# The life history and ecology of seahorses in the Philippines

**DRAFT REPORT**

*in support of eventual CITES implementation for seahorses in the Philippines*

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(Most text extracted from a review of seahorse biology and ecology by Foster & Vincent 2004, with updates)

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Introduction

Seahorses (*Hippocampus* spp.) are among the many genera whose life histories might render them vulnerable to overfishing or other disruptions such as habitat damage. They are generally characterized by a sparse distribution, low mobility, small home ranges, low fecundity, lengthy parental care and mate fidelity (Foster & Vincent 2004). In addition, the male seahorse, rather than the female, becomes pregnant. Indeed, curiosity about this phenomenon explains why currently more is known about reproduction than about other life-history parameters. Such life-history characteristics (notwithstanding exceptions to these generalities) may help explain why 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, and H. trimaculatus* (IUCN 2015-4). The other three species are listed as ‘Data Deficient’, which reflects substantial gaps in knowledge even for heavily exploited seahorses, such as the pygmy seahorses: *H. bargibanti, H. denise,* and *H. pontohi*.

This report aims to synthesize existing information on seahorse life history and ecology in the Philippines to promote management derived from the best-available biological knowledge. Understanding seahorse life history becomes particularly important now that changes in the New Fisheries Code or Republic Act 10654 Section 102 (b) mean that aquatic species listed on Convention on International Trade in Endangered Species (CITES) Appendix II will now be subject to export, unless scientific advice determines that such trade would be harmful to wild populations; all seahorse species are listed on Appendix II of CITES (see report on ‘Exploitation, trade, conservation and management of seahorses in the Philippines’ for more on this). Assessing the sustainability of seahorse exports under CITES, and the fisheries that catch them, requires knowledge of their biology and ecology.

Seahorse taxonomy

Seahorses are bony fishes (teleosts), complete with gills, fins and a swim-bladder (Lourie et al 1999). *Seahorses comprise one genus* (*Hippocampus*) *of the family Syngnathidae,* which otherwise consists of about 55 genera of pipefishes, pipehorses and seadragons (Kuiter 2000). The entire family Syngnathidae falls within the order Gasterosteiformes (Vari 1982; Fritzsche 1984; Palsson & Pietsch 1989; Nelson 1994; Orr 1995) (Figure 1).
Morphology and crypsis

All seahorses have the same basic body morphology and function: a horse-like head positioned at a right angle to an erect body; eyes that swivel independently; a long tubular snout (no teeth) that sucks food; a digestive tract without a differentiated stomach (Rauther 1925; Stoskopf 1993); skin (no scales) stretched over a series of bony plates visible as obvious rings around the trunk and tail; and a prehensile tail (Gill 1905). Adult seahorses have no pelvic and caudal fins, and retain only one propulsive dorsal fin, two small ear-like pectoral fins used for stabilization and steering, and a reduced anal fin (Foster & Vincent 2004) (Figure 2).

Size is a very important biological variable and measuring the sizes of focal organisms is a vital part of studies on growth and reproduction, ecology, behavior, habitat selection, the effects of tagging or other experimental manipulations, as well as for systematics, population assessments and constructing fisheries models (Lourie 2003). For studies to be repeatable and comparable it is essential that specimens be measured using standard methods.
Figure 2. The parts of a seahorse. Figure extracted from Loh et al 2014.

**The height measurement (Ht) is commonly applied to seahorses when measuring size,** particularly when live or in a field situation (Lourie 2003). This measurement is defined as the vertical distance from the tip of the coronet, to the tip of the outstretched tail, with the head held at right angles to the body (Figure 3; Lourie 2003). Height is the most intuitive way to represent seahorse size but can be difficult to measure on a dried seahorse that cannot be straightened (Lourie 2003). In the Philippines, maximum heights recorded for seahorses ranged from the tiny *H. pontohi* (1.4 cm) to the large *H. kelloggi* (28 cm) (Lourie et al 2004; Lourie & Kuiter 2008) (Table 1).

Table 1. Maximum heights recorded for species of *Hippocampus* in the Philippines

<table>
<thead>
<tr>
<th>Species</th>
<th>Maximum recorded height (cm)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>H. pontohi</em></td>
<td>1.40</td>
<td>Lourie &amp; Kuiter 2008</td>
</tr>
<tr>
<td><em>H. denise</em></td>
<td>2.10</td>
<td>Lourie &amp; Randall 2003</td>
</tr>
<tr>
<td><em>H. bargibanti</em></td>
<td>2.40</td>
<td>Gomon 1997</td>
</tr>
<tr>
<td><em>H. barbouri</em></td>
<td>15.0</td>
<td>Lourie et al 1999</td>
</tr>
<tr>
<td><em>H. histrix</em></td>
<td>17.0</td>
<td>Masuda et al 1984</td>
</tr>
<tr>
<td><em>H. kuda</em></td>
<td>17.0</td>
<td>Lourie et al 1999</td>
</tr>
<tr>
<td><em>H. trimaculatus</em></td>
<td>17.0</td>
<td>Masuda et al 1984</td>
</tr>
<tr>
<td><em>H. spinosissimus</em></td>
<td>17.2</td>
<td>Nguyen &amp; Do 1996</td>
</tr>
<tr>
<td><em>H. comes</em></td>
<td>18.7</td>
<td>Meeuwig in litt to S. Foster</td>
</tr>
<tr>
<td><em>H. kelloggi</em></td>
<td>28.0</td>
<td>Kuiter 2000</td>
</tr>
</tbody>
</table>
Project Seahorse has developed a more pragmatic measure for seahorse size – torso length (TsL) (Loh et al 2014). Torso length is the distance between the top of coronet and the base of the dorsal fin (Figure 4), and does not require manipulating the tail into a straightened position (very difficult to do in live animals, and impossible in dried).
Seahorse weights vary with reproductive stage, increasing considerably for females that are carrying eggs and for males that are pregnant (Lourie et al 2004). Some species are sexually dimorphic in length, with males longer than females, and many are sexually dimorphic in proportions, with males having longer tails and females’ longer trunks (Foster&Vincent 2004).

**Seahorses have excellent camouflage capabilities**, with crypsis probably facilitating both prey capture and predator avoidance. They remain virtually immobile for much of the time, can change color over a few days or weeks to match their background better, and sometimes have long skin filaments to blend better with their habitats. Short-term color changes may also occur during courtship and other intra-species interactions (Foster&Vincent 2004).

