Investigating seahorse populations and building capacity for seahorse monitoring in Vietnam, Feb-Apr 2014

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Tóm tắt

- Theo số liệu của Công ước về thương mại quốc tế các loài động, thực vật hoang dã nguy cấp (CITES), Việt Nam là một trong mười nước xuất khẩu cá ngựa hàng đầu trên thế giới.
- Để giúp quản lý thương mại cá ngựa và đánh giá quần thể cá ngựa ngoài tự nhiên, chúng tôi tiến hành khảo sát dưới nước và các cuộc phỏng vấn không chính thức ngoài khơi bờ biển Miền Trung và miền Nam của Việt Nam
- Trong chuyến khảo sát cá ngựa ít được bắt gặp, chúng chỉ được tìm thấy tại hai địa điểm: Hòn Ông (Whale Island) và đảo Phú Quốc, ở Phú Quốc cá ngựa phong phú hơn cả.
- Các loài phổ biến nhất từ các cuộc điều tra và sản lượng đánh bắt là loài *Hippocampus spinosissimus*.
- Các loài *Hippocampus spinosissimus*, *H. trimaculatus*, *H. Kuda* và *H. mohnikei* đều được tìm thấy trong môi trường sống đáy mềm, như bùn, cát và cỏ biển. Riêng hai loài *Hippocampus kelloggi* và *H. histrix* đã được tìm thấy trong vùng nước sâu hơn, và thường bị bắt bởi tàu giả cào đang hoạt động ngoài khơi xa.
- Cá ngựa thường được đánh bắt bằng lưới giả cào, và nhiều ngư dân ước tính rằng quần thể cá ngựa đã giảm trong mười năm qua.
- Xây dựng năng lực giám sát cá ngựa ở Việt Nam, chúng tôi tiến hành bảy cuộc hội thảo Xu hướng iSeahorse và đào tạo 103 người tham gia. Tham dự hội thảo bao gồm nhân viên từ khu bảo tồn biển (KBTB), vườn quốc gia, các viện nghiên cứu và các câu lạc bộ lặn, và ngư dân địa phương.

Abstract

- According to CITES data, Vietnam is one of the top ten exporters of seahorses globally.
- To help manage seahorse trade and assess wild populations, we conducted underwater surveys and informal interviews off the central and south coasts of Vietnam.
- Seahorses were scarce in the survey, and only found at two locations, Whale Island (Hon Ong) and Phu Quoc Island, with seahorses more abundant at Phu Quoc.
- The most common species from surveys and in catches was *Hippocampus spinosissimus*.

- *Hippocampus spinosissimus*, *H. trimaculatus*, *H. kuda* and *H. mohnikei* were all found in soft-bottom habitats, such as silt, sand and seagrass. *Hippocampus kelloggi* and *H. histrix* were found in deeper waters, and usually caught by trawlers operating far offshore.
- Seahorses were commonly caught in bottom trawls, and many fishers estimated that seahorse populations have declined over the past ten years.
- To build capacity for seahorse monitoring in Vietnam, we conducted seven iSeahorse Trends workshops and trained 103 participants. Workshop participants comprised staff from Marine Protected Areas (MPAs), National Parks, research institutes and dive organizations, and local fishers.

Introduction

Seahorses (*Hippocampus* spp.) are featured heavily in global wildlife trade both as dried (traditional medicines or curios) and live (aquaria) specimens (Vincent et al. 2011). This trade provides valuable cash flow to low-income communities, especially subsistence fishers in developing countries (Vincent 1996, Vincent et al. 2007). The seahorse trade for traditional medicine is particularly significant in Southeast Asia (Choo and Liew 2005, Giles et al. 2006, Perry et al. 2010, Vincent et al. 2011), with tens of millions of dried seahorse exported annually (Vincent et al. 2011). The main source of dried seahorses is trawl bycatch (Baum and Vincent 2005, Giles et al. 2006, Perry et al. 2010), while live animals are specifically targeted for capture (Rosa et al. 2006, Perry et al. 2010).

Since seahorses are slow-moving, have limited home-ranges, exhibit mate-fidelity and have low fecundity relative to other fish species, they are prone to overfishing (Foster and Vincent 2004), and the current harvest rates of seahorses are of great concern (Vincent et al. 2011). In addition, seahorses are sensitive to habitat degradation caused by trawling on soft-bottom environments, dynamiting of coral reefs, and other destructive capture methods (Duarte 2002, Marcus et al. 2007), further impeding population recovery. However, the geographic range, population size and habitat preferences for many species are still unknown, making it difficult to assess population impacts and manage trade. At present, there are 14 recognized seahorse species in Southeast Asia (Lourie et al. 2004), and six of these are listed as "Data Deficient" on the IUCN Red List.

