Exploitation, trade, conservation and management of seahorses in the Philippines

FINAL REPORT
in support of eventual CITES implementation for seahorses in the Philippines

Compiled by Sarah Foster[1] and Charity Mae Apale[1,2]
([1]Project Seahorse and [2]ZSL-PH)

Table of Contents

Suggested citation: Foster, S.J. and C.M. Apale. 2016. Exploitation, trade, conservation and management of seahorses in the Philippines. Project Seahorses and ZSL-Philippines. 40 pp.

INTRODUCTION

This report aims to consolidate existing information on seahorse exploitation, consumption, trade and conservation of seahorses (*Hippocampus* spp.) in the Philippines to promote management derived from the best-available knowledge. This information is being provided in direct support of eventual implementation of the Convention on International Trade in Endangered Species (CITES) for seahorses; all seahorses are listed on Appendix II of CITES which means trade is allowed only if it can be proved sustainable. It is our intention that this information will be fed into development of an adaptive management plan for sustainable exploitation and trade in seahorses under the new Fisheries Code or Republic Act 10654 which opens the door to future legal and sustainable seahorse fisheries and trades in the Philippines.

CONSUMPTION, FISHERIES AND TRADE

Data sources

Information on exploitation, consumption and trade in seahorses in the Philippines has been gathered from:

- ***First surveys*****:** the first investigation into the international trade in syngnathids in 1993 and 1995 (Vincent 1996).
- ***Second surveys****:* the second investigation into Philippines seahorse fisheries and trades in September 1998 and from April 1999 to March 2001 (Pajaro&Vincent 2015)
- ***CITES data***: trade involving the Philippines reported to the CITES trade database (UNEP–WCMC 2015)
- ***Focused research activities****:* extensive semi-structured interviews, fisher completed logbooks, and participatory mapping carried out by Project Seahorse during the past 20 years.

Information on the exploitation, consumption, trade and conservation of seahorses and other syngnathids in the Philippines has been gathered from 20 years of research and conservation efforts by Project Seahorse (PS) – first in partnership with the Haribon Foundation for the Conservation of Natural Resources, and then in 2002 the Project Seahorse Foundation for Marine Conservation (PSF) was established to oversee operations in the Philippines, replacing the joint venture with Haribon. PSF has since merged with the Zoological Society of London Philippines program (ZSL-PH), a Philippine-registered NGO since 2010, and still the leading conservation organization working on seahorse conservation in the Philippines***. When we refer to Project Seahorse in this report we mean to include any or all of PS, PSF and/or ZSL-PH activity in the region.***

Three sequential sets of nation-wide trade data have been supplemented with PS research on seahorse exploitation focused on the Central Philippines. The trade datasets each provide information on species, trade routes, source and consumer countries and total trade volumes of dried and live seahorses (Vincent 1996, Foster et al 2014, Pajaro&Vincent 2015). PS additional fisheries research used catch landings, logbook data and fisher interviews to generate information on seahorse catch and effort by lantern fishers across time and space in the Danajon Bank region of the Central Philippines (e.g. Pajaro et al 1997, Meeuwig et al 2003, Martin-Smith et al 2004, Vincent et al 2007, O'Donnell et al 2010a,b, O'Donnell 2012, Yasue et al 2015).

The first investigation into the international trade in syngnathids involved extensive Asian trade field surveys in 1993 and 1995 (Vincent, 1996). These early and brief trade surveys (*first surveys*) suggested that the Philippines was a leading exporter of seahorses for traditional medicines in Asia, aquarium display in Europe and North America, and curios globally. However, these surveys were limited to a few areas within the Philippines, and a more comprehensive survey was needed to understand the national scope of the seahorse fisheries and trade.

The next investigation into seahorse trade (with limited attention to other syngnathids) was conducted by Project Seahorse team member Marivic Pajaro in September 1998 and from April 1999 to March 2001 (Pajaro&Vincent 2015). The study aimed to obtain a comprehensive national view of catch and trade, so survey areas were selected based on prior knowledge (e.g. Vincent 1996) and from reliable contacts that recommended areas likely to have a seahorse fishery and/or trade. A total of 145 respondents were interviewed in 22 coastal provinces[1].

Both sets of trade field surveys drew on: (1) *in situ* interviews with participants in the trade (e.g. fishers, buyers, importers, exporters, and retailers) or those with knowledge of the trade (e.g. scientific researchers and non-governmental organisations); and (2) official data collected by government agencies detailing either the catch or trade of seahorses and pipefishes, primarily from Taiwan (from 1982) or Hong Kong Special Administrative Region, China (HKSAR, from 1998).

More information on seahorse trade became available once the genus *Hippocampus* was added to Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES: www.cites.org). Since that listing was implemented in 2004, all nations signatory to CITES (currently 182 parties) have been required to submit export, import and re-export records for seahorses (UNEP-WCMC 2013, 2015). In support of this report, the database of CITES records was queried on 30 October 2015 for all records for which the Philippines was reported as a source of seahorses in trade (UNEP-WCMC 2015). The Philippines was not reported as an importer of seahorses in the CITES database, and records which reported the Philippines as a re-exporter of seahorses were excluded from the analyses. A total of 31 export records were downloaded. Because implementation of the seahorse listing was deferred until May 2004, downloaded 2004 data may represent only a partial year of trade. CITES trade records involving the Philippines were analyzed for temporal and geographical trends in volumes and trade routes. The reliability of this analysis is subject to inherent challenges with the CITES database as explored in Foster et al (2014); e.g. reporting was submitted by Parties themselves, data might reflect permits or actual exports, units (individuals or kg) are often missing, export and import records did not match, and species were often not (or were wrongly) identified. All CITES records for seahorses related to the Philippines were reported by importing Parties – the Philippines did not report any trade in these species in its annual reports.

Further information on seahorse fisheries and trade in the Philippines has come from focused research activities carried out by Project Seahorse during the past 20 years. Project Seahorse has carried out more than 30 research projects – led by either PS graduate students or by PS field staff, involving extensive semi-structured interviews, fisher completed logbooks, and participatory mapping. These projects have resulted in 7 graduate theses (Lourie 2004, Morgan 2007, Guieb 2008, Anticamara 2009, Pajaro 2010, O'Donnell 2011, Kleiber 2014), 34 papers in primary journals (Pajaro et al 1997, 2001,

[1] Albay, Antique, Agusan Sur, Bohol, Camarines Sur, Capiz, Cavite*, Cebu, Davao†, Iloilo, Leyte, Manila†, Marinduque*, Masbate, Misamis Oriental, Mindoro, Palawan, Pangasinan*, Quezon, Samar, Sorsogon, Sulu, Surigao Norte/Sur, Tawi-Tawi, Zambales*, Zamboanga†; *Not visited but reported to have trade; †Trading only, no fishery reported

2010a,b, 2015, Vincent&Pajaro 1997, Perante et al 1998, 2002, Job et al 2002, 2006, Meeuwig et al 2003, Lourie&Vincent 2004, Martin-Smith et al 2004, Lourie et al 2005, Morgan&Lourie 2006, Marcus et al 2007, Morgan et al 2007, Morgan&Panes 2008, Ban et al 2009, O'Donnell et al 2010a,b, 2012, Samoilys et al 2001, 2007, Vincent et al 2007, Anticamara et al 2010, Molloy et al 2010, Yasué et al 2010, 2012, 2015, Hansen et al 2011, Morgan&Vincent 2013, Kleiber et al 2014, 2015), and five databases (which include data from: i) iSeahorse.org, ii) Marine Protected Area-Long-Term Monitoring (fish and habitat data), iii) Catch Landings–Fisheries Dependent surveys, iv) Catch Landings–Fisheries Independent surveys, and v) Photo-quadrant habitat surveys).

Although fishing seahorses has been illegal in the Philippines since 2004 – as a national reaction to international trade controls – fishers and buyers continued to trade openly (O'Donnell 2012). Project Seahorse has continued to obtain access to seahorse fishers by working through long-serving Filipino community organizers (who have engendered trust among villagers) and by maintaining open dialogue with fishing communities, emphasizing an interest in resource use rather than law enforcement.

Project Seahorse research has been complimented by a report on the potential socio-economic impact of the CITES listing of seahorses (Christie et al 2011), information on seahorse culture (SEAFDEC/AQD 2000) and fisheries data from DA-BFAR (2013).

Uses

Global demand for seahorses is high. Seahorses are valuable commodities, and are traded internationally for use in traditional medicine, as display animals in aquaria and also as curiosities and souvenirs.

Seahorses were used variously in the Philippines, including dried for medical purposes, good luck charms, shellcraft and curios; and live for ornamental display.

Global overview

Global trade surveys have revealed that seahorses and other syngnathids are used for traditional medicine (TM), aquarium display and curiosities (as reviewed in Vincent et al 2011). In conservation terms, it is irrelevant whether a seahorse taken from the wild is sold dried or live. That said, differences in the method of capture or in the preferred species or size may affect the overall conservation effect of removal and effective conservation actions. The great majority of seahorses, *c.* 95% of those in trade, are sold for use in TM and particularly in traditional Chinese medicine (TCM).

The global aquarium trade uses fewer seahorses than the dried trade, but can place heavy pressure on particular populations or species (as reviewed in Vincent et al 2011). The greatest demand in the live trade comes from the hobby market, but most public aquariums also display seahorses. Complex seahorse husbandry requirements mean that they often fare very badly in captivity, although considerable advances have been made in the last decade (Koldewey&Martin-Smith 2010). Those animals that die in the live trade are often sold dried for traditional medicine or as curios. Little is known about the curio trade for seahorses but, globally, large numbers are certainly involved.

Philippines

Seahorses were used variously in the Philippines, including for medical purposes and good luck charms (Vincent 1996, Pajaro&Vincent 2015). Coastal people of Mindanao and the central Visayas use seahorses to treat asthma, gas pains and hyperactivity (Alino et al 1990). In, Palawan, claims that seahorses cure asthma probably derive from TCM practices. On Bohol, and occasionally Palawan, seahorses were found to be used chiefly to treat stomach upsets. A local medicine man in Luzon prescribed a mixture of seahorses and herbs to patients with skin disorders, and one former seahorse trader had used seahorses to cure his arthritis. Fishers in some areas believe that ingesting a seahorse soaked in liquid (usually alcohol) will promote vigour and fertility, whereas fishers in Bohol explained that seahorse young – which they believed to be high in vitamins – served as a tonic food. Merchants in southern Philippines believe that a seahorse brings profits. Some villagers in Palawan hang a seahorse in the doorway to ward off evil spirits.

Seahorses were also an important part of shellcraft and the curio trade in the Philippines, with large volumes of dried seahorses finding their way into cheap seaside scenes and paperweights (Pajaro&Vincent 2015). Importers apparently requested small spiny seahorses, which would be considered very poor quality for TCM. While mostly for export, souvenir shops in Palawan and Cebu, and resorts in Balicasag (Bohol) and Boracay, sold seahorses to local and foreign tourists. The souvenir shops were supplied by traders from the same province and sold the seahorses dried and individually. The dried seahorses in the resorts were also sold individually and peddled by children or women along the beaches. No information was obtained on the source of these seahorses but they were most likely to have been provided by fishers or gleaners close to the resorts.

Live seahorses were sold in Manila's pet shops as ornamental fishes and were bought by local hobbyists (Pajaro&Vincent 2015). The domestic supplies were said to be 'rejects' of ornamental fish exporters, rather than purchased directly from fishers.

Species

At least seven species of seahorses have been recorded to be collected and/or traded in the Philippines: *H. barbouri* (dried and live), *H. bargibanti* (dried), *H. comes* (dried and live), *H. kelloggi* (dried), *H. kuda* (dried and live), *H. spinosissimus* (dried and live), and *H. trimaculatus* (dried).

Species designations in trade records and studies should be viewed with caution, given the high potential for misidentification, especially of dried specimens, and the high frequency with which multiple species are traded and sold in the same shipment or case (Foster et al 2014). However the first identification guide exclusively for seahorses (Lourie et al 1999), and the revised version published in support of CITES implementation (Lourie et al 2004), have allowed researchers executing surveys to identify seahorse species in fisheries and trade. A simplified identification guide to Southeast Asian seahorses is available at www.projectseahorse.org/ndf.

At least six species of seahorses were recorded to be collected and traded in the Philippines during the *second surveys*: *Hippocampus comes, H. kelloggi, H. kuda, H. spinosissimus*, and *H. trimaculatus* were reported throughout the Philippines, while *H. barbouri* was caught only in the country's southwest, along the Palawan and Sulu archipelagos (Pajaro&Vincent 2015). All six species were encountered in the dried trade while only four were commonly observed to be sold to the live trade: *H. barbouri, H.*

comes, *H. kuda* and *H. spinosissimus*. Another three seahorse species (*H. bargibanti, H. denise* and *H. histrix*) were not reported or encountered in trade. *Hippocampus pontohi* had yet to be described during *second surveys*.

Almost all CITES records for seahorses related to the Philippines were reported to the species level (N=26/35) (UNEP-WCMC 2015); seven of the ten species confirmed in Filipino waters were reportedly exported from the Philippines between 2004 and 2014, including *H. barbouri, H. bargibanti, H. comes, H. histrix, H. kuda, H. spinosissimus* and *H. trimaculatus*. A further five seahorses species were reportedly exported from the Philippines but they are neither confirmed nor suspected in or near Filipino waters, and instead found in Africa, the Americas or Europe (Lourie et al 2004). These records were likely identified incorrectly. Reported exports from the Philippines were dominated by *H. histrix* (84% of all reported individuals; N ≈13,800 individuals), while *H. kuda* and *H.* spp (no species specified) each made up 5% of reported individuals (N≈ 1,200 and 1,100 individuals respectively).

Fisheries research on the Danajon Bank revealed that *H. comes* made up 93 % of targeted seahorse landings, while another three species were found only rarely (*H. kelloggi, H. kuda* and *H. spinosissimus)* (Perante et al 1998). We are not aware of any species-specific information for seahorses caught as bycatch in the Philippines.

Fisheries

Philippines fisheries caught millions of seahorses in both target and non-target fisheries. *Second survey* data were extrapolated to infer that fishers in the survey areas landed an estimated 5 million seahorses annually. The vast majority of these (~4.2 million individuals) were caught by small-scale fishers targeting seahorses, and an estimated 800,000 seahorses were also caught each year as bycatch – mostly in trawls.