**Species in the Philippines**


There are 14 known species in SE Asia and so it is possible that the number of seahorse species in the Philippines may increase in the future. Indeed the number of known species increased as recently as
2013. In April of that year photographs from the Philippines of a weedy pygmy seahorse (*H. pontohi*) were submitted to the iSeahorse website (www.iSeahorse.org), which gathers sightings from the public, and have been verified as the first record of this species in the country. The seahorses were spotted near to the island of Romblon, which is one of the provinces that surround the Verde Island Passage. This species was previously only known to inhabit Indonesian waters. The new observation updated the number of seahorse species known to inhabit Philippine waters to a total of ten.

Another pygmy seahorse species (*H. severnsi*) was spotted in Romblon, same site where divers photographed *H. pontohi*. However, this species shares most meristic characters, proportions, body ornamentation with *H. pontohi* (Lourie & Kuiter 2008). The only distinguishing characteristic between the two is color, which normally is not considered as distinctive description. Project Seahorse therefore considers *H. severnsi* as a synonym species to *H. pontohi* (Lourie et al in prep).

### Key Characteristics/Identification

**The ease of seahorse specimen identification varies from species to species.** Very few species (e.g., *H. bargibanti*) are morphologically distinctive enough from other species to be immediately identifiable, but many species such as *H. trimaculatus*, have distinguishing characteristics that allow them to be readily identified (Lourie et al 2004). **The seven common large species in the Philippines can be broadly divided into three groups – “spiny”, “smooth”, and “pygmy”**. Spiny seahorses have spines or spikes covering their bodies, while smooth seahorses do not have (iSeahorse.org: SE Asian Seahorse ID Guide – Annex I). Pygmy seahorses are significantly smaller than other seahorse species.

**Spiny:** *Hippocampus barbouri* is a spiny seahorse with a well-developed usually sharp eye spine and has double cheek spines. Its similar species include spiny *H. histrix*, which has longer snout, shaper and often dark-tipped body spines, and *H. spinosissimus* with deeper body and its cheek spines usually are single while the nose spine is less prominent. Another spiny seahorse is *H. comes*, but it has rugged spines on body, low coronet and the tail can look blotchy or striped.

**Smooth:** *Hippocampus kelloggi* and *H. kuda* are both smooth seahorses and are considered similar species, however, the latter has a deeper body with fewer tail rings and more rounded coronet. Another smooth seahorse is *H. trimaculatus*, which has hook-like cheek and eye spines, and sometimes has three dark spots along back of the body.

**Pygmy:** The three remaining species – *H. bargibanti, H. denise* and *H. pontohi* – are pygmy seahorses which are tiny and well camouflaged. *Hippocampus denise* and *H. bargibanti* are somewhat similar species, but the latter has few or no tubercles, no coronet and has a longer snout. *Hippocampus pontohi* is much less robust overall than *H. bargibanti* and lacks the latter’s very large tubercles and bulbous snout tip (Lourie & Kuiter 2008).

### Distribution and habitat

Seahorses are found world-wide, usually in relatively shallow, coastal tropical and temperate waters. Most species are fully marine although some live in estuaries where they experience fluctuating salinity (Whitfield 1995). Many species in temperate and tropical regions live among seagrasses or eelgrasses while others occur in flooded mangrove forests. Seahorses also live in soft-bottom areas where sponges and sea squirts are abundant, and are found among coral in the tropics (Lourie et al 1999).
Seahorses are found throughout the Philippines (Figure 5 and Annex II.1-II.18). The Philippines is an archipelago comprised of about 7,500 islands (Mayuga 2016). The country’s marine waters contain important marine habitats – coral reefs, seagrass beds, and mangrove forests – and these habitats are where seahorses are mainly found. Seahorses are found throughout the country (Figure 5) with recorded sightings even from the northernmost region or Cagayan Valley (Annex II.3) and the southernmost region or Soccsksargen (Annex II.15).

Project Seahorse has been active in the Philippines for almost 20 years, with activities focused on the Danajon Bank in the central Philippines, which explains the richness of seahorse distribution data in northeastern part of Bohol as well as the defined coverage of the coral reefs and mangrove forests (Figure 5, Annex II.9). With the launching of iSeahorse-Philippines in 2013, Project Seahorse’s work scaled up to national level empowering citizens on a grander scale. Observations from citizen scientists and submitted to iSeahorse prove that there are seahorse species recorded outside from previously known range. Regional maps indicating the distribution of ten seahorse species in the Philippines, with different habitats, are found at the end of this report (Annex II.1 – 18).

In the Philippines, seahorses primarily occupy inshore habitats (Annex III). Three seahorse species (H. kuda, H. barbouri and H. histrix) are known to occur in seagrass beds, sandy sediments, and hard and soft corals. But there are seahorse species spotted in deeper waters (H. spinosissimus, H. kellogi and H. trimaculatus). These seahorses are usually associated with octocorals and deeper sandy bottoms. In contrast, pygmy seahorses, H. bargibanti and H. denise live only on gorgonian sea fans (Annex III) (Lourie et al 2003), and H. pontohi found among bryozoan, hydroid crops and specifically the coralline algae Halimeda and hydroid Aglaphenia cupressina (Lourie & Kuiter 2008). Seahorses in the Philippines are also found on anthropogenic habitats, for example crab traps, gill nets and enclosure pens set on seagrass beds and coral reefs (Pajaro & Vincent 2015).
Figure 5. Seahorse species distribution map with coastal habitats in the Philippines.
Some seahorses change habitat and depth choice as they grow. Hippocampus comes were thought to prefer Sargassum spp. beds in shallow subtidal environments as juveniles, and then move to adjacent communities composed of hard corals and sponges when older (Perante et al 1998).

Most seahorses grasp holdfasts with their tail (Foster & Vincent 2004). Holdfasts could be anything from a sponge to a branching coral, a piece of seagrass or a submerged tree branch. In the Philippines some species exhibited preferences for particular holdfasts for example, H. comes usually grasped sponges in communities dominated by seagrasses (J. Anticamara unpub data) while others exhibited no obvious preference (Perante et al 2002).

Most seahorse species studied to date were active during the day. Documented diurnal species included H. kuda (Do et al 1998, ex situ). Hippocampus comes in the Philippines may also have been active during both day and night, but were most commonly seen at night on reefs, when they emerged from the corals (Perante et al 2002). Hippocampus denise is more active than H. bargibanti and can be often be seen during daytime observations swimming across the surface of the seafan on which it lives (Lourie et al 2003).