All seahorses are listed on CITES Appendix II, requiring the 180 signatory nations (Parties) to cooperate on seahorse conservation. CITES data indicate that Vietnam is the sixth largest exporter of dried and live seahorses in the world, exporting up to 105,000 individuals per year (Project Seahorse, unpublished). A lack of basic information on distribution, habitat and abundance means that the sustainability of this exploitation cannot be assessed.

The aim of this project was to support Vietnam by documenting seahorse distribution, variation in spatial abundance and habitat preferences, and to enable areas of high seahorse density, or hotspots, to be identified as the basis for considering spatial management opportunities. Mapping these hotspots onto the distribution of Vietnam's MPAs and other spatial management will allow us to understand what protection such measures provide for seahorses, and what additional area restrictions are needed in support of seahorse management and conservation. The results from this mapping exercise will also inform priority areas for further monitoring and conservation action.

Initial efforts to survey seahorses were conducted in Thailand in 2013 using random belt transects. Only eight seahorses were sighted at 14 sites in spite of a huge survey effort; we surveyed a minimum total area of 1000 m^2 and a maximum total area of 2000 m^2 per site (Project Seahorse and Department of Fisheries Thailand, 2013). It became apparent that surveys restricted to areas defined by transects were not conducive to finding seahorses, which are typically found in low densities or rare, have patchy distributions, and are highly camouflaged. We instead needed a survey method that is flexible enough to increase the chances of spotting seahorses underwater, yet rigorous enough for spatial and temporal comparisons. As such, a novel methodology was developed for the citizen science program iSeahorse, as part of a comprehensive monitoring toolkit for wild populations of seahorses, iSeahorse Trends. This method was much more successful at detecting seahorses in subsequent surveys in Thailand, and was employed for this series of surveys in Vietnam.

With this new survey methodology, our focus turned once again to finding seahorse hotspots. The results from this mapping exercise can be applied to assess the sustainability of seahorse trade from Vietnam, and will feed into an adaptive management framework for seahorses. The objectives of our field season, carried out from February to April 2014 and primarily focused in central and south coasts of Vietnam, were to:

- Identify and ground-truth seahorse hotspots in Vietnam
- Characterize seahorse populations at hotspots
- Fill in seahorse distribution gaps through informal interviews with fishers and other local stakeholders

In addition to underwater surveys, we sought to expand the iSeahorse Trends program in Vietnam, building capacity by training local stakeholders to identify seahorse species and habitats and providing the tools to establish seahorse monitoring programs. To this end, we conducted a series of iSeahorse workshops in cooperation with local MPA offices, National Park office, dive centers and research institutes.

Seahorse species distributions and hotspot identification

Finding seahorse hotspots

Prior to heading to the field we made a concerted effort to extract seahorse sightings from all available sources of information including but not limited to internet resources, popular media, survey reports and published articles. An appeal to report seahorse sightings and localities around Vietnam was also made through mass emails, list-servs, social media (Facebook and Twitter) and direct contact with scuba divers and local dive shops. In-country, we questioned researchers from RIMF and the Institute of Oceanography (IO, Nha Trang) about existing data that indicate seahorse distribution and relative abundance.

Field Surveys - hotspot identification and ground-truthing

Seahorse surveys were based on methods developed for the iSeahorse Trends toolkit for underwater surveys (http://iseahorse.org/?q=uwtrends). Survey sites were selected based on

information gathered through email and social media outreach, and from anecdotal information obtained on site visits. Instead of searching a fixed transect area, a random swim, or survey "run", was conducted for each scuba dive or snorkeling session. Surveyors searched for seahorses during a run and recorded distance traveled and total active search time. When seahorses were encountered, characteristics such as sex, reproductive state, torso length and habitat type were recorded. One to two runs were conducted at each survey site, and seawater was analyzed *in situ* for the following parameters: salinity, kH, pH, nitrite, nitrate, phosphate and Secchi depth. Salinity was measured with a hydrometer and nutrients were measured using aquarium test kits. Reef Check benthic surveys were conducted on coral reefs and seagrass areas where applicable. For soft-bottom habitats that were predominantly composed of silt or sand, benthic cover was visually estimated.

From February to April 2014, a total of 23 sites was surveyed at the following locations- Cu Lao Cham, Whale Island (Hon Ong), Nha Trang, Phu Quoc, Nui Chua and Con Dao (Figure 1). Two researchers from IO, Dr. Do Huu Hoang and Mr. Lam, assisted with fieldwork at Whale Island and in Nha Trang MPA. At Phu Quoc, our survey team was assisted by Mr. Nguyen Tri Thanh, a local dive guide. In addition, MPA and National Parks staff provided logistical support for fieldwork and workshops.