Extraction and export of seahorses from the Philippines became illegal in 2004 under RA8550 Section 97, but fisheries and trades continued. The ban was an unintended consequence of the global listing of all seahorses species on CITES Appendix II. **The newly revised Fisheries Code, RA10654, has restored the potential for legal seahorse fisheries and trades** in and from the Philippines as long as scientific assessments show such activities to be sustainable.

Global overview

Globally, the vast majority of seahorses in trade are captured incidentally in nonselective fishing gears (Vincent et al 2011, Lawson et al in review), although they are targeted in some places (Vincent et al 2011). As much as 95% comes from trawl by-catch (e.g. McPherson&Vincent 2004; Baum&Vincent 2005; Giles et al 2006; Martin-Smith&Vincent 2006; Perry et al 2010), although seahorses are also obtained in many other non-selective gear types, ranging from beach, shore and purse seines to crab pots (e.g. McPherson&Vincent 2004;Murugan et al 2008; J. Selgrath pers. comm.). In some regions, seahorses are valuable enough, and income-earning opportunities are few enough, to warrant extraction from the piles of bycatch, or even perhaps to influence fishing patterns (Martin-Smith&Vincent 2006). Where they are not worth extracting, seahorses are presumably discarded or processed into lowgrade fishery by-products such as fishmeal along with the rest of the small species in the bycatch (Vincent et al 2011).

Most direct exploitation for seahorses is by small-scale or subsistence fishers in developing countries (e.g. McPherson&Vincent 2004; Perry et al 2010), although some are taken by aquarium collectors in developed countries such as Australia or the USA. (Larkin 2003; Martin-Smith&Vincent 2006). Targeted exploitation mostly occurs by hand (e.g. Philippines, Perante et al 1998; Vietnam, Stocks 2015), but can also involve pushnets (e.g. Florida, USA, H. Masonjones, pers. comm.) and even modified trawls (in Vietnam, Stocks 2015).

Philippines

Second surveys revealed that almost all of the millions of seahorses exported from the Philippines were obtained in the small-scale fisheries that engage 90% of Filipino fishers (DA-BFAR 2004), but they were also caught in large non-selective fishing gears such as trawls (Pajaro&Vincent 2015). Past surveys documented seahorse catches in 20 provinces across the Philippines (Figure 1). Survey data were extrapolated to infer that fishers in the survey areas (predominantly fishers targeting seahorses with compressors, lanterns and nets) landed an estimated 5 million seahorses (2 – 8 million) into trade (Figure 2).

Figure 1. Seahorse catches were documented in 20 provinces in the Philippines in the early 2000s. Catch was sold either live or dried. Figure from Pajaro&Vincent 2015.

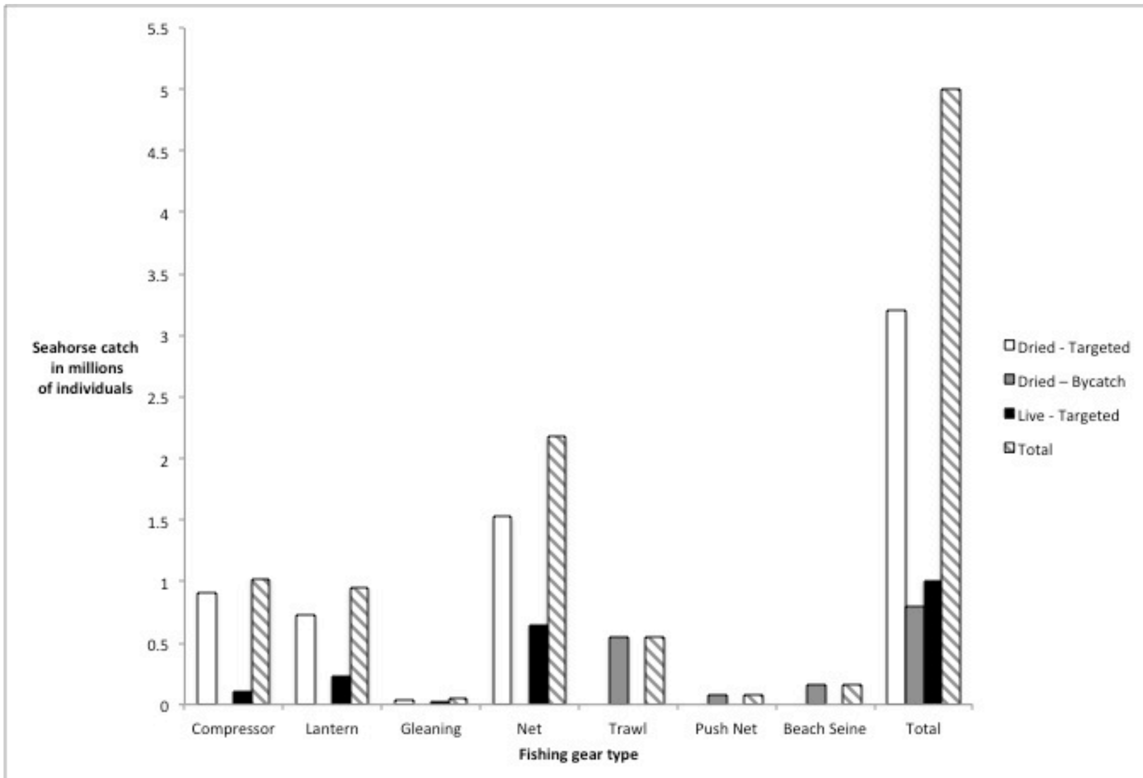

Figure 2. Seahorse catches by fishing gear type in the Philippines in the early 2000s. Catch was either targeted or incidental (bycatch), and sold either live or dried. Figure based on data in Table 2 of Pajaro&Vincent 2015.

Target fisheries

Second surveys estimated annual target catches of seahorses in the Philippines in the early 2000s to be about 4.2 million individuals (Pajaro&Vincent 2015, Figure 2). Numerous small-scale fishers across the Philippines targeted seahorses, collecting them by hand while free or compressor diving or in scoop or push nets (Pajaro&Vincent 2015, Figure 2). For example, fishers in Bohol swam at night under low-slung lanterns, towing their boats and free diving to collect the seahorses by hand (e.g. Perante et al 1998), while those in northern Palawan employed small dip-nets from rafts to obtain seahorses in waist-deep water (Vincent 1996). Fishers used compressor diving, or hooka fishing, to exploit *H. spinosissimus* in the central Philippines (Panes&Giles 2004, as cited in Morgan&Panes 2008). Fishers and coastal dwellers, including children and the elderly, also collected seahorses from intertidal flats (gleaning) when exposed at low tide (Pajaro&Vincent 2015). Most fishers opportunistically caught seahorses as one of several economically useful species, including food fishes, sea cucumbers and ornamental fishes (Pajaro&Vincent 2015).

In summary, fishing methods targeting seahorses in the Philippines included (Pajaro&Vincent 2015):

- Skin-diving in reefs or seagrass beds: during the day, with or without a paddled or small motorized outrigger boat fishing at 1.5-3m depth; during the night with the aid of a lantern slung on a paddled or motorized boat; they also used spears and/or scoop nets to catch food fishes or ornamental fishes.
- Deep diving in reefs, seagrass beds and soft-bottom habitats: at night or during the day in 3-50m depth using hookah compressors on a motorized boat with one to three divers breathing onto an air hose; like the skin-divers, they used spears and scoop nets to catch other fishes and supplement their income.
- Various nets in seagrass beds, up to waist-height: scoop nets (attached to a long pole held by one fisher collecting seahorses from a bamboo raft as soon as they are spotted); push nets (scissor-like nets pushed by one fisher); and seine nets (commonly operated by two fishers, one holding each end while wading in the water).
- Gleaning in intertidal flats exposed at low tide: carried out by children as young as 7 years old and elderly people collecting seahorses and other marine life.

The best-documented seahorse fishery is that around Bohol in the central Philippines, which is the area in which Project Seahorse has been most active. An active seahorse fishery in the Danajon Bank started in the late 1960s (Morgan 2007). Seahorses are collected at night, along with many other species, as fishers breath-hold dive by the light of kerosene lanterns anchored to the front of small outrigger canoes (lantern fishing, until 2009) or wearing an improvised flashlight/headlamp (from 2009). As mentioned above, *H. comes* made up the vast majority of the seahorse landings, while three other species were found only rarely (*H. kelloggi, H. kuda and H. spinosissimus*) (Perante et al 1998). Most seahorses are caught opportunistically (rather than strictly targeted catch) but have been important to local fishers because they could be reliably sold to local buyers for cash (Vincent et al 2007). Fishers catch seahorses on many fishing grounds, but the vast majority of seahorses (>80%) are caught on just one third of fishing grounds (Yasue et al 2015).

Past analysis of the fishery suggests current CPUE is extremely low and seasonal (Vincent et al 2007). The main lantern-fishing season in Bohol corresponded to the inter-monsoon window from February-May, when the weather warms, and water conditions are generally flat with low turbidity, which increases the visibility of benthic targets to fishers. At other times of the year, lantern fishers continued to catch seahorses, but also switched to other targets and used a diversity of other gears that include gill nets, hand nets, and hook and line (jigging) (Morgan 2007). Similarly, some fishers in Bantayan (Cebu), Palawan, Quezon, and Samar directed considerable effort specifically to catch seahorses for certain months each year, e.g. from December to July (Pajaro et al 2001).

Bycatch

Second surveys in the Philippines estimated the annual seahorse bycatch in the early 2000s to be about 800,000 individuals; seahorses were caught in trawls, push nets or beach seine nets that targeted shrimp, prawn and pelagic fishes (Pajaro&Vincent 2015, Figure 2). About 70% of the documented bycatch was caught by trawls, probably those illegally operating in municipal waters, which the Philippines Fisheries Code designates as extending 15 km from shoreline (Pajaro&Vincent 2015, Figure 2). Trawls use fine-meshed nets and dragging devices that are destructive to habitats. Trawls are classified as modified Danish seine (locally called hulbot-hulbot, liba-liba or hila-hila), baby trawl (locally called parakaya, palupad or bulibuli) and larger mechanized trawl boats (locally called dezipper or de-makenilya) (DA-BFAR 1998). Trawlers commonly targeted shrimps, prawn and other pelagic fishes, for example Carangids, Leiognathids and Caesionids.

Incidental capture of seahorses reportedly also occurred in other gear types, albeit at lower frequency, including crab traps, gill nets, and enclosure pens set on seagrass beds and coral reefs (Pajaro&Vincent 2015). The beach seine (baling or pokot) and push nets (sudsod or sakag) accounted for the remainder of documented bycatch during 2001 surveys (Figure 2); both also use fine-meshed nets, which are operated in shallow-water seagrass beds with shrimps as the major target. A beach seine usually involved two fishers, while a push net only one. These gears may be illegal, depending on the legislation of local government (Pajaro&Vincent 2015).

Fisheries legislation

Seahorse fisheries in the Philippines were not directly regulated at a national level prior to 2004, although fisheries legislation that aimed to control gears that catch seahorses may have helped (e.g. ban on trawling within 15 km of the coastline; DA–BFAR 1998). There were voluntary adoptions of seahorse regulations at the local level. For example, starting in 2002 an association of small-scale fishers in the central Philippines decided to adopt a 10 cm voluntary minimum size limit for seahorses to protect against recruitment overfishing (Martin-Smith et al 2004). Community based management measures are discussed under CONSERVATION ACTION FOR SEAHORSES IN THE PHILIPPINES, below.

Seahorse exploitation in the Philippines became illegal in 2004; an unintended consequence of the global Appendix II listing for seahorses on the Convention on International Trade in Endangered Species (CITES) was that fishing and trade of seahorses in the Philippines became an illegal activity. This was the result of Republic Act (RA) 8550 Section 97 which imposed a blanket prohibition on the fishing or collecting of all CITES-listed species without any distinction among the Appendices (DA–BFAR 1998). Section 97 provided that "it is unlawful to fish or take rare, threatened or endangered species as listed in the CITES." This was a much stricter national implementation of the CITES Appendix II listing for seahorses, which allowed trade to continue as long as it was managed for sustainability.

It is unclear how the sudden ban on seahorse extraction and export changed actual fishing practices on the ground. Research revealed that fisheries and some trade for seahorses continued illegally through the ban under RA 8550, with supply routes remaining active (Christie et al 2011; O'Donnell 2012). Illegal fishing continued because there was little enforcement, seahorses commanded a high price on the internationally legal market and fishers had few alternative sources of income (Christie et al 2011; O'Donnell 2012). An FAO study found that the majority of local policy-makers and seahorse fishers opposed the blanket ban on seahorse fishing, whereas national policy-makers had mixed opinions (Christie et al 2011). National policy makers in favour of the ban were so because it precluded them from having to implement CITES for these fishes; implementing CITES would require implementing monitoring and management by institutions that were understaffed and insufficiently funded (Christie et al 2011).

As of 2015, however, seahorse fishing and trade may no longer be an illegal activity in the Philippines. This is the result of a very recent revision of the Philippines Fisheries Code. The revised Code is intended to move fisheries toward sustainable exploitation and improve the Philippine government's compliance on CITES exports regulations that govern the marine species listed in Appendices II and

III. The new Section 102b of the Philippine Republic Act (RA) 10654 states that "it shall be unlawful to fish, take, catch, gather, sell, purchase, possess, transport, export, forward or ship out aquatic species listed in CITES Appendices II and III if scientific assessments show that population of the species in the wild cannot remain viable under pressure of collection and trade: Provided, that the taking or fishing of these species from the wild for scientific research, or conservation breeding simultaneous with commercial breeding my be allowed" (DA-BFAR 2015).

Although the wording of Section 102b seems to differ considerably from CITES with respect to burden of proof, BFAR has clarified that this is not the case. The wording of Section 102b has been interpreted by several NGOs as putting the burden of proof on science, essentially saying that harvesting, purchasing, exporting of species in CITES Appendix II or III **CAN** proceed or is now **ALLOWED** unless scientific assessment shows that these practices pose problems to the wildlife population. In other words, exploitation and trade can continue until such time scientific assessments prove these activities to be unsustainable. This would be opposite to CITES regulation, which puts the burden of proof on trade – such that exports should only be permitted if the export will not be detrimental to the survival of the species (cites.org/eng/disc/text.php#IV). However BFAR has clarified that seahorse fisheries and trades (and those of other Appendix II listed aquatic species) will only be re-opened when scientific assessments have informed legislation that govern take and trade at sustainable levels. **Therefore the new law is very much aligned with CITES provisions for sustainable trade.**

Trade

The Philippines was a major known exporter of seahorses in international trade prior to the CITES listing. Trade surveys at the start of this century estimated Philippines annual exports of *dried* seahorses at 4 million seahorses. Trade surveys also suggested that the Philippines exported hundreds of thousands of *live* seahorses each year (~400,000 individuals). Export of seahorses from the Philippines became illegal in 2004 under RA8550 Section 97, but CITES records and other customs data suggested trade might have continued.