Seahorses in the Philippines have been found as shallow as 0.5 m and as deep as 75 m (Annex II). For example fishers reported catching seahorses at different depths (references in Annex II): H. barbouri, and H. kuda at about 0.5 to 4 m; H. spinosissimus and H. trimaculatus from 5 to 20 m; H. kelloggi in waters estimated to be as deep as 35 to 75 m; and H. comes was reportedly landed both in shallow water and water as deep as 20 m.

Density and mobility

Seahorse densities tended to be low and they are patchy in distribution (Foster & Vincent 2004). Reported seahorse densities could be similar in fished and unfished populations, but the low densities in at least some populations probably derived from overexploitation (Foster & Vincent 2004). For example, Filipino fishers reported patchy H. comes densities as high as 20m⁻² on coral, or 10m⁻² in seagrass in the 1960s (Pajaro & Vincent 2015), while they were found at only 0.02m⁻² in the late 1990s (Perante et al 2002). Densities of H. spinosissimus were approximately five times more abundant than H. comes, which may represent real differences in the population sizes of these niche-separated congeners (Morgan 2007). Densities of the other seahorse species in the Philippines are unknown.

Most seahorse species studied thus far maintained individual home ranges, at least during the breeding season (Foster & Vincent 2004). As two examples, H. comes often ranged only 1m² on coral reefs at night (Perante et al 2002), although they moved considerably more on seagrass beds (J. Anticamara unpub data), and H. kuda had overlapping home ranges of 32-35 m² in a tropical eelgrass bed (C. Choo unpub data). While most species studied to date made limited daily movements, adults of some species may have made seasonal migrations to deeper waters in the winter months (Foster & Vincent 2004), including H. comes (J. Meeuwig unpub data).

Adult dispersal over large distances appeared primarily to occur when adults were cast adrift by storms or carried away while grasping floating debris (Foster & Vincent 2004). Young seahorses are more likely to disperse than adults. Some species were clearly planktonic immediately after birth, as juveniles were found in plankton samples. Juveniles of other seahorse species were inferred to be planktonic because they were positively phototactic immediately after leaving the pouch, rising to the
surface of the water column in captivity, or not settling immediately after birth in the wild (Foster & Vincent 2004). Philippine species that are known or inferred to be planktonic after birth include *H. bargibanti* (inferred), *H. comes* (known with 9.66-16.58 mm pelagic duration), *H. kuda* (inferred with 19-22 days pelagic duration) and *H. spinosissimus* (known with 6.52-23.8 mm pelagic duration) (refs in Foster & Vincent 2004).

Recent studies of seahorse population genetic structure over a range of dispersal distances produced conflicting results, according to species, the geographic region and the molecular marker used (Foster & Vincent 2004). For example, *H. comes* in the central Philippines appeared to have restricted gene flow based on microsatellites over a distance of 135km, through isolation by distance (Casey 1999). Deep genetic breaks were found among individuals of both *H. kuda* and *H. trimaculatus* collected only 800 km apart in Southeast Asia based on cytochrome *b* sequencing (Lourie et al 2004). In contrast, the same study of *H. trimaculatus* revealed identical genetic haplotypes across distances of up to 10,000 kms along the Asian continental shelf, suggesting extensive gene flow over the 10,000 years (Lourie et al 2004). A similar study, also using cytochrome *b* sequencing across Southeast Asia, shows distinct phylogenetic breaks within *H. barbouri*, but extensive gene flow in *H. spinosissimus* (Lourie et al 2005).

**Life span and mortality**

*Inferred life spans for seahorse species ranged from about 1 year in the very small species to an average of 3 to 5 years for larger species* (e.g. *H. comes*, J. Meeuwig unpud data, *in situ*; Morgan 2007) (Foster & Vincent 2004). As with life span, natural mortality rates were unknown for almost all seahorse species (Foster & Vincent 2004). *Hippocampus comes* was estimated to have a high rate of natural mortality (*M* = 2.7, Morgan & Vincent 2013).

Sub-adult and adult seahorses are presumed to have few natural predators because of their camouflage capabilities, and unpalatable bony plates and spines (Lourie et al 1999). Predation coinciding with high syngnathid densities suggests their predators are foraging opportunistically rather than targeting syngnathids as prey (Kleiber et al 2010). Invertebrates, fishes, sea turtles, waterbirds and marine mammals were all syngnathid predators (Kleiber et al 2010). Seahorses were preyed upon by anglerfish, flatheads and sea urchins (Kuiter 2000). Predation by such pelagic fishes suggests that seahorses may be found in the open ocean more regularly than previously thought (Kleiber et al 2010). In one account of predation by pelagic stingray, stomach contents included both seahorses and sargassum weed (Wilson & Beckett 1970). While predators may have ingested sargassum-associated prey in a demersal zone, it seems more likely that the seahorses were attached to floating sargassum in pelagic waters: such rafting of seahorses associated with floating plant material has been reported (Sharpe 1998). A seahorse was also recorded from the stomach of a loggerhead seaturtle (Burke et al 1993), and seahorses were taken by cormorants, penguins and other water birds (Kuiter 2000). Partial predation by crabs may be a threat to seahorses, as indicated by direct observations of seahorses with shortened tails (Baum et al 2003; A. Vincent, pers. obs.). Predation mortality was probably greatest in juveniles that were highly vulnerable to piscivorous fish and planktivorous organisms (J. Curtis pers comm, A. Vincent pers obs).

Feeding and growth

Seahorses are ambush predators, and consume primarily live, mobile prey types (James & Heck 1994; Bergert & Wainwright 1997). When feeding within the water column, they wait until prey comes close to the mouth, whereupon, they are drawn up into the long snout with a rapid intake of water (Foster & Vincent 2004). They ingest any organism small enough to fit into their snout; mostly small crustaceans such as amphipods, but also fish fry and other invertebrates (Boisseau 1967; Tipton & Bell 1988; Do et al. 1998; Teixeira & Musick 2001). Wild seahorses do not appear to target plants or algae (H. trimaculatus, Do et al. 1998).

Growth rates for seahorse species have not been investigated in any detail. There were few data on growth rates in captivity, and even fewer in the wild, with none of the data covering enough of a size range to give a clear picture of lifetime patterns of seahorse growth. The average growth of H. comes in captivity was reported at 0.66 mm day$^{-1}$ (Job et al. 2006), which is substantially less than that of H. kuda, which averaged between 0.90 and 1.53 mm day$^{-1}$ in terms of standard length (Job et al. 2002).

Reproduction

Available information on reproduction for Philippine seahorse species is summarized in Table 2.