Fig. 1. Seahorse survey sites in Vietnam. Seahorses were spotted at sites with green labels, and not spotted at sites with red labels.

Informal interviews

A total of 24 fishers was interviewed at Phu Hai, Phan Thiet, Nha Trang, Ha Tien and Rach Gia. When applicable, we also requested examinations of fresh and dried seahorse collections to assess the species caught in the area, the average sizes of seahorses caught and the relative proportions of each species in the collection. Questions varied by person but usually included asking about catch or sighting per unit effort, fishing grounds, seasonal sightings of seahorses and estimations of changes to seahorse populations over the last decade. A list of the standard questions can be found in Appendix A.

Additionally, we spoke with 33 people, including boat captains and crew, fishers, dive professionals, seahorse buyers and sellers, staff from MPA and National Parks offices and researchers to try and determine where seahorse populations could be found.

Results

Finding seahorse hotspots

Because the diving industry in Vietnam is relatively new and undeveloped, we did not receive many responses from divers about where they have seen seahorses. From our informal interviews on the ground, seahorses are found most often on seagrass, while divers usually visit coral reefs. Seahorses used to be spotted frequently at Seahorse Bay off Nha Trang, but not recently (M. McTernan, pers. comm.). Divers also observed seahorses at Whale Island (D. Harasti, pers. comm.), Con Dao and Hoi An (S. Valladares, pers. comm.). Local researchers pointed us towards fish landing sites such as Phan Thiet and Vung Tau. RIMF conducted a three-month sponge survey throughout Vietnam from August-October 2013, and encountered seahorses on Co To Island, Phu Quy Island and Phu Quoc Island. Many researchers at RIMF also indicated that seahorses can be found off Ham Ninh and Bai Bon on Phu Quoc.

Field Surveys - hotspot identification and ground-truthing

From the surveys, seahorses were found at two of the six survey locations- Whale Island and Phu Quoc, and five of 22 survey sites (Figure 1). Seahorses were most abundant off the east coast of Phu Quoc Island. This area is frequented by small trawlers and compressor divers, many specifically targeting seahorses. We did not observe any seahorses within the National Parks of Nui Chua and Con Dao. The highest densities of seahorses were found at Ran No and outside Da Chong off Phu Quoc, with 4.50 seahorses/100m and 5.00 seahorses/100m of search distance respectively. Off Phu Quoc, seahorses were also observed at Bai No (1.25 seahorses/100m) and Da Chong 3 (1.54 seahorses/100m). One *H. kuda* was observed in the bay off Whale Island Resort (0.18 seahorses/100m), a no-take area managed by the resort. A dive instructor and resort guest spotted two additional seahorses in the same afternoon. Further details by site are found in Table 1.

Table 1. Summary of field surveys to identify and ground-truth potential seahorse hotspots. The average individual search time was multiplied by the number of surveyors for each run. All sites except for My Ho were surveyed using SCUBA. The survey at My Ho (highlighted in blue) was conducted by snorkeling.

No.	Location	Site	No. of runs	No. of seahorses/100m (total seahorses)	Species	Dist. traveled/m	Search time/min	Habitat type	Depth range/m
1	Cu Lao Cham	Bai Huong	1	0	-	50	60	Silt	6-9
2		Bai Bac	1	0	-	200	60	Silt	4-7.7
3	Nha Trang	Mamahan	1	0	-	330	56	Rubble	9-13
4		Moray Beach	1	0	-	338	111	Sand	8-10.5
5		Seahorse Bay	2	0	-	200, 200	60, 60	Sand	8-10
6	Whale Island	Beach 1	1	0.18 (1)	*H. kuda*	550	160	Sand	8-10.5
7		Wreck	1	0	-	560	132	Sand, silt	1-12
8		Beach 2	1	0	-	750	144	Sand, silt	2.5-15
9	Phu Quoc	Bai Boi	1	0	-	270	153	Seagrass, sand	1-4
10		MPA	1	0	-	300	111	Sand	8-9
11		Da Bac	1	0	-	310	183	Seagrass, sand	2-3
12		Cay Sao	1	0	-	250	156	Seagrass	1.5
13		Da Chong	1	0	-	-	90	Silt	3.3
14		Bai No	1	1.25 (2)	*H. kuda*	160	141	Seagrass	5-6
15		Da Chung 3	1	1.54 (2)	*H. kuda*, *H. spinosissimus*	130	96	Silt	10.5-11.5
16		Ran No	1	2.00 (3)	*H. spinosissimus*, *H. trimaculatus*	150	78	Silt	5
17		Outside Da Chong	1	5.00 (5)	*H. spinosissimus*	100	78	Silt	5
18	Nui Chua	My Ho	1	0	-	250	110	Seagrass	0.5
19		Rach Thai An	1	0	-	100	82	Coral reef, sand	2.5-13
20	Con Dao	Mui Lo Voi	1	0	-	220	110	Silt	7.5-8