Trade surveys revealed that no fisher or trader reported relying on seahorses as their sole source of income, but **these fish may contribute important portions of their overall earnings**.

The newly revised Fisheries Code, RA10654 Section 102, has restored the potential for legal seahorse fisheries and trade in and from the Philippines if scientific assessments show such activities to be sustainable. Implementing CITES for seahorses in the Philippines requires the CITES Authorities to ensure exports are sustainable, and that seahorses were not fishes illegally.

Global overview

Seahorses are valuable global commodities. Project Seahorse's pioneering research shows that they are traded worldwide for use in traditional medicines, aquarium display and as curiosities (Vincent et al 2011). Approximately 15-20 million seahorses are caught and traded around the world each year, made up of more than 30 species. The trade in seahorses is global, covering all continents except Antarctica, and involving at least 80 countries (Foster et al 2014). The vast majority of the international trade in seahorses is dried and wild-sourced (Foster et al 2014). In spite of an observed geographic expansion of the seahorse trade, Asian countries have remained the main sources and destinations for dried seahorses (Foster et al 2014). All available trade data reveal that Thailand has been a dominant source of seahorses, by annual quantity, since 1996, and that the major consumers of dried seahorses were Hong Kong, Taiwan and mainland China. Notably, however, the main consumer of live seahorses has been the USA.

Philippines

The Philippines has historically been a dominant source of seahorses in international trade. The *first* and *second surveys* showed that the Philippines was a major exporters of both live and dried seahorses (Vincent 1996, Pajaro&Vincent 2015). Trade surveys carried out at the start of this century, estimated that 5 million seahorses (range 2-8 million) were exported from the Philippines annually, both dried (for traditional medicine) and live (for aquaria) (Pajaro&Vincent 2015). Exports from the Philippines were reported in official CITES data in 2004 (19,000 individuals) and 2005 (1,700 individuals) (UNEP-WCMC 2015), but then mostly ceased as the 2004 national ban on seahorse capture took effect (Section 97, see *Fisheries legislation*, above).

Seahorse catches in the Philippines were sold either live or dried based on the availability of a buyer and the prices offered (Pajaro&Vincent 2015). While targeted fishing was the only source for the live trade, it also supplied the dried trade, whereas bycaught seahorses mainly supplied the dried trade (Figure 2). In most areas surveyed during the *second surveys*, the only market was for dried seahorses (Figure 1). Where both markets existed, the decision to sell to the live versus dried market was often based on seahorse size. Seahorse value increased with size in the dried market, but was fixed per individual for live seahorses. Fishers in Jandayan Island (Bohol), for example, opted to sell small seahorses to live buyers rather than dried as this doubled their value. Conversely, larger specimens were sold to the dried market, where they fetched a higher price.

Dried trade

Volumes

Project Seahorse trade surveys were consistent in estimating that millions of dried seahorses were exported from the Philippines. *First surveys* suggested it was possible that national exports of dried seahorses from the Philippines could exceed 4.7 million individuals in the early 1990s, but gaps and inconsistences in available data made estimating total export volumes difficult (Vincent 1996). *Second surveys* at the start of this century inferred that fishers in the survey areas (predominantly compressor, lantern and net fishers targeting seahorses) landed an estimated 4 million seahorses (2-6 million) into the dried trade (Pajaro&Vincent 2015). The Philippines has not been known to be an entrepôt of trade, so interviewed traders were assumed to deal primarily with locally sourced seahorses. The volume estimates from fisher and buyer surveys were comparable and received further validation from official data collated by BFAR at export destinations (Pajaro&Vincent 2015).

Official trade data from importers analyzed for this report also show the Philippines to be an important source for dried seahorses prior to the domestic ban. Import data obtained from Hong Kong SAR showed average imports of 3.1 million (range 1.5-6.2 million) from the Philippines between 1998-2004. Import data obtained from Taiwan showed average imports of 440,000 (range 48,000-1.6 million) from the Philippines between 1986-2004. The Philippines was the second most important source for dried seahorses in these jurisdictions' official trade data prior to 2004, behind Thailand, with the former accounting for 23% and 13% of all imports recorded by Hong Kong SAR and Taiwan, respectively.

Available post-CITES should be interpreted with caution due to an immediate national ban on seahorse capture and trade in the Philippines with the listing of seahorses on CITES Appendix II (see *Fisheries legislation* section, above). CITES official data reported just 13,500 dried seahorses as exported from the Philippines in 2004 and 1,700 in 2005 – with only 86 individuals reported in years thereafter (UNEP-WCMC 2015). Most of the trade reported to CITES for the Philippines was marked as having been seized by importing Parties – more than half by volume in 2004, and all of reported trade after 2005. This suggests the exports were not accompanied by necessary or valid export permits under CITES. Two further records from the Philippines exist in the Hong Kong database post-CITES: 2006 (56,000 individuals) and 2010 (14,000 individuals).

Trade Routes

First surveys found that dried seahorse primary buyers were mostly local villagers, and exporters were usually merchants dealing in other commodities sought by Chinese markets, such as sea cucumbers and shark fin (Vincent 1996). Seahorses consolidated in Cebu were reportedly exported to Taiwan or Hong Kong, while those in Zamboanga went primarily to Japan, Italy or the USA. A few dried seahorses may also have passed through Manila.

Second surveys found that while some seahorses were sold locally for traditional medicine or as charms, most seahorses landed were destined for export (Pajaro&Vincent 2015). Seahorses were observed for sale as curios in Cebu, Manila, Palawan, and Zamboanga. Half of the traditional Chinese medicine (TCM) shops surveyed in Manila sold seahorses. It is not known if these seahorses were sourced locally or were imported; suggestions were heard that the ethnic Chinese who primarily use TCM may have preferred to import seahorses from Hong Kong SAR, even though the specimens may have originated in the Philippines. Seahorses landed in the diffuse fishery were concentrated through local buyers, who delivered their seahorses to exporters in one of four centers: Cebu, Manila, Tawi-Tawi, or Zamboanga. Dried seahorses were most commonly exported for TCM, usually to mainland China, Hong Kong SAR, Singapore, and Taiwan. Dried seahorses for the curio trade apparently went to Europe, the United States, and Japan, according to a Zamboanga curio exporter. Seahorses were also sent from southern Philippines to Malaysia, likely through unofficial trade.

Analysis of reported CITES data revealed reported destinations of dried seahorses from the Philippines were (in descending order): the USA, the UK and Portugal (UNEP-WCMC 2015). The USA was the main reported destination 2004 and 2005, reporting 99 and 64% of the dried seahorses from the Philippines in each year, respectively (N~13,500 and 1,100 individuals). The UK made up <1% of reported volumes in 2004 (N~10 individuals), while Portugal comprised 36% (N~600 individuals) of total reported export volumes in 2005.

Live trade

Volumes

First surveys estimated that more than half a million live seahorses left Manila each year from just three regions: Busuanga, Palawan and Bohol (Vincent 1996). This estimate did not account for many aquarium fish collectors in the large island of Luzon and the southern Philippines and so likely underestimated total live seahorse exports.

Second surveys suggested that the Philippines exported hundreds of thousands of live seahorses each year; however the small sample sizes and high variance of the data suggests interpretations must be made with caution (Pajaro&Vincent 2015). Buyers and exporters estimated the live trade at a median volume of 410,000 individual seahorses annually (range 250,000-570,000), a lower but perhaps more reliable median estimate than obtained from fishers (i.e., 1 million seahorses per year). Exporter surveys and limited official data from Palawan also corroborated trade in the hundred thousands (~400,000 individuals).

Available post-CITES data report just 5,000 live seahorses as exported from the Philippines in 2004 and only one individual in 2007 (UNEP-WCMC 2015). As with dried volumes, these data likely reflect the immediate national ban on seahorse capture and trade as of May 2004 (see *Fisheries legislation* section, above). About three-quarters of reported live exports from the Philippines in 2004 were of unknown origin, and one-quarter was reportedly wild caught.

Trade routes

First surveys revealed that live seahorses targeted around Palawan, Bohol and Cebu were sold immediately to buyers, who either held them in sea-cages or in bags supplemented with oxygen (Vincent 1996). In some cases secondary buyers visited villages buying seahorses from first buyer, and in other first buyer took the seahorses directly to the exporters. Most live seahorses appeared to be exported from Manila, to Australia, Canada, Europe, Hong Kong, Singapore, Taiwan and the USA.

Second surveys found live seahorse fisheries in eight coastal provinces (Figure 1), all supplied by target fishers diving or using nets (Figure 2). Palawan, in particular the northern part, appeared to be the major source for live seahorses, with large numbers also taken from Bohol. Live seahorses were purchased by local buyers and sent to exporters in either Cebu or Manila. Exporters cited Europe, USA, and Japan as the main importers of live seahorses from the Philippines. Official import and GMAD data recorded 21 destinations that had received live seahorses from the Philippines from 1999-2001; the main destinations were the USA (42% of total exports reported), Taiwan (24%), Japan (17%), Hong Kong SAR (8%), and Europe (5%) (as reported in Pajaro&Vincent 2015).

Six Parties reported imports from the Philippines in the CITES database: DK, US, GB, IT, DE, and ES in ascending order by volume (UNEP-WCMC 2015). Spain was the apparent destination of 64% of reported volumes in 2004, followed by Denmark at 22%.

Economic importance of the trade

Project Seahorse trade surveys revealed that no fisher reported relying on seahorses as their sole source of income, but these fish may contribute important portions of their small overall earnings (Vincent 1996, Meeuwig et al 2003, Pajaro&Vincent 2015, Yasue et al 2015). Interviews with seahorse fishers in 1995 suggested that fishers were generating one-third of their annual income from seahorse fishing and up to 100% of their income in the peak season (Vincent 1996), whereas fishers interviewed in the early 2000s estimated that they earned 25-50% of their daily income from seahorses (Meeuwig et al 2003, Pajaro&Vincent 2005). A more recent study of Bohol seahorse fishers revealed that seasonal income earned from seahorses varied greatly – the majority of fishers appeared to be earning small amounts (5% of a monthly income), but a small number of fishers earned significant amounts, approaching a quarter of their monthly income (Yasue et al 2015). The daily income from seahorses was greater in the dry season than in the wet season (Yasue et al 2015).

Similar to fishers, dried seahorse buyers and exporters also usually had additional sources of income (Pajaro&Vincent 2015). Most of the larger buyers of dried seahorses interviewed also bought other dried marine products such as sea cucumbers, abalone, shark fins, pipefishes and seaweeds. Buyers estimated that between 5 and 50% of their income came from selling dried seahorses.

The national ban on seahorse extraction in 2004 correlated with several changes in the seahorse fishery, including a change in price (Christie et al 2011; Yasue et al 2015). For example, the inflation-adjusted price for a 16 cm seahorse increased by 152% and 142% between 2005 and 2008 in two different communities near Bohol (Yasue et al 2015). The sharp price increases after the ban, particularly for larger seahorses, translated into an increased daily income per fisher from seahorses until 2008. This price increase may also have reflected a shortage of seahorses in trade at a national or global scale, regardless of local rates of extraction. After 2008 it appeared that the higher prices for seahorses were just able to compensate for the increased number of fishers selling seahorses each day, the lower daily catch and the progressively smaller seahorses. It also appears that the number of fishers selling seahorses each day and the price per seahorse increased after the ban on exploitation was implemented.

Trade legislation

The entire genus of seahorses was added to CITES Appendix II in 2002, with implementation from 2004. Seahorses were the first marine fish added to CITES Appendix II since the inception of the Convention (Vincent et al 2014). The CITES Appendix II listing requires Parties to make Non-Detriment Findings – essentially promising that international trade will not damage wild populations – before granting export permits (cites.org/eng/prog/ndf/index.php). Some Parties have moved well on this, other Parties have encountered difficulties and are under CITES review, and a third set of Parties have not yet implemented CITES listings for diverse reasons. As such they have no experience regulating exports at sustainable levels. The Philippines falls under this last category.

As addressed under *Fisheries legislation*, above, the Philippines has not implemented CITES for seahorses or any other Appendix II listed marine species since 1998. This is because its domestic Fisheries Code RA8550, Section 97, from that year banned even the extraction of any Appendix II listed marine species, whereas CITES actually has no direct role in regulating take or domestic trade. Now, in revising the Fisheries Code, the Philippines has recognized this confusion and sought to address it.

EFFECTS OF FISHERIES

Past research indicated **declines in populations of seahorses from direct exploitation and incidental catch of up to 95% over a ten year period**. An assessment of central Philippines seahorse populations for qualitative evidence of overfishing found some evidence that populations were overfished against six different categories of overfishing. **Fishers cited overfishing, increased competition from more fishers, and indiscriminate catch of seahorses in non-selective gear for the declining catches**.

Global overview

Direct or indirect fishing can affect seahorse individuals, populations and species in a variety of ways (Vincent et al 2011). For example, field sampling showed that trawls that obtained *H. erectus* in Florida had the potential to (1) injure or kill individuals, (2) disrupt social structure by selectively capturing females, (3) reduce reproduction by disrupting pair bonds, (4) affect cohorts differentially and (5) damage habitat by removing seagrasses (Baum et al 2003).

Seahorses (and other syngnathids) may be overexploited for the following reasons (Vincent et al 2011): (1) there is a high and persistent demand for seahorses, such that all animals extracted from the wild can find a market; (2) there is effectively no cost associated with catching seahorses in the non-selective gear that extracts so many; (3) the morphology of seahorses allows them to be dried and stored easily, giving fishers and buyers operating far from export centres the option of gradually accumulating marketable numbers of seahorses; (4) opportunity costs for the subsistence fishers that commonly target seahorses are low, given that the such fishers have few other sources of income; (5) with many luxury items, such as seahorses, the value per unit tends to rise as the target species becomes rarer (Courchamp et al 2006). Each of these factors render biological overfishing more likely, because the fishery will seem economically viable even as the resource heads towards collapse (Sadovy&Vincent 2002).