Reproductive timing

Smaller seahorse species mature at younger ages than larger seahorse species. Smaller seahorse species appeared to mature at 3 months (Strawn, 1953). Hippocampus barbouri reached maturity at 4 or 5 months (Wilson & Vincent, 1998), while many other species were thought to start breeding in the season after birth, at 6 months to 1 year (H. kuda, Jiaxin, 1990; H. spinosissimus, H. trimaculatus, Truong & Nga, 1995; H. comes, J.J. Meeuwig, unpubl. data).

For seahorses, body size served as a better predictor of first maturity than age of individuals (Foster & Vincent 2004). For example, H. trimaculatus populations in the South China Sea and North China Sea both matured at the same size, but the former were three months old while the latter were five months old (Cai et al. 1984a). Seahorse size at maturity was closely correlated with seahorse maximum height, and seahorses showed the same relationship between size at first maturity and maximum size as other marine teleosts (Foster & Vincent 2004).
Table 2. Reproduction information for seahorses in the Philippines (extracted from Lourie et al 2004; Lawson 2014)

<table>
<thead>
<tr>
<th>Species</th>
<th>Breeding Season</th>
<th>Height at physical maturity (cm)</th>
<th>Height at sexual maturity (cm)</th>
<th>Gestation Duration</th>
<th>Length at birth (mm)</th>
<th>Brood size</th>
<th>Young SH</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. bargibanti</td>
<td>Year round</td>
<td>1.3</td>
<td></td>
<td>average 2 weeks</td>
<td>average 2</td>
<td>34 from one male</td>
<td>planktonic (inferred)</td>
<td>Tackett in litt to Foster (2002), Whitley (1970)</td>
</tr>
<tr>
<td>H. Denise</td>
<td>Pregnant males have been found in February, May &amp; October (suggesting a year-round breeding season)</td>
<td>1.1</td>
<td>1.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lourie and Randall (2003) Lourie et al 2004</td>
</tr>
<tr>
<td>H. histrix</td>
<td></td>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lourie et al. (1999)</td>
</tr>
<tr>
<td>H. kelloggi</td>
<td></td>
<td>15.0</td>
<td>14.9 – 18.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lawson (2014) Lourie et al. (1999)</td>
</tr>
<tr>
<td>H. kuda</td>
<td>Breeding season year round</td>
<td>14.0</td>
<td></td>
<td>17 days</td>
<td>7</td>
<td>max reported: 1405</td>
<td>Pelagic duration of larvae: 19-22 days</td>
<td>Truong and Doan (1994), Mi et al. (1998), Foster and Vincent (2004), Jiaxin (1990)</td>
</tr>
<tr>
<td>H. spinosissimus (H. alatus)</td>
<td>Year round, peaking May to October</td>
<td>9.4 – 10.5</td>
<td>10.4</td>
<td></td>
<td>max reported: 683</td>
<td>Pelagic duration of 6.52-23.8 mm</td>
<td>Truong and Doan (1994), Truong and Nga (1995), Lawson (2014), S. Morgan, unpub data</td>
<td></td>
</tr>
<tr>
<td>H. trimaculatus</td>
<td>Breeding season year round, peaking March to May and in October</td>
<td>9.02 – 9.08 cm</td>
<td>11.6 – 12.8 cm</td>
<td>16 days</td>
<td>average 6 mm</td>
<td>max reported: 1783</td>
<td></td>
<td>Truong&amp;Nga (1995), Cai et al. (1984), Foster&amp;Vincent (2004), Nguyen&amp; Do (1996), Lawson (2014)</td>
</tr>
</tbody>
</table>
Conservation concern and pragmatism will dictate that the presence of a fully developed pouch will still be a key index of sexual maturity. In seahorses the most commonly used determinant of sexual maturity was the presence of a fully developed brood pouch in the males (Perante et al 1998; Wilson & Vincent, 1998; Baum et al 2003). The only species that lack externally obvious pouches are the pygmy seahorses *H. bargibanti* and *H. denise* (Lourie & Randall, 2003). While this variable allows one to infer maturity without having to kill the animals, the developed brood pouch may not indicate physiological maturity. In *H. trimaculatus*, for example, the first fully developed brood pouch appeared at 80–90 mm Ht, but dissection of the testes revealed the size at first maturity to be 120 mm Ht (Cai et al 1984a). As an alternative, some studies defined sexual maturity as the size of the smallest recorded pregnant male (Nguyen & Do 1996). This method also presented problems as males may have matured some time before they mated, especially where low seahorse densities or a skewed sex ratio reduced mating opportunities. Such error would result in an overestimation of size at onset of maturity (Foster & Vincent 2004). Ideally **size at first maturity should be defined as size when 50% of the males in a population first breed**; this point can only be deduced from meticulous behavioral analysis in the field or dissection of testes in destructive sampling.

Conservation concern and pragmatism also mean that female size at maturity is most likely estimated by assuming females mature at the same size as males (Foster & Vincent 2004). Methods for determining onset of female maturity were even more varied than those for males, and include the size at which ovaries appeared (Kanou & Kohno 2001), the size of the smallest recorded female with hydrated eggs (Nguyen & Do 1996) and the size of the smallest recorded female to release her eggs (Cai et al 1984a). All these methods require either dissection of females in destructive sampling or meticulous behavioural analysis in the field.

Overfishing assessments for seahorses can differ based on how length at maturity is defined, a variable that is often the cornerstone of data-poor assessment methods; comparing size at maturity to size at which 50% of specimens are retained in fishing gear is a common data-poor assessment method for teleosts (e.g. Rueda & Defeo 2003; Foster & Vincent 2005; Kuparinen et al 2009; Foster & Vincent 2010). Length at maturity can be defined as size at physical maturity or size at onset of reproductive activity. For seahorses, physical maturity is not always indicative of behavioural or physiological maturity (Cai et al 1984; Morgan & Vincent 2013). Studies have shown this to be the case for *H. comes* in the Philippines (Morgan & Vincent 2013), and *H. kelloggi, H. spinosissimus* and *H. trimaculatus* in Malaysia (Lawson et al 2015) (see Table 2). In the Malaysian study, height at first capture was either similar to or greater than height at physical maturity for all species. This could suggest that, on average, seahorses were able to reproduce before becoming vulnerable to capture. However, when height at first capture was compared to height at reproductive activity, it seems that all three species were being captured well before they actually started reproducing and are therefore unable to contribute to the next generation. **Therefore, the common practice of using external indicators of maturity for seahorses** (e.g. *H. trimaculatus: Murugan et al 2009; H. kelloggi: Lourie et al 1999; H. spinosissimus: Nguyen & Do 1996) would underestimate potential for fishing impact. Ideally, **length at maturity should always be defined as the point where reproductive activity begins**. This is especially true for rare or endangered species where maturity is often determined externally [e.g. skates and rays: Estalles et al 2011; fin whales: Aguilar & Lockyer 1987; leatherback turtles: Stewart et al 2007] (as cited in Lawson et al 2015).
Timing and length of breeding season