21		Bai Dat Duc	1	0	-	250	108	Silt	8-8.2
22		Bai Canh	1	0	-	200	78	Coral reef	9

Thirteen individuals from three seahorse species were recorded in this survey series- *H. kuda*, *H. spinosissimus* and *H. trimaculatus*. *Hippocampus spinosissimus* was the most commonly observed (n=8) species in the surveys, with all individuals found off Phu Quoc. Four individuals of *H. kuda* were spotted off Whale Island and Phu Quoc, and one *H. trimaculatus* (male, torso length = 52 mm, height = 111 mm) was recorded at Phu Quoc. Most of the seahorses (n=8) were found on pencil urchins, and the rest employed sponges, seagrass and a fouled fishing line as holdfasts. All seahorses were associated with soft-bottom, sandy and seagrass habitats. The mean torso length and height of *H. spinosissimus* (n=8) were 31.93 ± 3.92 (SE) mm and 72.33 ± 9.32 mm, and 30.48 ± 5.93 mm and 65.00 ± 15.66 mm respectively for *H. kuda* (n=4). Four male *H. spinosissimus* and one male *H. kuda* were observed, with the sex of one small *H. kuda* (torso length = 13 mm, height = 30 mm) undetermined. None of the males encountered were pregnant.

The species *H. spinosissimus* was most commonly encountered in our underwater surveys, and also in the collections of fishers and sellers. Only one *H. trimaculatus* was seen during in-water surveys. *Hippocampus spinosissimus*, *H. trimaculatus*, *H. kuda* and *H. mohnikei* were all found in soft-bottom habitats, such as silt, sand and seagrass. Off the east coast of Phu Quoc, seahorses frequently use pencil urchins as holdfasts. *Hippocampus kelloggi* and *H. histrix* were only observed when trawlers fished far offshore (e.g. 40nm from Con Dao), and could inhabit deeper waters.

Water parameters for each site can be found in Table 2. No measurable levels of phosphate were recorded, and nitrite and nitrate levels were low across all sites. The clearest waters were recorded from Nha Trang and Whale Island, with Secchi depths ranging from 8.32-15.12m. The soft-bottom sites off Phu Quoc were more turbid due to sedimentation in the water column, with Secchi depths of 2.42-9.52m. Salinity overall ranged from 32.5-35.0‰, with higher readings recorded off Nui Chua and Con Dao.

Table 2. Water parameters at each survey site. Blank cells indicate readings that were not taken.

No.	Location	Site	kH (ppm)	pH	NO_2^- (mg/l)	NO_3^- (mg/l)	PO_4^{3-} (mg/l)	Secchi depth (m)	Salinity (‰)
1	Cu Lao Cham	Bai Huong	120	7	0.5	20	0	-	-
2		Bai Bac	40	6	0.5	0	0	-	-
3	Nha Trang	Mamahan	40	7	0.5	20	0	10.12	33.5
4		Moray Beach	80	7	0.5	0	0	10.12	32.5
5		Seahorse Bay	120	8	0	0	0	15.12	33

6	Whale Island	Beach 1	120	8	0	0	0	15.12	33
7		Wreck	120	8	0	0	0	15.12	33
8		Beach 2	80	7.5	0.5	0	0	8.32	33.5
9	Phu Quoc	Bai Boi	120	7.5	0	0	0	5.12	33
10		MPA	80	7.5	0	0	0	5.32	32.5
11		Da Bac	120	7.5	0.5	20	0	2.42	32.5
12		Cay Sao	80	7.5	0	0	0	-	33.5
13		Da Chong	80	8	0.5	20	0	3.12	34
14		Bai No	120	7.5	0.5	0	0	5.12	-
15		Da Chong 3	120	7.5	0	0	0	9.52	31.5
16		Ran No	80	7.5	0.5	20	0	5.82	33.5
17		Outside Da Chong	120	8	0	0	0	5.22	33
18	Nui Chua	My Ho	180	7.5	0	0	0	-	35
19		Rach Thai An	120	7.5	0	0	0	-	35
20	Con Dao	Mui Lo Voi	120	7.5	0	0	0	7.42	34
21		Bai Dat Duc	180	8	0	0	0	8.12	34
22		Bai Canh	120	8	0	0	0	7.12	34

