).

This study provides no direct measure of the population status of seahorses in Vietnam, and no independent population assessments have ever been conducted. There was, however, strong agreement among fishers and buyers surveyed in Vietnam, and indeed around the world (Vincent 1996), that seahorse catches have declined. Declining catch rates, however, are indicators, not proof, of population declines. Moreover, assigning the portion of the decline due to fishing is complicated by other threats, including habitat destruction and pollution. Over-exploitation, along with habitat loss, was frequently cited for similar declines reported by fishers in other parts of Asia (Vincent 1996).

This paper provides information needed for implementation of the CITES Appendix II listing for seahorses in Vietnam. A recent review of Vietnam's fishery policies found no measures for the implementation of multilateral environmental agreements such as CITES (Tuan 2003). Unregulated trades have been cited as a concern for other species of wildlife (Le Dien Duc and Broad 1995; Li Wenjun et al. 1996; Li Yiming and Li Dinamo 1998) with as many as 190 vertebrate species traded across the Vietnam–China border, including species listed on CITES (Appendix I and II and under China's Wildlife Protection Law (Li Yiming and Li Dinamo 1998). With the listing of seahorses on CITES Appendix II, both China and Vietnam (as signatories), have responsibilities to monitor the trade. Identifying marine product exporters and importers in the trade routes reported here will be an important step in regulating that trade. Additionally it may benefit other species of concern to CITES often traded along with seahorses; such as shark (fin) and sea cucumbers, for which CITES has been evaluating options.

From a conservation perspective, non-selective trawling, rather than trade *per se*, posed the greatest threat to seahorse populations in Vietnam. Regulation, or even cessation, of the trade would do little to reduce seahorse landings. The CITES listing covers only the international trade in seahorses and provides no mechanism to address domestic trade or bycatch issues. Overall, seahorses were recorded in bycatch in more than 20 countries world wide (Project Seahorse, unpubl. data), and most seahorses in trade probably came from bycatch (Vincent 1996). Concerns have been raised about other rare bycatch species (Milton 2001; Stobutzki et al. 2001a, b), and the Code of Conduct for Responsible Fisheries (FAO 1995) requires consideration of the sustainability of all bycatch species. Devices designed for the prevention of bycatch, where employed, have shown mixed results, generally being more successful for large bodied or highly mobile species (Broadhurst 2000). It may, in any case, be difficult to engender much change in Vietnamese trawling for the sake of seahorses alone, given how few are caught and how little they are worth.

Significant numbers of seahorses were caught and traded in Vietnam, primarily from bycatch, without any monitoring or consideration of the effects on wild populations. While this exploitation creates a direct pressure on seahorse

populations, it is also emblematic of problems facing many other species taken in unregulated fisheries (e.g. for traditional medicines, aquarium) or as by-catch. In this, seahorses may serve as a case-study for the effects of bycatch on small, less-studied species; their distinctive shape makes it possible to track incidental landings, their relatively sedentary behaviour facilitates population census, and their CITES status mandates formal attention to their status.

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