The timing and length of the breeding season for seahorses varied with location, and could be influenced by environmental parameters such as light, temperature and food availability (Bye 1984). *Hippocampus trimaculatus* had a peak in breeding from March to May in the China Sea (Truong & Nga 1995), but bred consistently year round ex situ if temperatures were kept constant (Cai et al 1984a). Pregnant *H. comes* were found year round in the Philippines, where water temperatures were fairly constant, but with a peak in the number of pregnant males between July and December, corresponding to the rainy season (Perante et al 2002). Any one individual animal may have mated for only a portion of the entire breeding period (Foster & Vincent 2004).

Mating patterns

All seahorse species appeared to be monogamous within a single breeding cycle, the male accepting eggs from only one female (Foster & Vincent 2004) (Table 3). Monogamy probably acts to increase the reproductive success of fishes found in low densities, that have low mobility, and that depend on camouflage as a defense against predation (Barlow 1984, 1988; Vincent & Sadler 1995). Seahorses may have experienced increased reproductive efficiency from mating with the same partner, resulting in larger broods and reduced time spent on courtship (Foster & Vincent 2004).

Table 3. The occurrence of social groupings and mating patterns for seahorse species found in the Philippines. The nature of study is indicated (*ex situ*, *in situ*).

<table>
<thead>
<tr>
<th>Species</th>
<th>Social grouping</th>
<th>Mating pattern</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>H. bargibanti</em></td>
<td>Pairs (<em>in situ</em>)</td>
<td></td>
<td>Tackett &amp; Tackett 1997</td>
</tr>
<tr>
<td><em>H. barbouri</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>H. comes</em></td>
<td>Pairs (<em>in situ</em>)</td>
<td>Monogamous</td>
<td>Perante et al 2002</td>
</tr>
<tr>
<td><em>H. histrix</em></td>
<td>Pairs (<em>in situ</em>)</td>
<td></td>
<td>Kuiter &amp; Debelius 1994</td>
</tr>
<tr>
<td><em>H. Denise</em></td>
<td>Pairs</td>
<td></td>
<td>Lourie &amp; Kuiter 2008</td>
</tr>
<tr>
<td><em>H. kelloggi</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>H. kuda</em></td>
<td></td>
<td>Monogamous</td>
<td>Mi 1993</td>
</tr>
<tr>
<td><em>H. pontohi (H. severnsi)</em></td>
<td>Pairs</td>
<td></td>
<td>Lourie &amp; Kuiter 2008</td>
</tr>
<tr>
<td><em>H. spinosissimus (H. alatus)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>H. trimaculatus</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Monogamy, where it occurred, appeared to be reinforced by daily greetings (Foster & Vincent 2004). Morning interactions continued all through the pregnancy, and may have helped synchronize female egg preparation to the end of male pregnancy. On the day the male gave birth, or the next day, the routine greeting was prolonged into a courtship and mating. Given their inferred dependence on camouflage, it was surprising that seahorse courtships in situ were colourful, active and lengthy, lasting up to 9 hours (Vincent & Sadler 1995).
Egg and clutch size

In general for seahorses, larger eggs produced larger young. A study of 11 seahorse species found that the dry weight of individual eggs was positively correlated with the dry weight of individual young (Vincent 1990).

Recorded female clutch sizes (total number of eggs deposited or dropped in one mating) ranged from five (Vincent 1990) to over 1000 eggs (Teixeira & Musick 2001). Comparative analyses of clutch size were precluded by the great variation in methods used to determine clutch size, with some studies reporting the size of dropped clutches (Vincent 1990; Lawrence 1996), and others using histology of the ovaries (Strawn 1958; Boisseau 1967); this latter approach is problematic because seahorse ovaries spiral out, with eggs constantly maturing and being shed from the outer layer (Wallace & Selman 1981). Direct measurements of egg transfer would only be possible by intrusion into the male’s pouch, probably through destructive sampling. The difficulty in measuring clutch size was clear from the fact that three of the five estimates of maximum clutch size were smaller than the maximum brood size, despite monogamy within a particular reproductive cycle, for all species.

Pregnancy

Seahorses invest heavily in the development of each of their young. During mating the female seahorse deposits her entire clutch of eggs in the male’s brood pouch, where they are fertilized (ensuring paternity), whereupon the male seals the pouch shut (Foster & Vincent 2004). Both male and female seahorses exhibit visible evidence of having mated, as the female girth diminishes and the male pouch fills (Vincent & Sadler 1995).

Seahorse embryos develop in a marsupium that acts much like the mammalian uterus. The developing embryos are protected and provided with oxygen through a capillary network, while the pouch acts as an adaptation chamber with the osmolarity of the fluid inside the pouch changing from that of body fluids to that of salt water as pregnancy progresses (Linton & Soloff 1964). The male hormone prolactin in the pouch initiates enzymatic conversion of proteins of vitellogenic (maternal) origin which nourish the embryos (Boisseau 1967), along with male-contributed inorganic compounds (Linton & Soloff 1964). Waste products diffuse out into the male’s blood stream for removal (Linton & Soloff 1964). After fertilization, the pouch becomes spongy, vascularized and distended (Wetzel & Wourms 1991). The eggs induce pits in the wall of the pouch which become compartmentalized and then are enveloped in epithelial tissue until the end of yolk absorption (Boisseau 1967; Wetzel & Wourms 1991).

Across seahorse species the duration of the male’s pregnancy (gestation duration) ranged from approximately 9 to 45 days, depending on species and water temperature (Foster & Vincent 2004). Males of all species studied to date went through several pregnancies in a single breeding season, the number of pregnancies depending on the length of brooding and the length of the season: for example individual male H. comes were observed to undergo repeated pregnancies during a year (Perante et al 2002).

It is possible to calculate the maximum possible number of young produced by a pair of seahorses in a given year. Assuming that males became pregnant the day after giving birth, then the number of days available for breeding divided by average gestation duration produces an estimate of the maximum possible number of pregnancy events per year for a species. This multiplied by the
maximum possible brood size gives an estimate of the maximum annual reproductive output for a species. Estimates ranged from approximately 388 ± 172 for H. comes (Morgan 2007) to over 29,000 young for H. kuda (Vincent&Sadler 1995).