Philippines

Project Seahorse past research has indicated that seahorses were an important marine resource to subsistence fishers, but one that has declined significantly over time. Fishers in a 2001 study on the Danajon Bank assessed seahorse populations, fishing ground habitat quality and their livelihood indicates to have been largely healthy in the past (10 years ago), but felt conditions had deteriorated with a poor outlook for the future (Meeuwig et al 2003). Most fishers and buyers interviewed for second surveys reported a decline in seahorse catch over the 5-10 years prior to 2000; fishers reported declines of 50-95% over the previous 2-10 years, and buyers reported declines in supply of 80-85% over the previous 5 years (Pajaro&Vincent 2015). Indeed three available sources of CPUE for seahorses (seahorses^{-1}fisher^{-1}night^{-1}), interviews, logbooks and landings, all suggested a decline in CPUE of 75-93% from the 1970s to 1994, followed by an inferred stabilization in CPUE from 1996 to 2004 (O'Donnell et al 2010, O'Donnell 2012). More recent research suggested that while lantern fishing methods may seem benign, fishers are capable of exerting considerable exploitation rates on the shallows and could take 40 – 60% of fish each year in waters <5 m (O'Donnell 2012).

Fishers and traders reported declines in seahorse CPUE (Vincent 1996; Pajaro&Vincent 2015), coupled with reports of increasing demand, price, and effort, suggests the seahorse fishery in the Philippines was overexploited (Martin-Smith et al 2004). Martin-Smith et al (2004) assessed central Philippines seahorse populations for qualitative evidence of overfishing, and indeed found some evidence that populations were overfished against six different categories of overfishing (Table 1). Overfishing was confirmed by a semi-quantitative assessment of the fishery using catch data from the fishery, fishery-independent biological data and estimates of fisheries parameters (Table 2). Past (and possibly current) exploitation practices risked both growth and recruitment overfishing. In the former, fish are taken at a rate that exceeds the optimal yield per recruit, so that more fishing yields less catch and hence fewer economic benefits than could be generated from a resource (Morgan 2007). The latter occurs when the number and size of adults being extracted decrease a population's reproductive potential to the point where it no longer has the capacity to replenish itself (Peterson 2002).

Fishers responding to interviews in the communities and at a consultative workshop (November 2000) cited overfishing, increased competition from more fishers, and indiscriminate catch of seahorses in non-selective gear for the declining catches (Martin-Smith et al 2004). They also cited habitat damage and proliferation of illegal fishing methods such as dynamite, cyanide, trawl, and fine-meshed nets as indirect causes. Environmental violations were perceived by fishers to receive little attention with few resources from the law enforcement officers, purportedly because they were preoccupied with insurgency and political unrest. By contrast, buyers attributed seahorse population declines primarily to competition with other buyers, perceived better enforcement of a ban in use of trawl or seine nets and diversification of the marine catch to include sea cucumber products and seaweed culture (Pajaro&Vincent 2015). Fishers interviewed for an FAO study carried out in 2007 also reported a decline in seahorse abundance and attributed it primarily to an increase in the number of seahorse gatherers, in turn attributed to increased seahorse prices (Christie et al 2011). The catching of pregnant and juvenile seahorses, and illegal fishing methods (such as seining), were also considered important factors behind the reported declines in seahorse abundance.

Table 1. Assessment of central Philippines seahorse populations for qualitative evidence of overfishing (table from Martin-Smith et al 2004).

Type of overfishing	Assessment of seahorse fishery	Conclusion
Economic	Economic optimum for seahorse fishery is unknown. Reported historical declines in catch-per-unit-effort (CPUE) leading to decreased income	Almost certainly overfished
Growth	High proportion of juveniles taken and strong size-dependent value	Almost certainly overfished
Recruitment	Level of recruitment required to maintain population is unknown. Adult standing stock vs. low ($<0.02\,m^{-2}$) and high proportion of catch is juveniles	Probably overfished
Biological	Time series (1996–2001) for CPUE not really sufficient to evaluate biological overfishing. Although CPUE was stable for 3 yr and then increased, fishers report declines from historical CPUE	Probably overfished as both growth and recruitment overfishing appear to be taking place
Ecosystem	Historical declines in proportion of species from higher trophic levels. Declines in catches of piscivores	Total fishery suffering ecosystem overfishing. Effects on seahorse component unknown
Malthusian	Seahorses are not caught with gears that are destructive. However there is abundant evident that these gears are being used for other species. Effects of degraded habitat on seahorse populations are unknown	Total fishery suffering Malthusian overfishing. Effects on seahorse component unknown

Data sources: [13,16,29].
Definitions of each category of overfishing can be found in Pauly [27] and McManus [28].

Table 2. Quantitative assessment of seahorse fishery for evidence of overfishing against unpublished criteria developed by Carl Walters (Fisheries Centre, UBC, pers. comm.) (table from Martin-Smith et al 2004).

Criterion	Direct evidence	Indirect (inferred) evidence
1. High proportion of individuals of at least one life-history stage must be accessible to fishery	High levels of fishing effort across known seahorse habitat	Fishers' knowledge of habitat preferences of *H. comes* (coral reefs, *Sargassum* beds) Reported historical declines in CPUE
2. Age/size at recruitment to fishery substantially less than age/size at first maturity	Calculated size at 50% maturity = 102 mm Smallest individual recorded in fishery = 52 mm. 18% of catch recorded as juveniles	
3. Current biomass substantially less than virgin biomass	None (no surveys of virgin biomass were undertaken)	Fishers reported declines of 70% over the 5 yr to 1995 Population densities of only $0.02\,m^{-2}$ very low, even for coral reef species
4. Fishing mortality (*F*) greater than approx. 0.6 × natural mortality (*M*)	None (estimates of *F* and *M* from catch data only)	Estimates of *F* range from 1.7 to $2.5\,yr^{-1}$ (from catch data[a]) Estimates of *M* range from 0.8 to $1.6\,yr^{-1}$
5. Population biomass will increase in response to lower *F*	Increases in population size within no-take Marine Protected Areas	Increased CPUE in 1999 following period of reduced fishing pressure (seaweed farming)

Data sources: [25,30].
[a] J. Meeuwig, unpublished data.

All available evidence suggested that seahorse fisheries were having a detrimental impact on seahorse populations, but it is unclear what effects declining seahorse populations have had on the wider ecosystem. Targeted seahorse fishing, in which fishers capture animals while breath-hold diving, is largely benign from an ecosystem perspective (Morgan 2007). When seahorses are hand-harvested, there is little to no gear impact on habitat. Furthermore, tropical food webs are speciose, but with few individuals of any given species in most communities. Seahorses are among hundreds of fish species on reefs in the Philippines and there is presently no strong evidence that seahorses play a sufficiently substantial role in the trophic structure of tropical foodwebs (Morgan 2007) that their removal is likely to shift systems to alternative stable states (for examples to the otherwise, see Myers&Worm 2003). There may be greater potential for community/ecosystem effects where seahorses are found at much higher densities (Curtis 2004), such as in some temperate systems (although most such populations are not presently targeted by fisheries).

HABITAT DAMAGE AND DESTRUCTION

Seahorses in the Philippines live in some of the countries most threatened marine habitats: seagrasses, mangroves and coral reefs. Each of these habitats has been declining in quantity and quality due to both natural and anthropogenic stressors. **Where there is a loss of seahorse habitat, there will be a loss of seahorses.**

Global overview

Seahorses and other syngnathids live in some of the world’s most threatened marine habitats: seagrasses, mangroves, coral reefs, estuaries and macroalgae. Most areas of the world's oceans are experiencing habitat loss. But coastal areas, with their proximity to dense human population centers, have suffered disproportionately – mainly from anthropogenic stresses. Habitat loss here has far-reaching impacts on the entire ocean's biodiversity, including seahorses. Although natural causes, such as hurricanes, can cause massive habitat damage, it is usually temporary. Human activities, however, are significantly more impactful and persistent.

Philippines

Seahorses can be affected (lethally or sublethally) by physical degradation and destruction of their habitats (Vincent et al 2011) – and the Philippines is no exception. In the Philippines, coral reefs that had been degraded by blast and poison fishing had very low densities of *H. comes* (Marcus et al 2007). Fishers consulted in the early 2000s cited illegal fishing as the most important reason for the degradation of fishing grounds: dynamite (“blast” fishing), cyanide and tubli, a local plant poison, were the major illegal gears used (Meeuwig et al 2003). Commercial fishing, primarily trawling and Danish seining (liba liba), was cited as the second contributor to degradation of fishing grounds. Fishers considered that the fishing grounds were likely to deteriorate further due primarily to continuing illegal and destructive fishing, and also increasing numbers of fishers and a lack of concern regarding protection of the seas from fishers and government.

The Meeuwig et al (2003) study also found evidence of “shifting baselines”, in that long term blast fishing and other destructive fishing methods in the study regions meant that fishers’ perceptions of a healthy fishing ground had changed and differed markedly from the researchers. Fishers described their fishing grounds to be in good condition in the scoping and feedback surveys, but independent transect surveys revealed averages of just 15% live coral and more than one third cover of rubble/dead coral cover (an indication of blast fishing damage) for the same fishing grounds (Samoilys et al 2001), suggesting the fishing grounds were actually in poor condition.

Mangroves

Mangrove forests have long been recognized for their various ecological and socio-economic services (Salmo et al 2014) – and are also a key seahorse habitat (Foster&Vincent 2004). Mangroves the Philippines mangroves are known habitat for *H. kuda* (Kuiter 2000). Unfortunately mangrove forest cover in the Philippines has declined from half a million hectares in 1918 to 120,000 ha in 1994 (a decline in cover of 76%) (Primavera 2000). The decline has continued, with another 10% lost from 1990 to 2010 (Long et al 2014). This, in turn, has contributed to the decline of nearshore fisheries (White and De Leon, 2004).

Like other coastal ecosystems, Filipino mangroves are threatened by both natural and human induced stresses. Among these stresses are the occurrences of typhoons, pollution, siltation, land reclamation (e.g. wharf, pier and human settlement), harvesting for timber products and fuelwood, charcoal making and conversion to fishponds (Primavera 2000, Salmo et al 2014). The latter appears to be the most significant factor causing the decline of mangrove forests not only in the Philippines, but also elsewhere in Southeast Asia (Salmo et al 2014).

Seagrasses

Seagrass beds are another key seahorse habitat in decline, and in the Philippines they are home to *H. barbouri* (Lourie et al 2004), *H. comes* (Morgan and Vincent 2007), and *H. histrix* (Lourie et al 1999). Between 30 percent to 50 percent of the seagrass beds in the Philippines have been lost due to industrial development, ports, and recreation in the last 50 years (Lim as cited in PNEJ 2012). As a resource in need of protection, its status as such is yet largely unknown, becoming a focus of scientific inquiry only in the last 30 years, and as an object of conservation, only in the last 15 years (Fortes 2013).

Studies on seagrasses by institutions in the Philippines showed that aside from natural causes, anthropogenic impacts are the primary cause for the losses and these are increasing as human population increases. A substantial number of people dwell close to shallow bays, lagoons and islands infringed by seagrass bed (Fortes and Santos 2004). Seagrass losses and degradation result from coastal development (industries, ports), waste disposal, sedimentation, destructive fishing (raking, trawling, and the construction of fish corrals), eutrophication (water pollution caused by excessive plant nutrients), boat traffic, and aquaculture (Fortes 1995).

Coral reefs

Coral reefs are arguably the Philippines most degraded seahorse habitat, home to many seahorse species including *H. barbouri* (Wilson and Vincent 1998), *H. bargibanti* (Gomon 1997, and Tackett & Tackett 1997), *H. comes* (Perante et al. 1998), *H. denise* (Lourie and Randall 2003), *H. histrix* (Kuiter 2000), *H. kelloggi* (Choo and Liew 2003), *H. pontohi* (Lourie and Kuiter 2008), *H. spinosissimus* (Nguyen and Do 1996), and *H. trimaculatus* (Masuda et al. 1984). The general trend is negative for the coral reefs in the country (World Bank 2005). For example, a study of the Central Visayas indicated that 75% of the reefs had poor coral cover (less than 25% living coral cover substrate) (Liza Eisma-

Osorio et al 2009). In a broader investigation, Bruno&Selig (2007) compiled and analysed a coral cover database of 2667 Indo-Pacific coral reefs and reported that average Indo-Pacific coral cover declined from 42.5% in 1980s to 22.1% by 2003.

According to the study conducted by World Resources Institute (Burke et al 2002), 98% of coral reefs in the Philippines are at risk from human activities, with 70% at high or very high risk. Rich coral reef and sea-grass coastal habitat areas – such as the Danajon Bank in northern Bohol Island; portions of western Palawan Island; the Lingayen Gulf in northern Luzon; and parts of Marinduque, Mindoro and selected areas of other major islands – have mostly been degraded by sedimentation (World Bank 2005). Destructive fishing is also a culprit, but in areas where it is being slowed and stopped, it is sedimentation that continues to take its toll on water quality and coral reefs and their associated fisheries (World Bank 2005).

Water quality

It is unclear how adverse water quality affects seahorses. Some effects of reduced water quality arise from lower light levels or hypoxia associated with eutrophication or pollution (Vincent et al 2011). However syngnathids have been found to be quite tolerant of low water quality indicators such as low dissolved oxygen (Vincent et al 2011). Such tolerance accords with observations that seahorses are often found in habitats with suboptimal water quality, in and around busy marinas, for example.

The extent of water pollution in Philippine bays can be gleaned from the frequent occurrence of red tide since it first came to the attention in 1983 (BFAR-JICA 2002). Red tide usually occurs when high organic loading from rivers drain into bays resulting in harmful algal blooms (HABs). At first only a few coastal areas of the country were affected in scattered locations, but this had grown to a total of 20 coastal areas by 2002 (BFAR-JICA 2002). In December 2015, the Eastern Visayas was threatened by what described as the biggest red tide bloom in more than three decades (Manila Bulletin 2015).