Informal interviews

Most of the fishers interviewed (n=18) worked on trawling boats, at the fishing ports at Phan Thiet, Nha Trang and Ha Tien (Table 3). Five other fishers from Phu Hai were compressor divers, and we also spoke to one seine fisher in Rach Gia. All fishers reported catching seahorses, and no fishers targeted seahorses specifically. Three species- *H. kuda*, *H. spinosissimus* and *H. trimaculatus*, were observed from examination of the catches. Consistent with our underwater survey findings, fishers reported that seahorses tend to be found in soft-bottom, sandy or seagrass habitats. Most fishers estimated that seahorse populations have declined over the past decade from overfishing and increased fishing efforts, with declines ranging from 40-90%.

Table 3. Summary of fisher interviews in Vietnam. Seahorse species were identified from direct observations of catches, species were marked as unknown otherwise. Seahorse habitats were reported by fishers, and fishers were also asked to estimate the population trend of seahorses over the past decade.

Location	Date	No. of fishers	Fishing gear	Seahorse spp.	Habitat	Ten year population trend
Phu Hai	5 Mar 2014	5	Compressor diving	*H. kuda*	Seagrass	↓ 70-80%
Phan Thiet	6 Mar 2014	8	Trawl	*H. trimaculatus, H. spinosissimus*	Sand, silt, seagrass	↓ 65-90%
Nha Trang	13 Mar 2014	3	Trawl	Unknown	Unknown	↓ 50-70%
Ha Tien	1 Apr 2014	7	Trawl	*H. trimaculatus, H. spinosissimus, H. kuda*	Sand, silt, rock, seagrass	↓ 40-50%
Rach Gia	2 Apr 2014	1	Seine	Unknown	Unknown	Unknown

From other informal interviews, seahorses have been spotted, but rarely, at Cu Lao Cham (n=3) and Con Dao (n=2). The museum on Cu Lao Cham showcases specimens of *H. spinosissimus* and *H. trimaculatus*, which were collected around the island. The trawlers that stop at Ben Dam port on Con Dao fish approximately 40 nautical miles from the island, near the border with Malaysia and Indonesia (coast guard pers. comm). Within the dried seahorse collection of a buyer at Ben Dam port, *H. spinosissimus* was most common, followed by *H. trimaculatus.* One individual each of *H. kelloggi* and *H. histrix* were also spotted. Within Nha Trang MPA, respondents from the dive industry (n=3), reflected that seahorses used to be more common around the islands, but are now rare. A dive guide estimates that he sees 2-3 seahorses over the duration of the whole summer season. Occasionally, seahorses can still be spotted off Hon Mun, at the sites Moray Beach, Northern Ridge, Mamahan and Seahorse Bay, and at Small Hill and Big Wall, farther south. Estimated seahorse declines range from 70-99% (n=2). *Hippocampus kuda* used to be common ten years ago at Song Cau, Phu Yen province, on seagrass beds (Do HH, pers. comm.), but fishers now seldom catch seahorses, and they are only found in bycatch from trawlers that range further afield (n=1). Aside from the seagrass beds off the east coast of Phu Quoc, divers reported seeing seahorses at the northern dive sites of Nudibranch Garden (Vung Bau and Cau Can beaches) and Nail Clip, and at Seahorse Bay and MPA within the An Thoi island group (n=5). One dive guide estimated that seahorse abundance around Phu Quoc has declined 40% over the past three years he has lived there. Another respondent reported witnessing local fishers using the destructive method of breaking corals with lead boots while compressor diving to catch fish, three days before our interview at one of the northern dive sites off Phu Quoc. At Ham Ninh port on Phu Quoc, we came across freshly dead specimens of *H. mohnikei*, which were caught by trawlers fishing off the east coast.

Our informal sessions included conversations with researchers from the RIMF and IO. Seahorses are reportedly distributed from north to south Vietnam, but are more abundant in the south (Nguyen KB, pers. comm). Information from Dr. Do Huu Hoang (IO) covering survey areas in central and south Vietnam, is summarized in Table 4. During a three-month survey of sponge biodiversity along the coastal waters of Vietnam in 2013, RIMF researchers encountered seahorses off Co To (all *H. spinosissimus*), Phu

Quy and Phu Quoc islands. The Department of Marine Resources at RIMF has carried out annual research trawls since 1996 in four major areas: the Tonkin Gulf, central Vietnam, southeastern Vietnam and southwestern Vietnam. Seahorses were occasionally encountered in the trawls; they were only recorded in 1996 (n=4), 2000 (n=2), 2002 (n=21), 2003 (n=2), 2007 (n=1), 2010 (n=1) and 2011 (n=1). The map of reported seahorse distribution based on interviews and research observations can be found in Figure 2.