Young and brood

At the end of pregnancy males go into labor (usually at night), actively forcing the brood out of his pouch for hours (Vincent 1990). Young resemble miniature adult seahorses, complete with hardened fin rays, trunk rings and pigmentation (Boisseau 1967; Gomon&Neira 1998; Mi et al 1998). They are independent from birth and receive no further parental care.

Total reproductive success is ideally calculated as the total number of offspring that reach sexual maturity from the lifetime output of an individual. This is the product of the number of offspring produced per mating event, number of mating events per season, number of reproductive seasons and offspring survival (Clutton-Brock 1988). The latter two components are very difficult to measure for wild fish because an individual can seldom be tracked throughout its life. As a result, presumed indicators of reproductive success that are easier to measure are employed, such as number and size of offspring (Wootton 1990; Cole&Sadovy 1995; Vincent&Giles 2003).

Brood size is the number of young per pregnancy released by a male in one birth cycle. Males of most seahorse species produced about 100–300 young per pregnancy (Foster&Vincent 2004). Bigger seahorses produce more young across species; maximum reported brood size was positively related to maximum body size across species.

Larger parents may also produce fitter young. Large parents of H. kuda are known to produce offspring with postnatal growth that is significantly higher than the offspring from younger and smaller parents (Dzyuba et al 2006). Under ex situ conditions, the young from larger parents also exhibited increased rates of survivorship, relative to the young from smaller parents (Dzyuba et al 2006). Researchers have also observed that large H. comes males produce both a greater number of young and larger offspring than smaller fathers (S. Morgan, unpub data).

Research needed for conservation and management

Distribution

The distribution of most seahorse species in the Philippines remains poorly defined – both across the Philippines and more specifically by depth and habitat (see Figure 5, Annex II.1-18). It is important to understand where the seahorses are so we can evaluate overlap with both pressures (such as fishing effort) and management measures (such as MPAs). Understanding partitioning of habitat by size and/or age classes, or life history stage, can be important for developing management strategies, especially when addressing the effects of non-selective fishing gear. For example, a greater understanding of how seahorses segregate by size or sex would enable spatial management of trawling and use of other non-selective gear to reduce indiscriminate fishing pressure on vulnerable cohorts or classes. If reproductively active animals were concentrated in particular areas (e.g. Baum et al 2003), then trawling could be redirected away from these regions during important breeding periods. Also, if sub-adult seahorses were found in shallower water than adult seahorses (as is the case with H. comes in
the Philippines, Perante et al 1998), then elimination of trawling activities from shallow zones might reduce the risk of recruitment overfishing.

**Movement**

Understanding seahorse movement is also important for evaluating pressures and the potential utility of management responses. Seahorses may recover particularly slowly if inferences that their limited mobility and dispersal anchor the continuum of fish movement hold true (Jennings 2000). Nonetheless, the small home ranges of *H. comes* mean that existing populations will be secure within MPAs, since only animals on the edge should be vulnerable to fishing pressure (Chapman & Kramer 2000).

**Population size**

There are no available population estimates for seahorses in the Philippines such that population inferences must instead often be drawn from trade surveys (See report on “Exploitation, trade, conservation and management of seahorses in the Philippines” for details). While fishers’ and traders’ reports and records of changes in trade volumes are invaluable, they often lack information on the effort involved in obtaining the animals, thus diminishing the worth of the data for population estimates.

Priority research for seahorses in the Philippines includes obtaining long-term population or catch time series. Insight into seahorse population health, the adverse impacts of stresses such as fishing practices, and the effectiveness of management tools, can be found by monitoring seahorse populations or catches over time for changes in any of the following parameters:

- Geographic distribution (presence/absence across space).
- Relative abundance [population size and/or catch per unit effort (CPUE)].
- Mean size of animals.
- Frequency of male pregnancy (indicates disruption of breeding activities).
- Sex ratio.

Monitoring for indicators of adverse impacts from fishing activities can occur on two levels: 1) **Population monitoring** – usually consists of underwater surveys of seahorse populations (using SCUBA or snorkel), but may also involve using pushnets or other gears to systematically survey seahorses in shallow waters. Project Seahorse has a toolkit for underwater seahorse monitoring, available at [www.projectseahorse.org/NDF](http://www.projectseahorse.org/NDF) and [www.iseahorse.org/trends-underwater](http://www.iseahorse.org/trends-underwater), and can provide guidance for Parties wishing to try other means. 2) **Fisheries monitoring** – monitor catches, including discards where possible – or at least landings. The key to fisheries dependent monitoring is to **collect information on fishing effort** – the data are only truly useful and dependable if they are accompanied by a measure of effort. Project Seahorse has a toolkit for monitoring seahorse landings at ports, available at [www.projectseahorse.org/NDF](http://www.projectseahorse.org/NDF) and [www.iseahorse.org/trends-landings](http://www.iseahorse.org/trends-landings). There are of course many other approaches to fisheries dependent monitoring, such as on-board observers, deployment of Vessel Monitoring Systems (VMS) and/or onboard cameras.
Survival

Data on natural mortality/survival rates of seahorses, particularly if age or stage specific, are important parameters for modeling population viability and devising management plans (Macpherson et al 2000), but are virtually nonexistent for most Philippines seahorses (Foster & Vincent 2004).

Fishing mortality remains virtually unknown for most seahorse populations, despite the importance of such data in formulating catch guidelines for a sustainable fishery. Some research indicates that fishing mortality of fish that have spawned once must be lower than natural mortality for the fishery to be sustainable (Myers & Mertz 1998). For *H. comes*, even with high estimates of natural mortality in some parts of their range, fishing mortality exceeded those rates (Martin-Smith et al 2004, Meeuwig et al 2006). Presumably as a consequence, fishers reported that *H. comes* catches on one Philippines barrier reef had declined 70% in the 10 years from 1985 to 1995 (Vincent 1996), with associated changes in the length–frequency distribution of the catch (Perante et al 1998); more data of greater precision are needed to determine whether fishers had begun targeting smaller seahorses or whether the size structure of the seahorse populations had changed under exploitation. See the report “Conservation and management of seahorses in the Philippines” for more information on fishery impacts on seahorses in the Philippines.