Climate change

Climate change is expected to negatively affect inshore marine habitats and their fauna, including seahorses, through changes in, for example, temperature, rainfall patterns, atmospheric CO_2, community composition, oceanographic patterns, status of coastal habitats and storm action (Parry et al 2007). For example, predicted levels of CO_2 are expected to lead to mass bleaching and ocean acidification of coral reefs (Veron et al 2009), presumably with adverse consequences on reef-associated syngnathids. In the Philippines, declines of up to 46% of live coral cover were observed in some sites after the 1997-98 bleaching event, with the northwestern part being most susceptible to elevated sea temperatures (Arceo et al 2001).

SEAHORSE CONSERVATION IN THE PHILIPPINES

Seven species of seahorses are considered globally threatened according to the IUCN Red List of Threatened Species, and there is insufficient information about the remaining six to assess their conservation status. Seahorses have not yet been listed on a national threatened species list in the Philippines.

Conservation actions taken for seahorses in the Philippines to date include no-take MPAs and the voluntary adoption of a 10 cm MSL by fishers. An analysis across MPAs did not show an increase in seahorse numbers, but did reveal an increase in seahorse size, which could lead to enhanced reproduction. However, individual MPAs have shown an increase in seahorse numbers. The MSL seems to have resulted in a stabilizing of seahorse CPUE. MSLs could continue to be an important management tool for target fisheries in the Philippines, but would not be effective for managing bycatch. Non-selective fisheries will be best managed with spatial exclusion of fishing effort – such as more and larger MPAs, or enhanced enforcement of the trawl exclusion zone in municipal waters.

Ensuring that proposed export of the seahorses will not harm wild populations usually relies on developing good management. The CITES Animals Committee has recommended a minimum height of 10 cm as a simple precautionary means of making initial NDFs. Other management options are reviewed in the NDF framework for seahorses, available at www.projectseahorse.org/ndf.

Conservation status of Philippine seahorse species

All ten seahorse species found in the Philippines are now included in the IUCN Red List of Threatened Species, which serves to warn of serious concern but does not itself impose any restrictions (www.iucnredlist.org). Seven seahorse species in the Philippines are listed as 'Vulnerable' on the 2015 IUCN Red List of Threatened Species: *H. barbouri*, *H. comes, H. histrix, H. kelloggi, H. kuda, H. spinosissimus, H. trimaculatus* (IUCN, 2015-4), based on observed, estimated, inferred or suspected population declines of 30% over a 10-year period. These declines are attributed to changes in area of occupancy, extent of occurrence, habitat area or quality and levels of exploitation. The other three species are listed as Data Deficient because there is inadequate information to make an assessment of their risk of extinction based on their distribution and population status: *H. bargibanti*, *H. denise*, and *H. pontohi.*

Seahorses are also found on lists of threatened species on regional, national or local levels but it is important to note that many of these lists do not use IUCN Red List criteria, even where the status names are the same. Again, most of these lists simply warn that a species faces trouble without necessarily supporting or protecting them in any direct manner. There is no national Red List for aquatic species in the Philippines, but plans are underway to have one available in the next year or so as is legislated in the Philippines Fisheries Administration Order on Aquatic Wildlife Conservation (FAO233[2]).

Better information about basic life-history variables relevant to management is needed for seahorse species, particularly to reduce the number of Data Deficient seahorse species on the IUCN Red List and to assist CITES parties in setting export controls (Vincent et al 2011). The national scale of this

[2]www.bfar.da.gov.ph/files/img/photos/fao233v1.pdf

research and conservation enterprise means that co-ordinated contributions from volunteers, such as educational institutions, public aquariums, citizen groups and dive clubs, would be an indispensable asset. Project Seahorse's citizen science initiative for seahorses, iSeahorse.org, provides a very helpful starting point. It harnesses the power of citizen scientists – anyone, anywhere in the world who sees a seahorse in the wild – to improve our understanding of these animals and protect them from overfishing and other threats. Scientists from Project Seahorse and seahorse experts around the world will use the information submitted by citizen scientists to better understand seahorse behavior, species ranges, and the threats seahorses face.

iSeahorse.org was launched in the Philippines in January 2014, since then, over 50 wild observations of a total nearly 250 animals were recorded. Submitted seahorse sightings are from all over the country and one species (*H. pontohi*) was spotted for the first time ever in the Philippines.

Conservation action for seahorses in the Philippines

At least three clear anthropogenic pressures must be addressed for seahorses globally, and in the Philippines specifically: overexploitation in target fisheries, their incidental take in non-selective gear, and threats from habitat degradation. Goals may take the form either of trends (a defined percentage increase) or of targets (a defined number of individuals) and should conserve the evolutionary potential of the species, not just a viable population size (Redding&Mooers 2006; Isaac et al 2007). Regular monitoring of index (or sentinel) populations, fisheries and trades may be the most pragmatic way to assess conservation action.

Seahorse populations will benefit from regulations and practices that protect the animals themselves. Existing restrictions for syngnathids range from complete bans on seahorse capture and exports to requirement for export permits implemented independent of CITES regulations or other trade monitoring measures (as reviewed in Vincent et al 2011). Management measures that may benefit seahorses can be species-specific or they may be generic. Species-specific management measures are those directed at the seahorse species concerned (e.g. a seahorse sanctuary or minimum size limit). Generic management measures are those in place to manage the overall catch or effort of a fishery, and though not specific to seahorses they may confer on them some benefit (e.g. spatial restrictions on destructive fishing activities). Management measures applicable to seahorses are outlined in Project Seahorse guidelines for making Non-Detriment Findings for seahorses, available at www.projectseahorse.org/ndf (Foster&Vincent 2016).

Ecosystem protection

Marine protected areas have gained considerable support globally over the past three decades. In theory, they represent a simple way of spurring ecological, social and economic benefits to the waters they protected and the communities who rely upon them. In reality, their effectiveness is highly variable and dependent upon many influences, ranging from community support and local fishing practices to climate-change impacts (Project Seahorse 2011).

In the Philippines, MPAs are a story of two sides. On one hand, the Philippines is a world leader in MPA implementation, boasting over 1000 protected zones, many of which are run by local community groups (Project Seahorse 2011). MPAs are now a fundamental tool in the effort to fulfill the national target of protecting 15% of coastal waters. On the other hand, most Filipino MPAs are very small, covering only about 3% of the coastline, and many fall woefully short of being truly protected. Finding ways to increase the number and effectiveness of MPAs is imperative to protecting important marine life.

Project Seahorse has used seahorses effectively as flagship species to help generate 34 small, community enforced and managed no-take MPAs in the central Philippines, with sizes ranging from 3.6 to 256 ha (Figure 3). At least nine of these marine reserves were created with the explicit objective of protecting seahorse habitat, among other objectives. iSeahorse has also prompted the creation of a marine protected area (MPA) in Anda, Bohol, adding to Project Seahorse's total of 35 in the region, and the would-be 2nd seahorse sanctuary in the country (the first being in Handumon, Getafe, Bohol). Furthermore, *H. kuda* was one of the threatened species used to inform the placement of Key Biodiversity Areas in the Philippines (CI et al 2009).

There is evidence that MPAs can improve the health of seahorse populations. Published research to date has shown that seahorse body size, but not numbers, increase inside MPAs. A survey of seahorses inside and immediately adjacent to eight MPAs in Danajon Bank, and in four distant unprotected fishing areas, showed these MPAs had no significant effect on seahorse densities; although densities in and near MPAs were higher than in the distant fished sites, seahorse densities did not change over time (Yasue et al 2012). Seahorse size did show a reserve effect, with slightly larger seahorses being found inside MPAs as compared to the distant unprotected fishing areas, presumably with consequent reproductive advantages (Yasue et al 2012). There are a few unpublished datasets, however, that show evidence of increased seahorse densities within individual MPAs (S.M. Buen-Ursua, SEAFDEC-AQC, unpublished data; PS-ZSL, unpublished data).

There are several explanations for why small MPAs did not appear to build seahorse populations in the Philippines. Given the high site fidelity, small home ranges (Foster&Vincent 2004; Curtis et al 2007) and limited swimming ability (Perante et al 1998) of adult seahorses, the MPAs may be too small and isolated (Hansen et al 2011) to enhance seahorse populations inside MPAs. Adult seahorses may be unable to move into MPAs or disperse effectively from one MPA to another. In addition, the very low densities of seahorses outside the MPA sites (for example 5.2 seahorses ha^{-1}; Marcus et al 2007; Yasue et al 2012) means that there may be few sources of juvenile seahorses to populate the MPA sites. Moreover the high dispersal rates of juveniles may limit self-recruitment of seahorses living in MPAs (Morgan&Vincent 2007). Finally, juvenile seahorses undergo an initial planktonic phase in which they are passively drifting in the water column (Foster&Vincent 2004). During this period, seahorses born inside an MPA are much more likely to disperse into fished sites than to other MPAs because the MPAs are surrounded by fished areas and isolated from other MPAs (Yasue et al 2012).

Although MPAs may eliminate local fishing pressure, they may not reduce other threats such as pollution or destructive fishing outside the reserves. Other recovery tools, such as ecosystem-based management, habitat restoration and limits on destructive fishing outside of MPAs, may be necessary to rebuild seahorse populations. Philippine MPAs are also small and largely limited to shallow coral reef habitat (Project Seahorse 2011). MPAs must become large and more diverse if we are to restore ecological integrity.

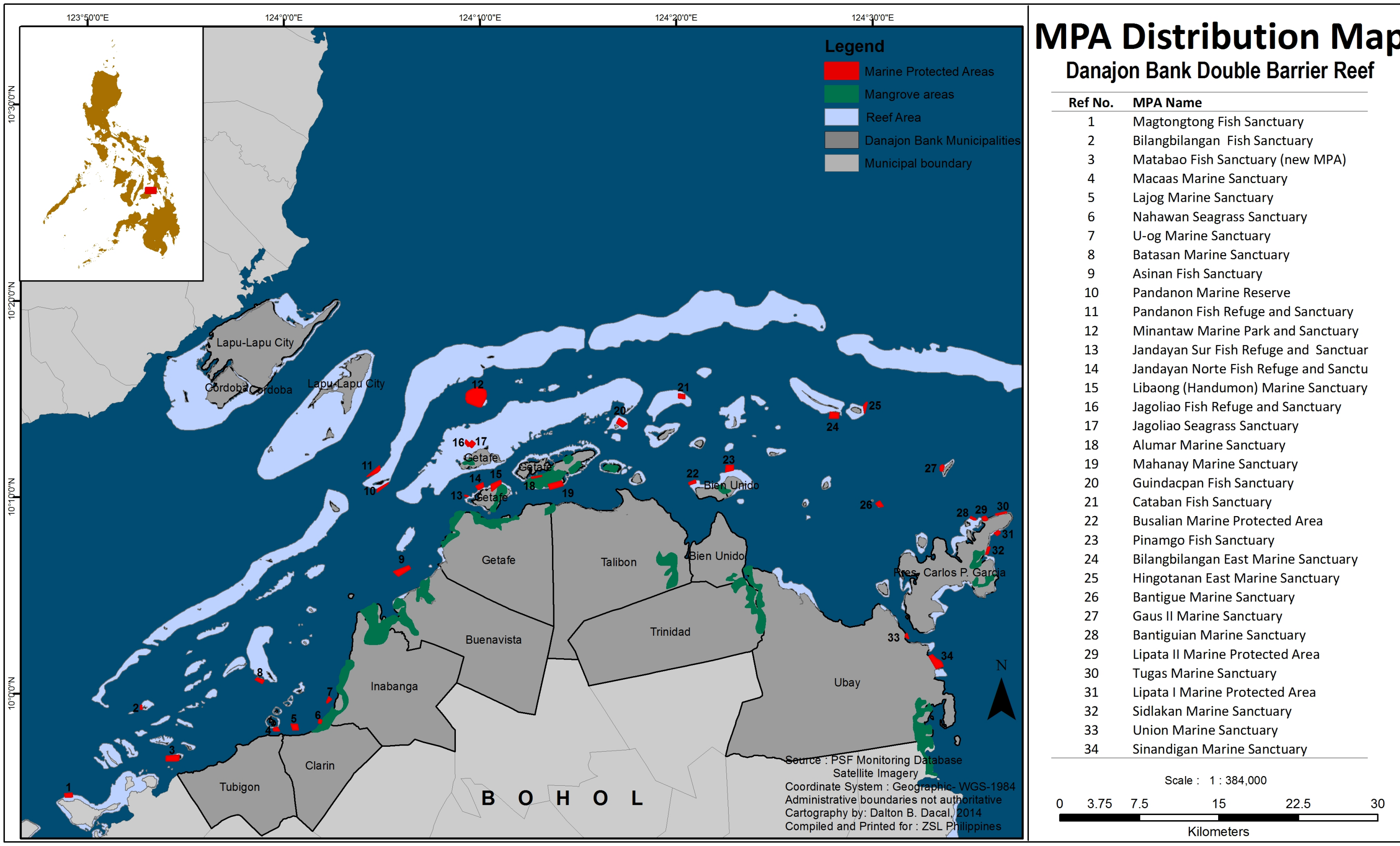

Figure 3. Distribution of community enforced and managed no-take MPAs in the central Philippines.

Fisheries management

Past qualitative and semi-quantitative assessments of seahorse populations in central Philippines suggested that they were overfished (see EFFECTS OF FISHERIES, above), but management of these fisheries was often inadequate or absent, partly because they are data poor – but mainly because they have been "illegal" since 2004. The new Philippines Fisheries Code provides an opportunity to manage these fisheries for sustainability, benefiting both fishes and fishers. Management objectives should focus on rebuilding seahorse stocks, maintaining income for fishers and ensuring long-term persistence of seahorse populations.

In support of sustainable seahorse fisheries, Project Seahorse examined the management options for seahorses in the Philippines (Martin-Smith et al 2004). We sought to develop a management plan for *H. comes* by incorporating expertise from a wide cross-section of involved parties. Management actions were directed towards the following objectives that were developed through our long-term involvement with the fishing community in Bohol:

i. increases in populations of seahorses;
ii. long-term sustainability of populations of seahorses (i.e. low probability of extirpation);
iii. maintenance or increase in catch-per-unit-effort of seahorses;
iv. maintenance or increase in value for the seahorse fishery.

The authors developed a list of eleven management options at a workshop of fisheries experts from a variety of backgrounds. They then undertook an iterative process of consultation involving fishers, traders, consumers, conservationists, aquarists, national and international policy groups).