Table 4. Summary of seahorse distribution in Vietnam by Dr. Do Huu Hoang (IO).

Location	**Seahorse spp.**	**Habitat**	**Notes**
Danang	*H. kelloggi*	Not reported	Big seahorses
Song Cau	*H. kuda*	Seagrass	Surveyed in 2004
Khanh Hoa province (including Nha Trang)	All species	Not reported	
Cam Ranh, Khanh Hoa province	*H. kuda*, *H. spinosissimus*, *H. trimaculatus*, *H. histrix*,	Seagrass	
Cua Be estuary (Belong to Nha Trang, Khanh Hoa)	*H. kuda*, *H. mohnikei*	Near fish traps	Surveyed in 1995/96
Van Ninh	*H. kuda*, *H. spinosissimus*, *H. trimaculatus*	Not reported	
Ninh Thuan province	*H. kuda*, *H. spinosissimus*, *H. trimaculatus*, *H. histrix*, *H. kelloggi*	Not reported	
Binh Thuan (including Mui Ne)	*H. spinosissimus*, *H. trimaculatus*, *H. kuda*	Gravel, sandy, mudy for *H.trimaculatus* (by diving and trawl	Seahorses caught by trawlers and divers
Ham Tan, Binh Thuan province	*H. spinosissimus*, *H. trimaculatus*, *H. kuda*	Not reported	Near Vung Tau
Vung Tau	*H. kuda*, *H. kelloggi, H. trimaculatus, H. spinosissimus*	Mangrove, estuary, mud	Not many seahorses here. *H. kelloggi* is caught by big trawlers fishing far offshore, possibly near Con Dao. *H. trimaculatus* caught by small trawlers together with *H. kuda*
Can Gio, Ho Chi Minh	*H. kuda*, *H. trimaculatus*	Not reported	Near Vung Tau. Locals caught seahorses in mangroves and seagrass

Ca Mau	*H. kuda, H. trimaculatus*	Mud, mangrove	From trawlers, not many
Rach Gia	*H. spinosissimus* or *H. barbouri*, *H. trimaculatus*	Gravel, mud/sand	Seahorses from big trawlers that stay out at sea for several months, can supply 100kg of seahorses in one trip (1-2 months). Fishing grounds are near Phu Quoc and south An Thoi islands, Nam Du, Da Bac islands.
Ha Tien	*H. spinosissimus*, *H. trimaculatus*, *H. kuda*	Not reported	Near Cambodian border, *H. kuda* is also known here as the "Cambodian seahorse"
Tac Cau (Kien Giang province)	*H. kuda*	Not reported	
Phu Quoc island	*H. spinosissimus*, *H. trimaculatus*, *H. kuda*	Not reported	Surveyed in 2004/2005
Ganh Hao (Bac Lieu province)	*H. trimaculatus*, *H. kuda*	Mud	
Song Doc (Ca Mau province)	*H. trimaculatus*, *H. kuda*	Mud	