Reproduction

A greater understanding of seahorse mating patterns and reproduction is important for conservation (Foster & Vincent 2004). Exploitation could disrupt seahorse social structure by disturbing pairs more quickly than they are established. Removing a member of a monogamous pair could decrease short-term reproductive output, by leaving the remaining animal without a partner, and possibly by reducing the size of its later broods if familiarity enhances brood success. Sex-selective fishing would also have important effects, especially in monogamous populations where members of the more abundant sex might be less likely to find a mate thereafter. More needs to be discovered about how mating patterns respond to environmental and social parameters.

More research on age- or size-specific reproductive output could allow us to tailor fisheries plans more usefully (Foster & Vincent 2004). For example, if further research confirmed that brood size increased with male size, then maximum size limits might be considered for fisheries, in order to allow the most fecund animals to continue reproduction. Realistically, however, such a management measure, no matter how apparently desirable, might prove politically difficult to implement given that larger seahorses fetch a higher price (Vincent 1996).

Conclusions

While present knowledge of seahorse life history for species found in the Philippines is incomplete, existing information indicates that seahorse populations are commonly vulnerable to overexploitation, whether direct or indirect: low population densities mean that seahorses may have trouble finding a new partner (Allee effects: e.g. Knowlton 1992); low mobility and small home range sizes mean that seahorses may be slow to recolonize overexploited areas (although this may be offset by planktonic dispersal of juveniles); possible low rates of natural mortality mean that heavy fishing will place unsustainable pressure on the population; monogamy in most species means that a widowed partner...
may stop reproducing, at least temporarily; male brooding means that survival of the young in *marsupio* depends on the survival of the male; and a small brood size limits the potential reproductive rate of the pair (although this may be offset by frequent spawning and enhanced juvenile survival through parental care) (Foster & Vincent 2004). Even if seahorses are returned to the water after being caught in non-selective gear, they may still experience deleterious effects that include physical injury, habitat damage, removal from home ranges and disturbance of pair bonds (Davis 2002; Baum et al 2003).

For example, monogamy and site fidelity may render *H. comes* – the most well studied seahorses in the Philippines – particularly vulnerable to over-exploitation. Removal of one partner would compromise the reproductive rate of the other, and over-fished areas would probably not be replenished quickly through immigration from elsewhere. On the other hand, it’s continuous breeding and nocturnal activity might make *H. comes* less vulnerable to fishing than other seahorses with seasonal breeding and diurnal activity (Perante et al 2002). Furthermore, the small home ranges of *H. comes* reported here should mean that existing populations will be secure within MPAs, since only animals on the edge should be vulnerable to fishing pressure (Chapman & Kramer 2000).

In the context of conservation management, variation in life history parameters across the genus requires thorough analysis, in order to assess the relative vulnerability of different species to exploitation and habitat damage. With such information, management initiatives can be improved for the long-term security of wild seahorse populations (Foster & Vincent 2004).

**Acknowledgements**

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**References**


### Annex I. Description of seahorses in the Philippines

<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
<th>Photo</th>
<th>Reference</th>
</tr>
</thead>
</table>
| *H. barbouri* (Jordan & Richardson 1908) | Two pairs of cheek spines  
Prominent nose spine  
Stripes on snout  
Spine in front of coronet | ![Image of H. barbouri](image1.png) | iSeahorse:  
Common  
Large  
Seahorses of SE |
| *H. bargibanti* (Whitley 1970) | Coronet: Rounded knob  
Spines: Irregular bulbous tubercles scattered over body and tail; single, prominent rounded eye spine; single, low rounded cheek spine  
| **H. comes** (Cantor 1850) | Blunt spines  
Double cheek spines  
Prominent nose spine  
Low coronet  
Striped tail (can look blotchy) | ![Image of H. comes](image) |
|---------------------------|-------------------------------------------------------------------------------------------------|
| **H. Denise** (Lourie and Randall 2003) | Limited number of tubercles on the body  
Coronet: No raised coronet  
Spines: none |
| **iSeahorse:** | Common Large  
Seahorses of SE |
<p>| <img src="image" alt="Image of H. Denise" /> | <img src="image" alt="Image of Male and Female Seahorses" /> | Lourie et al (2004) |</p>
<table>
<thead>
<tr>
<th><strong>H. histrix</strong> (Kaup 1856)</th>
<th><strong>H. kelloggi</strong> (Jordan &amp; Snyder 1902)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long snout</td>
<td>Distinct coronet</td>
</tr>
<tr>
<td>Single cheek spine</td>
<td>Narrow body (compared to <em>H. kuda</em>)</td>
</tr>
<tr>
<td>Sharp spines on coronet</td>
<td>Thick truck rings</td>
</tr>
<tr>
<td>Prominent nose spine</td>
<td>Long, back-pointing, rounded cheek</td>
</tr>
<tr>
<td>Sharp, often dark-tipped</td>
<td></td>
</tr>
<tr>
<td>body spines</td>
<td></td>
</tr>
</tbody>
</table>

**iSeahorse:**

Common Large Seahorses of SE

**iSeahorse:**

Common Large Seahorses of SE
| **H. kuda** (Bleeker 1852) | Deep body (fatter compared to *H. kelloggi*)  
Low/round coronet  
Spines are rounded bumps | iSeahorse: Common Large Seahorses of SE |
|---|---|---|
| **H. pontohi** (*H. severnsi*) | Body is small and slender with a prehensile tail  
Head is relatively large  
eyes are prominent  
moderately long snout, no bulbous tip  
tail has red bands | iSeahorse.org, Lourie and Kuiter (2008) |
| **H. spinosissimus (H. alatus)** (Weber 1913) | Low/no nose spine  
Short snout (compared to *H. histrix*)  
Single or double cheek spines  
Blunter and shorter body spines than *H. histrix* | ![Image of H. spinosissimus](image1) | *iSeahorse: Common Large Seahorses of SE* |
|---|---|---|---|
| **H. trimaculatus** (Leach 1814) | Low coronet  
3 dark spots (sometimes)  
Hook-like cheek spine | ![Image of H. trimaculatus](image2) | *iSeahorse: Common Large Seahorses of SE* |
Annex II. Regional maps of seahorse species distribution with delineated municipal waters boundaries, different habitats, fishery area closures and temporal restrictions in the Philippines.