The creation of no-take Marine Protected Areas (MPAs) and minimum size limits (MSLs) for seahorses were strongly supported by all groups, emerging as the preferred options (Figure 4). Tenure over marine estate was strongly supported but may prove difficult to implement in the Philippines. Sex-selective fishing (leaving pregnant males) had moderate support across all groups but may be relatively easy to introduce because of fisher acceptance. We discussed Philippines MPAs in the previous section, *Ecosystem protection*, and now turn our attention to MSLs.

Starting in 2002, an association of small-scale fishers in the central Philippines decided to adopt a 10 cm voluntary MSL for seahorses to protect against recruitment overfishing (Martin-Smith et al 2004). This limit is endorsed by CITES[3] and is intended to ensure that seahorses were able to reproduce before being fished (Foster&Vincent 2005). It seems that the MSL may have had some effect (Yasue et al 2015). The number of seahorses sold per fisher per day stabilized from 2002, even while the total number sold per day continued to increase. The mean size of the seahorses in trade also increased from 2003, with an apparent and abrupt selection for seahorses larger than 10 cm. Target fishers clearly filtered for size: underwater visual censuses in this region that employed seahorse fishers between 2002 and 2008 indicated that 15% of seahorses were <10 cm in height, whereas between 2003 and 2008 only 2% of landed seahorses were less than 10 cm where the MSL was adopted (Yasué et al 2012).

MSLs are a well-tested approach to managing fisheries that are data limited, largely because they do not require elaborate assessment or enforcement (Foster&Vincent 2005). This is probably because in contrast to large seahorses, the opportunity cost of leaving small seahorses is relatively small (Martin-

[3] https://cites.org/eng/notif/2004/033.pdf

Smith et al 2004). In comparison to this small opportunity cost, since the minimum size limit was part of a community agreement, individuals going against this agreement and selling seahorses may incur a greater cost in terms of community social capital (Pretty&Smith 2004).

It should be noted that on biological merits alone, slot sizes perform better than minimum size limits. Slot limits means that you set both a minimum and a maximum size limit. The aim is to allow seahorses to reproduce before being exploited and to leave the larger and so more fecund individuals in the sea (Foster&Vincent 2016). They may also serve to avoid potential evolutionary size-shifts that could results from minimum size limits alone (Morgan 2007). But it is well known that fisher support for management measures is a prerequisite to their success, and slot sizes were unanimously opposed by small-scale fishers in the central Philippines, primarily because larger seahorses command higher prices in the market (Martin-Smith et al 2004, Figure 4).

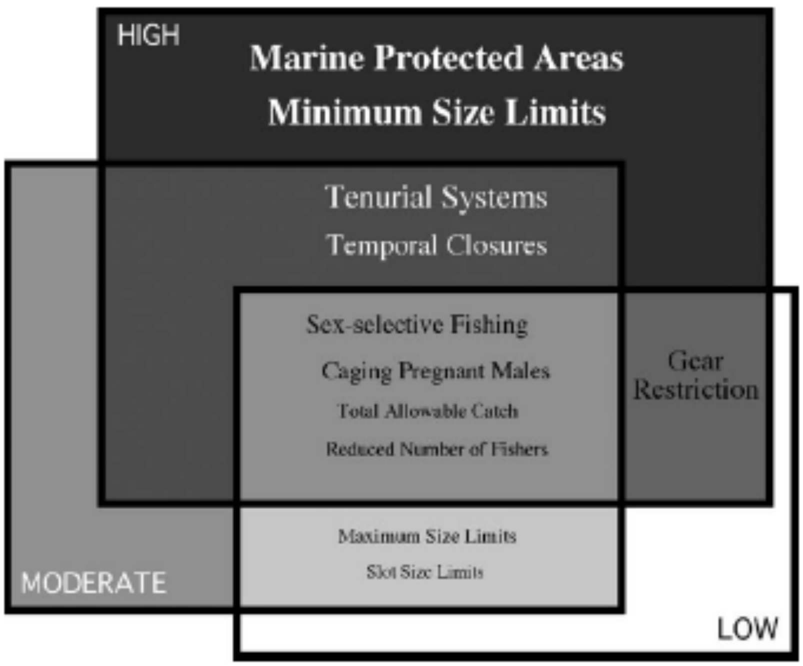

Figure 4. Graphical representation of preferences for management options in a seahorse fishery by stakeholder groups. Each large shaded box represents one of three preference levels: High, Moderate or Low. Areas of overlap indicate different preferences levels by different groups, e.g. temporal closures lie in an area of overlap between High and Moderate preference. Deeper shading represents higher preference levels. Font size for each option is proportional its level of support with maximum size indicating High preference from all stakeholder groups consulted for that option. (Figure from Martin-Smith et al 2004).

MSLs could continue to be an important management tool for target fisheries in the Philippines, but would not be effective for managing bycatch (Foster&Vincent 2005). Fishers targeting seahorses are able to be selective, taking only those larger than the agreed minimum size, and leaving smaller individuals where they are found. Non-selective fishing gears that catch seahorses cannot be selective for seahorse size – mesh size does not matter. Indeed mesh size regulations on fishing nets are not likely to select for seahorses by size, as seahorses have body shapes that get them caught no matter what the mesh size is (Foster&Vincent 2016).

Non-selective fisheries will be best managed with spatial exclusion of fishing effort (Foster&Vincent 2005). It is incredibly helpful that the Philippines already has legislation excluding trawlers and other bottom-contact gears from within 15 km of the coastline (DA-BFAR 1998). Enhanced enforcement of this trawl exclusion zone should greatly reduce the pressure on seahorse populations from these non-selective and habitat-damaging fishing practices.

Trade management/CITES

Implementing CITES in the Philippines means the export of seahorses requires a permit from CITES Management Authorities (MAs) (as summarized in Foster&Vincent 2016). Such an export permit should only be granted when all three of the following conditions have been met: 1) the export of seahorses must not harm wild populations of seahorses; 2) seahorses caught in a way that violated any laws must not be exported; and 3) live seahorses have to be treated humanely when shipped from one country to another.

1) A Non-Detriment Findings (NDF) is how Parties show that exporting seahorses will not harm wild populations. Project Seahorse has developed a framework for undertaking NDFs for seahorses, available at www.projectseahorse.org/ndf. But at the most basic level, three important pieces of information are needed in order to move toward making defensible positive NDFs for seahorse exports:

i. Where are the seahorses in national waters.
ii. Where does existing management overlap with different seahorse species: this will come from layering maps of management measures on top of maps of seahorse distributions.
iii. What are the trends in populations or catch per unit effort (CPUE) for different seahorse species: only then will we know if existing management measures are helping seahorses, or if further work is needed to secure national seahorse populations. Understanding trends in CPUE will require regular monitoring of seahorses. Project Seahorse has developed basic guidelines for such monitoring, available at www.iseahorse.org/trends-landings.

2) Seahorses sourced from activities that violate national laws cannot be traded.
Examples of seahorses sourced in ways that violate national laws:

- Sourced from illegal fishing activities, such as from trawlers operating in areas closed to trawling;
- Taken from inside the boundaries of no-take marine protected areas (MPAs) or reserves;
- Caught during closed fishing seasons;
- Caught even though regional or national laws prohibit fishing seahorses.
- And, of course, if export is banned by national legislation.

3) Live seahorses have to be treated humanely when shipped from one country to another. To understand what this means for seahorses, consult the CITES Guidelines for transport and preparation for shipment of live wild animals and plants at: http://www.cites.org/eng/resources/transport/E-TranspGuide.pdf.

Most species included in CITES Appendix II need management plans in order to grant an export permit – the same is true for seahorses. Ensuring that proposed export of the seahorses will not harm wild populations usually relies on developing good management. Pressures do not have to be a problem for seahorses where they are appropriately and effectively managed. The CITES Animals Committee has recommended a minimum height of 10 cm for all seahorses in trade as one component of an adaptive management plan, and as a simple precautionary means of making initial NDFs (CITES Decision 12.54: www.cites.org/eng/notif/2004/033.pdf). This recommendation is under review and may well increase – and species-specific size limits could be implemented where species are relatively easy to tell apart. Other management options are reviewed in the NDF framework for seahorses (Foster&Vincent 2016).

CAPTIVE BREEDING/AQUACULTURE

Culturing seahorses will only be of conservation benefit if it reduces pressures of exploitation on wild populations. SEAFDEC has undertaken a programme whose aim is to develop ecologically sound strategies for stock enhancement, including hatchery production and release of genetically diverse and disease-free juveniles. So far, research has produced broodstock from hatchery seeds of three species of seahorses, *H. comes*, *H. barbouri* and *H. kuda*. Project Seahorse stresses that the release of captive animals must be approached carefully as it has the potential to severely damage wild syngnathid population – and that **any release should be carried out according to the guidelines of the The Re-introduction Specialist Group (RSG) of the World Conservation Union (IUCN)** (www.iucnsscrsg.org).

Global overview

For many years, seahorses have been cultured by experienced marine hobbyists on a small scale, primarily motivated by an interest in many aspects of seahorse husbandry including breeding (e.g. Giwojna 1990). Commercial aquaculture of seahorses has been repeatedly proposed as one solution to replace wild-caught animals, provide economic opportunities for fishers in developing countries and to meet any future increases in global demand (e.g. Forteath 1997; Payne and Rippingale 2000; Job et al 2002, 2006).

The biggest challenge for seahorse aquaculture in developing countries related to technical problems, such as rearing and disease (Koldewey and Martin-Smith 2010). Seahorse aquaculture faces the same problems as most intensive fish monoculture (Koldewey and Martin-Smith 2010): outbreaks of disease due to the increased vulnerability to infection caused by high stocking densities and elevated stress levels; provision of the appropriate diets at a viable growth rate/cost balance; and environmental issues (Jennings et al 2001). Significant improvements have been made in the culture of seahorse species over the last decade, and many of the issues relating to feeding in particular have been resolved for some species (Koldewey and Martin-Smith 2010). However, live food culture can be expensive in staff time, equipment and consumables and are a significant cost for a seahorse aquaculture operation, particularly with the high demands of frequency of feeding (2–7 times per day).

Culturing will only be of conservation benefit if it reduces pressures of exploitation on wild populations. As developing countries are the major exporters of wild seahorses, well-planned, sustainable aquaculture in these countries has the greatest potential to ensure the benefits for seahorse fishing communities and alleviate the pressure on wild seahorse populations (Koldewey and Martin-Smith 2010).

Proposals to release captive-reared seahorses often emerge in discussions on seahorse conservation and usually ignore a key area of conservation policy. The Re-introduction Specialist Group (RSG) of the World Conservation Union (IUCN) notes that the pressures leading to population declines must have been alleviated and the effects on host populations evaluated before any release can be contemplated (IUCN/SSC 2013; www.iucnsscrsg.org). They further convey that formal releases are lengthy, complex and expensive processes that require preparatory and follow-up activities. They should not be attempted without guaranteed long-term financial political and local support, and the RSG strongly discourages casual releases.

Indeed the release of captive animals must be approached carefully as it has the potential to severely damage wild syngnathid population and marine ecosystems. Release of captive bred seahorses, even in well-intentioned restocking (*e.g.* restocking of *H. hippocampus* along sites on the Canary Islands' coasts, Domínguez&Ferrer 2009), might well convey disease, alter genetics and disrupt social and spatial behaviour of wild conspecifics or congenerics (as with other marine species, Naylor et al 2000). Please refer to the Project Seahorse position statement on "Release of captive-bred and captive-held syngnathids into the wild", available at www.projectseahorse.org/conservation-tools/2015/9/23/release-of-captive-bred-and-captive-held-syngnathids-into-the-wild.

Philippines

Heightened public interest in environmental protection and resource conservation has become an important factor in fisheries development. To address these environmental concerns, particularly those related to threatened or endangered species, SEAFDEC has undertaken a programme whose aim is to develop ecologically sound strategies for stock enhancement, including hatchery production and release of genetically diverse and disease-free juveniles (Ekmaharaj 2008). It is also expected that stock enhancement technologies and social strategies will be transferred to the countries in the region. It initially focuses on depleted species for which hatchery technologies have already been developed and seahorses were chosen for this program. So far, research has produced broodstock from hatchery seeds of at least three species of seahorses, for *H. barbouri, H. comes* and *H. kuda*. Current research in progress includes manipulation of broodstock diets, stock density and feeding of young seahorses (SEAFDEC/AQD 2000; Buen-Ursua et al 2010, 2015). The species are continuously being propagated in the SEAFDEC/AQD hatchery for possible release in Taklong Island Marine Reserve in Guimaras, Iloilo (S Aquaculture Department, Southeast Asian Fisheries Development Center 2013).

SOCIAL, DEVELOPMENT, GOVERNANCE

Fishers' compliance and support are essential to any conservation action for exploited species. Much of the local *in situ* seahorse conservation activity to date has been executed in collaboration with subsistence fishing communities on Danajon Bank, a double barrier reef in the central Philippines (Vincent&Pajaro, 1997). Project Seahorse and its partner in the Philippines, the Project Seahorse Foundation for Marine Conservation, have worked closely with small-scale fishers who depended heavily on catching seahorses (to sell live and dried) for substantial portions of their annual income. Apart from assisting communities to establish MPAs (Samoilys et al 2007; Yasue et al 2010), the teams helped build citizens' groups responsible for MPA management, created an alliance of small-scale fishing families and developed local government capacity for marine resource management.

One key example was the establishment of a lantern fishers' alliance in the central Philippines. Consultations were undertaken in 2002 with some of the poorest fishers in the region, the lantern fishers, to identify the key issues that affected their livelihood security. These were as follows: 1) smaller catches due to over-collecting, and environmental degradation caused by illegal fishing activities; 2) poverty and a lack of alternative livelihood sources; 3) the dependence on middlemen for marketing fish catches, and 4) the lack of a seahorse population management plan. To tackle these issues, the fishers recognised the need for strict enforcement of fishing laws; development of sustainable new livelihoods; and the conservation of natural resources.

In order to implement these activities, it was agreed that a lantern fishers' alliance would be established in the northern Bohol province. As interest and commitment to marine conservation by the fishers grew, the idea to expand the alliance to a Danajon Bank-wide organisation of lantern fishers emerged. This would bring together four neighbouring provinces - Bohol, Cebu, Leyte and Southern Leyte to develop a marine resource management plan for the sustainable use of the coral reefs. In July 2002, KAMADA (The Alliance of Lantern Fishers in Danajon Bank) was formed. In 2003, membership was widened to all fishers and at its peak KAMADA was a federation of fishers' organisations with over 540 members and is composed of 16 independent barangay (village) level people's organisations. Project Seahorse supported KAMADA in organisational development and leadership capacity building. With this support, KAMADA developed a three-year strategic plan including its vision, mission statement, goals and annual operational plans.