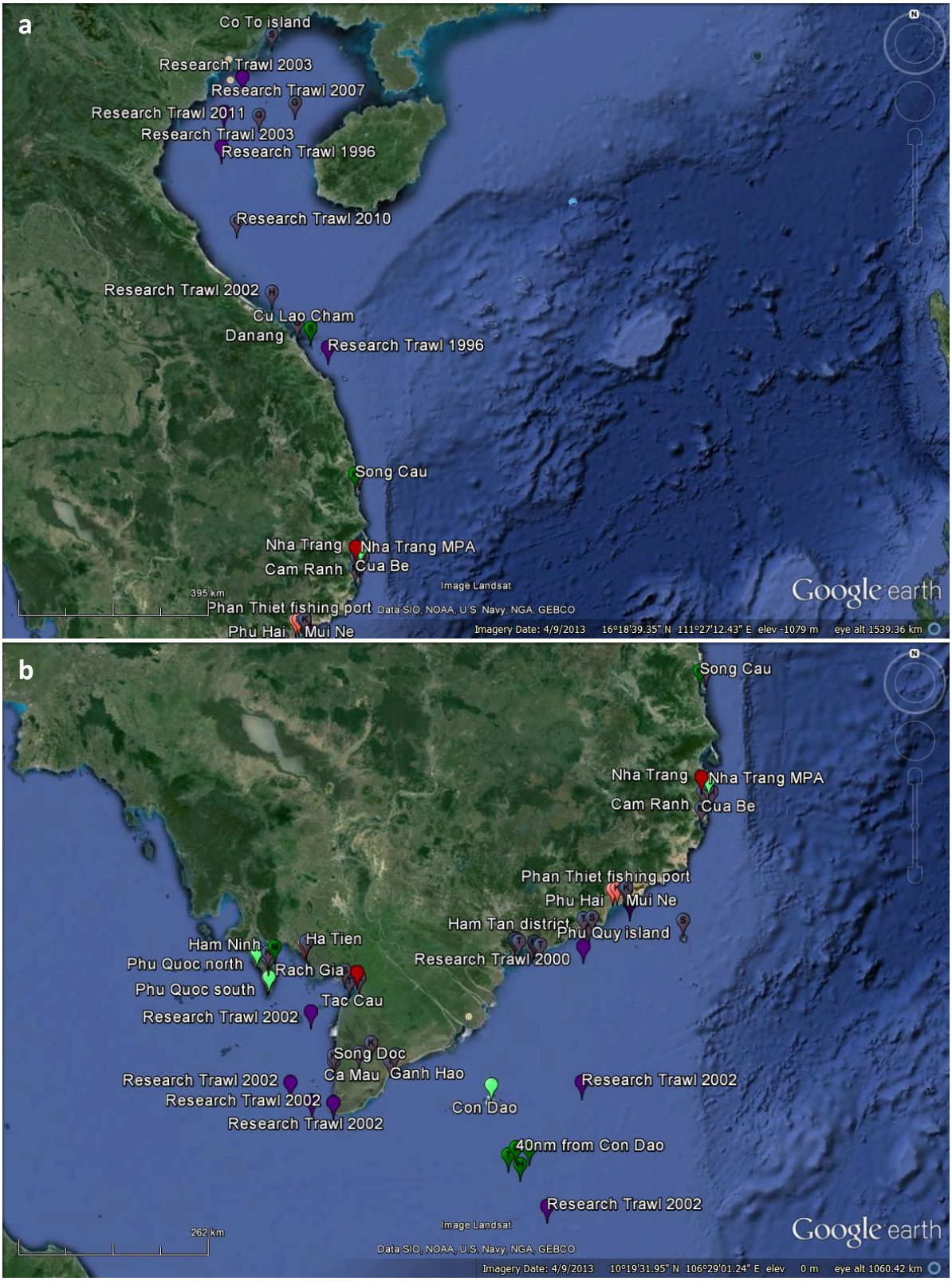

Fig. 4. Seahorse distribution in (a) north and (b) south Vietnam from interviews with fishers (red labels) and other local stakeholders (green labels), and from previous research efforts (purple labels).

iSeahorse Trends training workshops

Workshops to train stakeholders in the iSeahorse monitoring methods (http://iseahorse.org/?q=uwtrends) were conducted with the following participants: the MPA staff and fishers at Cu Lao Cham; Whale Island Resort staff and guests; IO researchers, Nha Trang MPA staff and dive professionals at Nha Trang, MPA staff, fishers and dive professionals at Phu Quoc; National Park staff and fishers at Nui Chua; and National Park staff at Con Dao (Table 5). More than 100 participants attended the workshops in total. Participants learned how to identify the common seahorses in their region, search for suitable survey sites, collect data on seahorses and their habitats and report data to iSeahorse. Shedd Aquarium sponsored bilingual training materials for the workshops, including the survey manuals, laminated identification guides for seahorse species in Southeast Asia and laminated survey summary handouts. These workshops raised awareness among the local stakeholders of the iSeahorse citizen science program, and encouraged resource managers to start their own seahorse monitoring programs, especially if they already monitor habitats such as seagrass beds and coral reefs.

Table 5. iSeahorse workshop details. Workshops at Cu Lao Cham and Nha Trang included an in-water practice of survey methods.

Location	Date	No. of participants	Participants
Cu Lao Cham	Mar 1-2, 2014	15	MPA staff, local fishers
Whale Island	Mar 9, 2014	4	Rainbow Divers staff, resort guests
Nha Trang	Mar 12-13, 2014	25	Institute of Oceanography (IO) staff, MPA staff, divers
Phu Quoc	Mar 29, 2014	27	MPA staff, local fishers, divers
Nui Chua	Apr 4, 2014	19	NP staff, local fishers
Con Dao	Apr 8, 2014	10	NP staff
Con Dao Six Senses Resort	Apr 8, 2014	3	Dive instructors from Senses Diving
Total		**103**	

Discussion

The results of this study contribute to our understanding of seahorse distributions along the coast of Vietnam. From the results of our surveys and interviews, at least six species of seahorses are found in Vietnam's waters- *H. spinosissimus*, *H. trimaculatus*, *H. kuda*, *H. mohnikei*, *H. kelloggi* and *H. histrix*. The species *H. barbouri* and *H. comes* are reportedly found off Vietnam as well (Do H.H. pers. comm.), but were not encountered in our study. The east coast of Phu Quoc Island, where seahorses were most abundant, falls outside the no-take zone of Phu Quoc MPA. Seahorse populations here are under pressure as this area is frequented by small trawlers and compressor divers, many specifically targeting seahorses. We did not observe any seahorses within marine protected areas, such as Nha Trang MPA and the National Parks of Nui Chua and Con Dao. Individuals of *H. kuda* were spotted in the bay off Whale Island Resort, a private no-take area managed by the resort.