II.1 National Capital Region (NCR)
II.2 Region 1 (Ilocos Region)
II.3 Region 2 (Cagayan Valley)
II.4 Region 3 (Central Luzon)
II.5 Region 4-A (Calabarzon)
II.6.1 Region 4-B (Mimaropa)
II.6.2 Region 4-B (Mimaropa)
II.7 Region 5 (Bicol Region)
II.8 Region 6 (Western Visayas)
II.9 Region 7 (Central Visayas)
II.10 Region 18 (Negros Island Region)
II.11 Region 8 (Eastern Visayas)
II.12 Region 9 (Zamboanga Peninsula)
II.13 Region 10 (Northern Mindanao)
II.14 Region 11 (Davao Region)
II.15 Region 12 (Soccsksargen)
II.16 Region Caraga
II.17 Autonomous Region in Muslim Mindanao – Eastern
II.18 Autonomous Region in Muslim Mindanao – Western
Annex III. Observed geographic distribution, depth & habitat of seahorses in the Philippines.

<table>
<thead>
<tr>
<th>Species</th>
<th>Distribution</th>
<th>Depth</th>
<th>Habitat</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cuyo Island, Culion Island, Palawan, Zamboanga (?),</td>
<td></td>
<td></td>
<td>Lourie et al, 1999</td>
</tr>
<tr>
<td></td>
<td>Sagay, Negros Occidental</td>
<td></td>
<td></td>
<td>SEAFDEC Stock Enhancement</td>
</tr>
<tr>
<td></td>
<td>Malapascua, Cebu Apo Island and Dauin, Negros Oriental</td>
<td></td>
<td></td>
<td>iSeahorse.org,</td>
</tr>
<tr>
<td></td>
<td>Mabini, Batangas Malapascua, Cebu Mactan, Cebu Anda, Bohol Samal Island, Davao Cabilao, Bohol Panglao, Bohol Puerto Galera, Oriental Mindoro</td>
<td></td>
<td></td>
<td>iSeahorse.org,</td>
</tr>
<tr>
<td>Location</td>
<td>Distribution and Habitat</td>
<td>Observations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masbate</td>
<td>Lonos, Romblon</td>
<td>Ducks Diving Romblon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dauin, Negros Oriental</td>
<td></td>
<td>atmosphereresorts.com</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H. comes</strong></td>
<td>Philippines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Typically found at &lt;10m depth, maximum reported depth 20m</td>
<td>coral reef, sponge gardens, kelp, floating <em>Sargassum</em>; thought to prefer <em>Sargassum</em> as juveniles, moving to corals and sponges when older</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tablas Strait, Northern Masbate, Bantayan Island, Cebu, Malapascua, Cebu, Moalboal, Cebu,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sogod Bay, Sibulan, Neg. Or Dumaguete City, Neg. Or Dauin, Neg Or. Iloilo, Gingoog Bay,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Samal Island, Davao, Bien Unido, Bohol</td>
<td>Juveniles generally used macroalgal holdfasts; adults used a greater diversity of specialized microhabitats including branching sponges, branching corals and tall seagrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Morgan and Vincent (2007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tablas Strait, Romblon Pass, Malapascua, Cebu Moalboal, Cebu Cebu Strait, Cabilao, Bohol Panglao, Bohol Samal Island, Davao</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| H. histrix | Philippines | typically found &gt;6 m depth, maximum reported depth 20 m | seagrass bed, weedy rocky reefs, sponges, soft bottom with soft corals and sponges | Lourie et al, 1999 Kuiter and Debelius (1994), Kuiter (2000) |
| Mabini, Batangas Puerto Galera, Oriental Mindoro Tablas Strait, Romblon, Romblon Daanbantayan, Cebu | | iSeahorse.org, |</p>
<table>
<thead>
<tr>
<th>Location</th>
<th>Species</th>
<th>Distribution Details</th>
<th>Associated with</th>
<th>Found in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jolo</td>
<td></td>
<td>deep water</td>
<td>Lourie et al (1999)</td>
<td></td>
</tr>
<tr>
<td>Northern Cebu (Daanbantayan), Dumaguete City, Neg. Or.</td>
<td></td>
<td></td>
<td>iSeahorse.org,</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td><em>H. kuda</em></td>
<td>typically found at 0-8 m depth, maximum reported depth 55 m</td>
<td>coastal bays and lagoons, in seagrass and in floating weeds, sandy sediments in rocky littoral zone, macroalgae and seagrass beds, branches, muddy bottoms, mangroves, estuaries, harbours, lower reaches of rivers (can inhabit brackish waters)</td>
<td>Lourie et al (2004), Lourie (2001), Randall (1996), Kuiter and Debelius (1994), Lee (1983), Kuiter (2000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>shallow inshore waters up to 40-</td>
<td>found in mangroves, seagrass beds, estuaries</td>
<td>Lourie et al (1999)</td>
</tr>
<tr>
<td>Location</td>
<td>Depth</td>
<td>Habitat</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>----------</td>
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<td>---------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Northwestern Bohol</td>
<td>50m deep and on steep mud slopes; also found in open water and attached to drifting <em>Sargassum</em> up to 20km from shore</td>
<td>seagrasses</td>
<td>Perante et al (1998)</td>
<td></td>
</tr>
</tbody>
</table>

**Aparri**
- Masinloc, Zambales
- Puerto Galera, Or Mindoro
- Bantayan Island, Cebu
- Danajon Bank (Bohol)
- Moalboal, Cebu
- Dumaguete, Neg Or Dauin, Neg Or Bacong, Neg Or Siaton, Neg Or Apo Island, Neg Or Samal Island, Davao Sarangani, Southern Mindanao
- Romblon, Romblon Maigo, Lanao Del Norte Iloilo

**H. pontohi (H. severnsi)**
- Romblon, Romblon
- Holotype and paratype specimens found at 16 m and 12 m depth respectively, recorded between 11-25m
- Found among algae, bryozoans, hydroid crops and specifically the coralline algae *Halimeda* and hydroid *Aglaphenia cupressina*

**H. spinosissimus**
- Philippines
- Typically found at octocorals, macro algae,
- Lourie et al (2004), Lourie
<table>
<thead>
<tr>
<th>(H. alatus)</th>
<th>&gt;8 m depth, maximum reported depth 70 m, not hard corals, sand but not mud, near coral reefs on sandy bottoms</th>
<th>(2001), Weber and de Beaufort (1922), Nguyen and Do (1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavite Bohol (Danajon Bank)</td>
<td>muddy or sandy bottoms and coral reefs</td>
<td>Lourie et al (1999)</td>
</tr>
<tr>
<td>Puerto Galera, Or Mindoro Malapascua, Cebu</td>
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<td>iSeahorse.org,</td>
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<tbody>
<tr>
<td>Bohol</td>
<td>trawled from less than 20 m</td>
<td>gravel and sandy bottom habitats</td>
<td>Lourie et al (1999)</td>
</tr>
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