KAMADA is not presently active, but nonetheless the organization demonstrates how effective stakeholder groups can be in advancing marine management and conservation in the Philippines. We here touch on three of KAMADAs key activities.

Tackling illegal fishing

KAMADA, with support from Project Seahorse, established dialogue with the Local Government Units (LGUs) with regard to illegal fishing in the area. In 2003, KAMADA compiled a list of fishers involved in illegal fishing on the Danajon Bank. This consolidated list was presented to the Governor of Bohol Province. In response, KAMADA signed a Memorandum of Understanding with the Governor, which enabled members of KAMADA to be deputized as fish wardens. Through working with the LGUs, KAMADA had the authority to help control illegal fishing. At least three illegal operators were apprehended, cases against compressor divers filed in court and illegal fishing totally stopped in Sagise barangay.

Marine Protected Areas

The KAMADA chapters in Sinandigan and Sagise villages established three new MPAs in order to build up diminished fish stocks. Project Seahorse facilitated the establishment of the MPAs in conjunction with barangay officials, Bohol Environmental Management Office and the municipal LGUs. Government funding was been secured for their management by KAMADA. The initial results of the biological surveys and monitoring undertaken by Project Seahorse indicated that the health of the coral reef and fish stocks was recovering.

Sustainable fisheries

KAMADA worked closely with Project Seahorse to develop a management plan for the seahorse fishery that would enable the sustainable harvest of these species, which are largely exported for the traditional medicine industry. A minimum size limit (10 cm) was been adopted in at least five KAMADA chapters. Also, KAMADA actively pushed for the amendment of the Philippine Fishery Code to allow for the sustainable use of species currently listed in Appendix II and III of CITES.

KAMADA served as a critical link in the Danajon Bank connecting resource management efforts with fishers and their families. Through collaboration with local and national government and non-governmental organisations, the fishers and their families strove to protect their natural resources and thus benefit from increased livelihood and food security.

CONCLUSIONS

The vast scale and detrimental effects of the global trade in seahorses led CITES to list all seahorse species (*Hippocampus* spp.) on Appendix II in 2002, with implementation in 2004. This means that 181 countries are required to ensure that exports not damage wild populations and are legally sourced. This report aimed to collate what is known about seahorse exploitation, trade, conservation and management in support of the Philippines eventual implementation of the Appendix II listing for seahorses, under its new Fisheries Code RA10654 Section 102b.

The Philippines was a major known exporter of seahorses in international trade prior to the CITES listing. Philippines fisheries caught millions of seahorses in both target and non-target fisheries. The vast majority of these (~4.2 million individuals) were caught by small-scale fishers targeting seahorses, but an estimated 800,000 seahorses were also caught each year as bycatch – primarily in trawls. These catches entered either the live or dried trade; trade surveys at the start of this century estimated Philippines annual exports of dried seahorses at 4 million seahorses, and live trade at ~400,000 seahorses. Seahorse exploitation and trade in the Philippines became illegal in 2004 as a result of RA8550 Section 97, but fisheries and trades seems to have continued through the ban with supply routes remaining active.

Seahorses in the Philippines can be considered to at risk due to fishing and habitat damage. The exploitation of seahorses in the Philippines has had detrimental impacts on seahorse populations. Past research indicated declines in populations of seahorses from direct exploitation and incidental catch of up to 95% over a ten year period. Fishers cited overfishing, increased competition from more fishers, and indiscriminate catch of seahorses in non-selective gear for the declining catches. Seahorses in the Philippines are under additional pressure due to damage and destruction of their vulnerable near shore habitats. Where there is a loss of seahorse habitat, there will be a loss of seahorses.

Conservation actions taken for seahorses in the Philippines to date include no-take MPAs and the voluntary adoption of a 10 cm MSL by fishers. MPAs did not seem to increase seahorse numbers overall, but did result in an increase in seahorse size, which could lead to enhanced reproduction, and individual MPAs have shown increases in seahorse density. The MSL seems to have resulted in a stabilizing of seahorse CPUE. MSLs could continue to be an important management tool for target fisheries in the Philippines, but would not be effective for managing bycatch. Non-selective fisheries will be best managed with spatial exclusion of fishing effort – such as more and larger MPAs, or enhanced enforcement of the trawl exclusion zone in municipal waters.

Now that seahorse fisheries and trades may be re-opened under the revised Fisheries Code RA10654, the Philippines CITES Authorities will have to ensure three things before they can issue permits for any proposed exports of seahorses: i) proposed exports are not detrimental to wild populations, ii) the specimens have been legally obtained, and iii) that live seahorses are transported humanely. Ensuring that the first of these is met – that proposed export of seahorses will not harm wild populations – usually relies on developing good management. Management options for seahorses are reviewed in the

NDF framework for seahorses, available at www.projectseahorse.org/ndf. But at the most basic level one needs to know overlap of management measures with seahorse populations, and then whether the management measures have doing their job. The latter can only be determined by monitoring trends in seahorse populations or CPUE: only then will we know if existing management measures are helping seahorses, or if further work is needed to secure national seahorse populations.

ACKNOWLEDGEMENTS

Funding for this report was provided by SOS – Save our Species (www.SaveOurSpecies.org) and Guylian Chocolates Belgium (www.guylian.be) through their partnership with Project Seahorse for marine conservation.

REFERENCES

Alino, P. M., Cajipe, G. J. B., Ganzon-Fortes, E. T., Licuanan, W. R. Y., Montano, N. E., & Tupas, L. M. (1990). The use of marine organisms in folk medicine and horticulture: a preliminary study. SICEN Leaflet 1: Supplement of SICEN Newsletter University of the Philippines.

Anticamara, J.A. (2009) Ecology Of Recovering Degraded Reef Communities Within No-Take Marine Reserves. PhD thesis, The University of British Columbia, Vancouver.

Anticamara, J. A., Zeller, D., & Vincent, A. C. (2010). Spatial and temporal variation of abundance, biomass and diversity within marine reserves in the Philippines. Diversity and Distributions, 16(4), 529-536.

Arceo, H. O., Quibilan, M. C., Aliño, P. M., Lim, G., & Licuanan, W. Y. (2001). Coral bleaching in Philippine reefs: coincident evidences with mesoscale thermal anomalies. Bulletin of Marine Science, 69(2), 579-593.

Ban, N. C., Hansen, G. J., Jones, M., & Vincent, A. C. (2009). Systematic marine conservation planning in data-poor regions: socioeconomic data is essential. Marine Policy, 33(5), 794-800.

Baum, J. K. & Vincent, A. C. J. (2005). Magnitude and inferred impacts of the seahorse trade in Latin America. Environmental Conservation 32, 305–319.

Bruno, J. F., & Selig, E. R. (2007). Regional decline of coral cover in the Indo-Pacific: timing, extent, and subregional comparisons. PloS one, 2(8), e711.

Buen-Ursua, S. M. A., Azuma, T., Recente C. P. & Batatin, R. E. (2010). Effects of UV-Treated Sea Water, Chlorinated Sea Water, and Formalin-Treated Copepods on Survival and Growth of Newborn Seahorses, *Hippocampus comes*. The Israeli Journal of Aquaculture - Bamidgeh, IIC:63.2011.629.

Buen-Ursua, S. M. A., Azuma, T., Arai, K. & Coloso, R. M. (2015). Improved reproductive performance of tiger tail seahorse, *Hippocampus comes*, by mysid shrimp fed singly or in combination with other natural food. Aquaculture International, 23, 29-43.

BFAR-JICA (2002) Guide on Paralytic Shellfish Poisoning Monitoring in the Philippines, 2002 and F.A.Bajarias, Red Tide Monitoring Program in the Philippines.

Burke, L., Selig, E., & Spalding, M. (2002). Reefs at risk in Southeast Asia. World Resources Institute, 76pp

Christie, P., Oracio, E.G., Eisma-Osorio, L. (2011). Impacts of the CITES listing of seahorses on the status of the species and on human well-being in the Philippines: a case study. FAO Fisheries and Aquaculture Circular. No. 1058. Rome, FAO. 44pp

(CI) Conservation International Philippines, Department of Environment and Natural Resources-Protected Areas and Wildlife Bureau, Department of Agriculture-Bureau of Fisheries and Aquatic Resources. (2009). Priority Sites for Conservation in the Philippines: Marine Key Biodiversity Areas (Overview). Quezon City, Philippines: Conservation International Philippines.

Courchamp, F., Angulo, E., Rivalan, P., Hall, R. J., Signoret, L., Bull, L. & Meinard, Y. (2006). Rarity value and species extinction: the anthropogenic Allee effect. PLoS Biology 4, 2405–2410.

Curtis, J. M. R. (2004). Life history, ecology and conservation of European seahorses. PhD Thesis, McGill University, Montreal, Canada.

Curtis, J. M. R., Ribeiro, J., Erzini, K. & Vincent, A. C. J. (2007). A conservation trade-off? Interspecific differences in seahorse responses to experimental changes in fishing effort. Aquatic Conservation: Marine and Freshwater Ecosystems 17, 468–484.

Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA–BFAR) (1998). Republic Act No. 8550 – the Philippine Fisheries Code of 1998.

Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA–BFAR). (2004). In turbulent seas: the status of Philippine marine fisheries. Coastal Resource Management Project. Cebu City, Philippines

Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA–BFAR) (2013). Philippine Fisheries Profile. Diliman, Philippines. 36 pp.

Department of Agriculture, Bureau of Fisheries and Aquatic Resources (DA–BFAR) (2015). Republic Act No. 10654 – the Philippines Fisheries Code of 2015.

Domínguez, L. M., & Ferrer, F. O. (2009). Aquaculture and marine biodiversity boost: case examples from the Canary Islands. Water Resources Management, 97, 97-102.

Ekmaharaj, S. (2008). SEAFDEC support to aquaculture programmes in Southeast Asian countries. In A. Lovatelli, M.J. Phillips, J.R. Arthur and K. Yamamoto (eds). FAO/NACA Regional Workshop on the Future of Mariculture: a Regional Approach for Responsible Development in the Asia-Pacific Region. Guangzhou, China, 7–11 March 2006. FAO Fisheries Proceedings. No. 11. Rome, FAO. 2008. pp. 307–315.

Eisma-Osorio, R. L., Amolo, R. C., Maypa, A. P., White, A. T., & Christie, P. (2009). Scaling up local government initiatives toward ecosystem-based fisheries management in Southeast Cebu Island, Philippines. Coastal Management, 37(3-4), 291-307.

Forteath, N. (1997). The large bellied seahorse, Hippocampus abdominalis. A candidate for aquaculture. Austasia Aquac. 11 (3), 52–53

Fortes, M. D. (1995). Seagrasses of East Asia: Environmental and management perspectives. United Nations Environment Programme.

Fortes, M. D., & Santos, K. F. (2004). Seagrass ecosystem of the Philippines: status, problems and management directions. In turbulent Seas: the status of Philippine marine fisheries, 93.

Fortes, M. D. (2013). A Review: Biodiversity, Distribution and Conservation of Philippine Seagrasses. The Philippine Journal of Science, 142, 95-111.

Foster, S. J., & Vincent, A. C. J. (2004). Life history and ecology of seahorses: implications for conservation and management. Journal of fish biology, 65(1), 1-61.

Foster, S. J., & Vincent, A. C. J. (2005). Enhancing sustainability of the international trade in seahorses with a single minimum size limit.Conservation Biology, 19(4), 1044-1050.

Foster, S., Wiswedel, S., and Vincent, A. (2016) Opportunities and challenges for analysis of wildlife trade using CITES data – seahorses as a case study. Aquatic Conserv: Mar. Freshw. Ecosyst., 26: 154–172. doi: 10.1002/aqc.2493.

Foster, S.J. & Vincent, A.C.J. 2016. Making Non-Detriment Findings for seahorses – a framework, Version 3.1. Project Seahorse, The Institute for the Oceans and Fisheries (formerly the Fisheries Centre), The University of British Columbia. 70 pp.

Giles, B. G., Truong, S. K., Do, H. H. & Vincent, A. C. J. (2006). The catch and trade of seahorses in Vietnam. Biodiversity and Conservation 15, 2497–2513.

Giwojna, P. (1990). A Step-by-Step Book about Seahorses. T.F.H. Publications, Inc,Neptune City, USA. 64 pp.

Guieb, E. R. (2008) Community, Marine Rights, and Sea Tenure: A Political Ecology of Marine Conservation in two Bohol Villages in Central Philippines. PhD thesis, Department of Anthropology, McGill University, Montreal.

Hansen, G. J., Ban, N. C., Jones, M. L., Kaufman, L., Panes, H. M., Yasué, M., & Vincent, A. C. (2011). Hindsight in marine protected area selection: a comparison of ecological representation arising from opportunistic and systematic approaches. Biological Conservation, 144(6), 1866-1875.

IUCN (2015). IUCN Red List of Threatened Species. Version 2015.4. <www.iucnredlist.org>. Downloaded on 17 February 2016

IUCN/SSC (2013). Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission, viiii + 57 pp.

Isaac, N. J. B., Turvey, S. T., Collen, B., Waterman, C. & Baillie, J. E. M. (2007). Mammals on the EDGE: conservation priorities based on threat and phylogeny. PLoS ONE 2, 296.

Jennings, S., Kaiser, M.J., Reynolds, J.D. (2001). Marine Fisheries Ecology. Blackwell Sciences, London.

Job, S.D., Do, H.H., Meeuwig, J.J., Hall, H.J. (2002). Culturing the oceanic seahorse, Hippocampus kuda. Aquaculture 214, 333–341.

Job, S.D., Buu, D., Vincent, A.C.J. (2006) Growth and survival of the tiger tail seahorse, Hippocampus comes. J. World Aquac. Soc. 37, 322–327.

Kleiber, D.K. (2014) Gender and small-scale fisheries in the central Philippines. PhD thesis, The University of British Columbia, Vancouver.

Kleiber, D., Harris, L. M., & Vincent, A. C. (2015). Gender and small-scale fisheries: a case for counting women and beyond. Fish and Fisheries, 16(4), 547-562.