As was the case in the eastern Gulf coast of Thailand, *H. spinosissimus* was the most commonly encountered species in underwater surveys and catch collections. Although only one *H. trimaculatus* was seen during in-water surveys, this species was frequently present in the collections of fishers and sellers that we examined. From fisher interviews in Bangsaray, Thailand, *H. trimaculatus* was usually trawled from depths of 25-40m. These are depths not usually reached on SCUBA due to no-decompression dive time limits. From our observations and from conversations with local stakeholders, seahorses in Vietnam were not present on coral reefs, and were instead found mainly on soft-bottom habitats, such as silt, sand and seagrass. Similar to findings off Pattaya, Thailand, seahorses frequently use pencil urchins as holdfasts off the east coast of Phu Quoc, probably because few holdfast alternatives were available on the silty bottom.

Vietnam has measures such as the establishment of marine park and national park networks already in place to regulate fishing pressure and designate no-take zones. However, from our observations, more needs to be done to protect seahorses and their habitats. Many interview respondents indicated steep declines in seahorse populations over the past ten years, with seahorses rarely spotted in areas where they were once common. Off Phu Quoc, which hosts the highest abundances of seahorses in our underwater surveys, fishing pressure is intense. Trawlers and compressor divers catch seahorses every day, which are sold alive in tanks or freshly dead at Ham Ninh port. When we dived in the trawl fishing grounds, we noted the absence of seagrass, the presence of several broken shell and urchin fragments and a general lack of topography- evidence of damage by bottom-trawling nets. Information from these surveys and informal interviews need to be integrated with data from fisher interviews and port sampling for a fuller understanding of seahorse distribution and threats off Phu Quoc, and to manage the seahorse catch and trade here.

It is evident that there are already substantial efforts to collect information from coastal areas off Vietnam. The integration of seahorse data from research trawls, large-scale surveys and local monitoring programs, in addition to citizen science efforts through iSeahorse, would be a powerful tool to inform seahorse conservation and management in Vietnam, especially with more than 100 people currently trained in iSeahorse monitoring methods. We propose that the collation of these data could be carried out by an in-country iSeahorse coordinator or coordination team, who would liaise directly with Project Seahorse to contribute to iSeahorse. Outreach and participation would be greatly expanded if a Vietnamese version of iSeahorse.org were developed, or an iSeahorse Vietnam Facebook page where users can submit seahorse photographs and location information, which could then be exported to iSeahorse on a regular basis.

In the meantime, decision makers in Vietnam could consider conserving known seahorse hotspots such as Phu Quoc in the face of intense fishing efforts. This could be achieved by establishing and maintaining relationships with local stakeholders such as the MPA staff, conservation groups and dive shops to collaboratively manage the seahorse areas. These community groups can then act as local monitors or enforcement agents to continue collecting data on seahorse populations, and ensure the longevity of the populations in the area.

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Appendix A: Interview questions for fishers

First, introduce ourselves. Ask if it is okay to ask questions and record answers.

Important Questions (we need the answers to all these questions)
Not necessary to ask questions in order. You can mix up the order.

- What kind of boat do you use?
- What type of fishing gear? Trawl, push-net, longline, fish traps, etc.
- How long is the average fishing trip? OR How long did you fish last night?
- How many times do you set the net/cages?
- How long do nets/cages stay in the water?
- How many days fishing every month? Do you fish all year?
- Do you catch seahorses?
- What type of gear catches seahorses?
- Any seahorse season?
- How many seahorses per night/per month usually?
- Any difference in seahorse numbers in wet or dry season?
- Which habitat do you catch seahorses?
- Which depth do you catch seahorses?
- Any fishing area where seahorses are more common?
- Compared to 10 years ago, are there MORE, FEWER or SAME number of seahorses?
    - Why?
    - If less, how many % less?

Other Questions (good to know, but not compulsory)

- How many people on the boat?
- How long have you been fishing?
- Do you use the same gear all year round?
- Where do you fish? Also other fishermen?