Kleiber, D., Harris, L. M., & Vincent, A. C. (2014). Improving fisheries estimates by including women's catch in the Central Philippines. Canadian Journal of Fisheries and Aquatic Sciences, 71(5), 656-664.

Koldewey, H. J. & Martin-Smith, K. M. (2010). A global review of seahorse aquaculture. *Aquaculture* **302,** 131–152.

Kuiter, R. H. (2000). Seahorses, pipefishes and their relatives: a comprehensive guide to Syngnathiformes. Twayne Publishers.

Larkin, S. L. (2003). The U.S. wholesale marine ornamental market: trade, landings, and market options. In *Marine Ornamental Species: Collection, Conservation and Culture* (Cato, J. C. & Brown, C. L., eds), pp. 77–93. Ames, IA: Iowa State Press.

Lawson, J.M., Foster, S.J. and Vincent, A.C.J (in review) Small bycatch of small fishes adds up to big numbers.

Long, J., Napton, D., Giri, C., & Graesser, J. (2013). A Mapping and Monitoring Assessment of the Philippines' Mangrove Forests from 1990 to 2010. Journal of Coastal Research, 30(2), 260-271.

Lourie, S.A. (2004) Phylogeography Of Southeast Asian Seahorses In A Conservation Context. PhD thesis, Department Of Biology, Mcgill University, Montreal

Lourie, S. A., Vincent, A. C. J. & Hall, H. J. (1999). Seahorses: An Identification Guide to the World's Species and Their Conservation. London: Project Seahorse.

Lourie, S. A., Foster, S. J., Cooper, E. W. T. & Vincent, A. C. J. (2004). A Guide to the Identification of Seahorses. Washington, DC: University of British Columbia and World Wildlife Fund.

Lourie, S. A., & Vincent, A. C. (2004). A marine fish follows Wallace's Line: the phylogeography of the three-spot seahorse (Hippocampus trimaculatus, Syngnathidae, Teleostei) in Southeast Asia. Journal of Biogeography,31(12), 1975-1985.

Lourie, S. A., Green, D. M., & Vincent, A. C. J. (2005). Dispersal, habitat differences, and comparative phylogeography of Southeast Asian seahorses (Syngnathidae: Hippocampus). Molecular ecology, 14(4), 1073-1094.

Manila Bulletin (2015). Biggest red tide bloom in 30 years hits Eastern Visayas. http://www.mb.com.ph/biggest-red-tide-bloom-in-30-years-hits-eastern-visayas/#foHq14bATTJtXhj2.99 (Retrieved 20 February 2016)

Masonjones, H. pers. comm.

Marcus, J. E., Samoilys, M. A., Meeuwig, J. J., Villongco, Z. A. D., & Vincent, A. C. J. (2007). Benthic status of near-shore fishing grounds in the central Philippines and associated seahorse densities. Marine pollution bulletin, 54(9), 1483-1494.

Martin-Smith, K. M., Samoilys, M. A., Meeuwig, J. J., & Vincent, A. C. (2004). Collaborative development of management options for an artisanal fishery for seahorses in the central Philippines. Ocean & Coastal Management, 47(3), 165-193.

Martin-Smith, K. M. & Vincent, A. C. J. (2006). Exploitation and trade in Australian seahorses, pipehorses, sea dragons and pipefishes (Family Syngnathidae). Oryx 40, 141–151.

Masuda, H., K. Amaoka, C. Araga, T. Uyeno & T. Yoshino (ed). 1984. The fishes of the Japanese Archipelago. Tokai University Press, Tokyo. 437 pp.

McPherson, J. M. & Vincent, A. C. J. (2004). Assessing East African trade in seahorse species as a basis for conservation under international controls. Aquatic Conservation: Marine and Freshwater Ecosystems 14, 521–538.

Meeuwig, J. J., Samoilys, M. A., Erediano, J. & Hall, H. (2003). Fishers' perceptions on the seahorse fishery in central Philippines: interactive approaches and an evaluation of results. In Putting Fishers' Knowledge to Work Conference. Vancouver, B.C., Canada

Molloy, P. P., Anticamara, J. A., Rist, J. L., & Vincent, A. C. (2010). Frugal conservation: What does it take to detect changes in fish populations? Biological conservation, 143(11), 2532-2542.

Morgan, S. K., & Lourie, S. A. (2006). Threatened Fishes of the World: Hippocampus comes Cantor1850 (Syngnathidae). Environmental biology of fishes, 75(3), 311-313.

Morgan, S.K. (2007) The Ontogenetic Ecology and Conservation of Exploited Tropical Seahorses. PhD thesis, Department Of Biology, Mcgill University.

Morgan, S. K., & Vincent, A. C. J. (2007). The ontogeny of habitat associations in the tropical tiger tail seahorse Hippocampus comes Cantor, 1850. Journal of Fish biology, 71(3), 701-724.

Morgan, S.K. and Panes, H.M. (2008) Threatened seahorses of the world: Hippocampus spinosissimus Weber 1913 (Syngnathidae) Environmental biology of fishes 82(1), 21-22.

Morgan, S. K., & Vincent, A. C. (2013). Life-history reference points for management of an exploited tropical seahorse. Marine and Freshwater Research, 64(3), 185-200.

Murugan, A., Dhanya, S., Rajagopal, S. & Balasubramanian, T. (2008). Seahorses and pipefishes of the Tamil Nadu coast. Current Science 95, 253–260.

Myers, R. A. & Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. *Nature* **423,** 280–283.

Naylor, R.L., Goldberg, R.J., Primavera, J.H., Kautsky, N., Beveridge, M.C.M., Clay, J., Folke, C., Lubchenco, J., Mooney, H., Troell, M. (2000). Effect of aquaculture on world food supplies. Nature 405, 1017–1024.

O'Donnell, K.P. (2011) Uniting historic perspectives, human behaviour, and habitat use to assess the future for overfished seahorses. PhD thesis, The University of British Columbia, Vancouver.

O'Donnell, K. P., Pajaro, M. G., & Vincent, A. C. J. (2010). Improving conservation and fishery assessments with local knowledge: future directions. Animal Conservation, 13(6), 539-540.

O'Donnell, K. P., Pajaro, M. G., & Vincent, A. C. J. (2010). How does the accuracy of fisher knowledge affect seahorse conservation status? Animal Conservation, 13(6), 526-533.

O'Donnell, K. P., Molloy, P. P., & Vincent, A. C. (2012). Comparing fisher interviews, logbooks, and catch landings estimates of extraction rates in a small-scale fishery. Coastal Management, 40(6), 594-611.

Pajaro, M. G., Vincent, A. C. J., Buhat, D. Y., & Perante, N. C. (1997). The role of seahorse fishers in conservation and management. In: Proceedings of the 1st International Symposium in Marine Conservation (pp. 118-126).

Pajaro, M.G. (2010) Indicators of effectiveness in community-based Marine Protected Areas. PhD thesis, The University of British Columbia, Vancouver.

Pajaro, M.G., Mulrennan, M. E., & Vincent, A. C. (2010). Toward an integrated marine protected areas policy: connecting the global to the local. Environment, Development and Sustainability, 12(6), 945-965.

Pajaro, M.G., Mulrennan, M. E., Alder, J., & Vincent, A. C. (2010). Developing MPA effectiveness indicators: comparison within and across stakeholder groups and communities. Coastal Management, 38(2), 122-143.

Pajaro, M. G., N. C. Perante, A. Cruz-Trinidad, & Vincent, A. C. J. (2001). Market analysis of the seahorse fishery in Jandayan Island, Bohol, Philippines. Whitepoint Document, Whitepoint, Nova Scotia.

Pajaro, M.G. & Vincent, A,C.J. (2015) The catch and export of the seahorse trade in the Philippines, pre-CITES. Fisheries Centre Working Report 2015-02

Parry, M. L., Canziani, O. F., Palutikof, J. P. Linden, P. J. V. D. & Hanson, C. E. (2007). Technical summary. Climate change 2007: impacts, adaptation and vulnerability. In Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Parry, M. L., Canziani, O. F., Palutikof, J. P., Linden, P. J. V. D. & Hanson, C. E., eds), pp. 23–78. Cambridge: Cambridge University Press.

Payne, M.F. & Rippingale, R.J. (2000). Rearing West Australian seahorse, Hippocampus subelongatus, juveniles on copepod nauplii and enriched Artemia. Aquaculture 188, 353–361.

Perante, N. C., Pajaro, M. G., Meeuwig, J. J., & Vincent, A. C. J. (2002). Biology of a seahorse species, Hippocampus comes in the central Philippines. Journal of Fish Biology, 60(4), 821-837.

Perante, N. C., Vincent, A. C. J., & Pajaro, M. G. (1998). Demographics of the seahorse Hippocampus comes in the central Philippines. In 3rd International Conference on the Marine Biology of the South China Sea, Hong Kong (pp. 439-448).

Perry, A. L., Lunn, K. E. & Vincent, A. C. J. (2010). Fisheries, large-scale trade, and conservation of seahorses in Malaysia and Thailand. Aquatic Conservation: Marine and Freshwater Ecosystems 20, 464–475.

Peterson, C. H. (2002). Recruitment overfishing in a bivalve mollusc fishery: hard clams (Mercenario mercenaria) in North Carolina. Canadian Journal of Fisheries and Aquatic Sciences 59:96-104.

Philippine Network of Environmental Journalists (PNEJ) (2012). Protecting seagrasses is like protecting our oceans, scientists. http://pnej.org/?p=949 Retrieved 20 February 2016.

Pretty, J., & Smith, D. (2004). Social capital in biodiversity conservation and management. Conservation biology, 18(3), 631-638.

Primavera, J. H. (2000). Integrated mangrove-aquaculture systems in Asia.Integrated coastal zone management, 2000, 121-128.

Project Seahorse (2011). MPAs in the Philippines: Ever more; ever better. Workshop report. 60 pp.

Redding, D. W. & Mooers, A. Ø. (2006). Incorporating evolutionary measures into conservation prioritization. Conservation Biology 20, 1670–1678.

Sadovy, Y. J. & Vincent, A. C. J. (2002). Ecological issues and the trades in live reef fishes. In Coral Reef Fishes (Sale, P., ed.), pp. 391–420. San Diego, CA: Academic Press.

Salmo III, S. G., Lovelock, C. E., & Duke, N. C. (2014). Assessment of vegetation and soil conditions in restored mangroves interrupted by severe tropical typhoon 'Chan-hom'in the Philippines. Hydrobiologia, 733(1), 85-102.

Samoilys, M.A., Meeuwig, J.J., Villongco, Z.A.D., & Hall, H. (2001). Seahorse fishing grounds of Danajon Bank, central Philippines: habitat quality and seahorse densities. Indo-Pacific Fish Conference, Durban South Africa, May 2001. Program Abstracts, p.51

Samoilys, M. A., Martin-Smith, K. M., Giles, B. G., Cabrera, B., Anticamara, J. A., Brunio, E. O., & Vincent, A. C. (2007). Effectiveness of five small Philippines' coral reef reserves for fish populations depends on site-specific factors, particularly enforcement history. Biological conservation, 136(4), 584-601.

SEAFDEC/AQD (2000). Advances in aquaculture research and development. Biennial Report 1998 and 1999. SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines. 32 pp

Aquaculture Department, Southeast Asian Fisheries Development Center. (2013). SEAFDEC/AQD highlights 2012. Tigbauan, Iloilo, Philippines: SEAFDEC, Aquaculture Department.

Selgrath, J.C. pers comm

Stocks, A.S. (2015) Diversification and depletion in Vietnamese seahorse fisheries. MSc thesis. The University of British Columbia, Vancouver.

UNEP-WCMC (2013). A guide to using the CITES database. V8. 23 pp. (available at: http://trade.cites.org/cites_trade_guidelines/en-CITES_Trade_Database_Guide.pdf)

UNEP–WCMC (2015). CITES Trade Database. www.trade.cites.org [accessed 30 October 2015].

Veron, J. E. N., Hoegh-Guldberg, O., Lenton, T. M., Lough, J. M., Obura, D. O., Pearce-Kelly, P., Sheppard, C. R. C., Spalding, M., Stafford-Smith, M. G. & Rogers, A. D. (2009). The coral reef crisis: the critical importance of < 350 ppm CO2. Marine Pollution Bulletin 58, 1428–1436.

Vincent, A. C. J. (1996). The International Trade in Seahorses. Cambridge: TRAFFIC International.

Vincent, A. C. J. & Pajaro, M. G. (1997). Community-based management for a sustainable seahorse fishery. In The 2nd World Fisheries Congress (Hancock, D. A., Smith, D. C., Grant, A. & Beumer, J. P., eds), pp. 761–766. Brisbane: CSIRO Publishing.

Vincent, A. C., Meeuwig, J. J., Pajaro, M. G., & Perante, N. C. (2007). Characterizing a small-scale, data-poor, artisanal fishery: Seahorses in the central Philippines. Fisheries Research, 86(2), 207-215.

Vincent, A. C. J., Foster, S. J., & Koldewey, H. J. (2011). Conservation and management of seahorses and other Syngnathidae. Journal of fish biology,78(6), 1681-1724.

Vincent, A. C., Sadovy de Mitcheson, Y. J., Fowler, S. L., & Lieberman, S. (2014). The role of CITES in the conservation of marine fishes subject to international trade. Fish and Fisheries, 15(4), 563-592.

White, A. T., & De Leon, R. O. (2004). Mangrove resource decline in the Philippines: government and community look for new solutions. In Turbulent Seas: The Status of Philippine Marine Fisheries.

World Bank (2005). Philippines Environment Monitor 2005: Costal and Marine Resource Management. The World Bank, Manila, 76 pp

Yasué, M., Kaufman, L., & Vincent, A. C. J. (2010). Assessing ecological changes in and around marine reserves using community perceptions and biological surveys. Aquatic Conservation: Marine and Freshwater Ecosystems, 20(4), 407-418.

Yasué, M., Nellas, A., & Vincent, A. C. J. (2012). Seahorses helped drive creation of marine protected areas, so what did these protected areas do for the seahorses? Environmental Conservation, 39(02), 183-193.

Yasué, M., Nellas, A., Panes, H., & Vincent, A. C. J. (2015). Monitoring landed seahorse catch in a changing policy environment. Endangered Species Research, 27(2), 95.