
Journal of Natural History

ISSN: 0022-2933 (Print) 1464-5262 (Online) Journal homepage: http://www.tandfonline.com/loi/tnah20

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**To cite this article:** Natalie Villar Freret-Meurer, Amanda Vaccani do Carmo, Nayara Brandão Okada & Tatiane Fernández do Carmo (2018) A snapshot of a high density seahorse population in a tropical rocky reef, Journal of Natural History, 52:23-24, 1571-1580, DOI: 10.1080/00222933.2018.1478459

**To link to this article:** https://doi.org/10.1080/00222933.2018.1478459

Published online: 25 Jun 2018.

JOURNAL OF NATURAL HISTORY, 2018
VOL. 52, NOS. 23–24, 1571–1580
https://doi.org/10.1080/00222933.2018.1478459



# A snapshot of a high density seahorse population in a tropical rocky reef

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**ABSTRACT**
Seahorses are fishes that suffer high trading pressure in the international market. Three species have been recorded in Brazil, *Hippocampus reidi*, *Hippocampus erectus and Hippocampus patagonicus*, already classified as threatened or data deficient. Guaíba Island is an ecologically relevant site due to its position between two bays in Rio de Janeiro state. The present study aimed to survey the seahorse population of Guaíba Island, verifying several population structure parameters. Eight diving sites were selected around the island. Only the longsnout seahorse *H. reidi* was recorded. The population showed the largest density ever recorded in the world for the species. Sex ratio was 1:1 and seahorses were reproductively active. We observed three juveniles. The mean length recorded was 8.9 ± 1.64 cm. The population structure was similar to others populations studied throughout the Brazilian coast.

**ARTICLE HISTORY**
Received 11 August 2016
Accepted 9 May 2018

**KEYWORDS**
Conservation; *Hippocampus reidi*; survey; population

## Introduction

Seahorses are fishes commonly found in coastal shallow waters in all tropical and subtropical regions around the world (Lourie et al. 1999). Seahorses live in many types of habitat, such as seagrasses, rocky reefs, coral reefs and mangroves (Foster and Vincent 2004). Only three species are present in Brazil, *Hippocampus reidi* Ginsburg, *Hippocampus erectus* Perry and *Hippocampus patagonicus* Piacentino and Luzzatto (Silveira et al. 2014). *H. reidi* is commonly known as the longsnout seahorse or the Brazilian seahorse, because it is the most abundant seahorse species in the Brazilian coast (Rosa et al. 2007). There are several records of the Brazilian seahorse in mangroves (mean density = 0.026 ind $m^{-2}$) (Rosa et al. 2007; Mai and Rosa 2009; Aylesworth et al. 2015), coral reefs (mean density = 0.002 ind $m^{-2}$) (Pereira 2007) and rocky reefs (mean density = 0.018 ind $m^{-2}$) (Freret-Meurer et al. 2008; Oliveira and Freret-Meurer 2012).

Although the Brazilian seahorse may have a wide distribution from Cape Hatteras (USA) to Argentina (Lourie et al. 2004), the population density of the longsnout seahorses has been decreasing in the last years, especially due to human pressure by fishing, habitat destruction and the aquarium market (Rosa et al. 2005). These activities, specially by-catch and capture for the aquarium market, led the longsnout seahorse to

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Published online 25 Jun 2018

be classified as *vulnerable* status by the Brazilian National List of Overexploited Fish (Environmental Ministry 2010) and the list of Threatened Species of the State of Rio de Janeiro (Mazzoni et al. 2000). Globally, it is still considered *data deficient* by the IUCN Red List of Threatened Species (2010).

The Rapid Assessment is a method to create baseline data, e.g. a checklist of species, and type of habitat structure and use, and to evaluate disturbance and pressures in a short time (Alonso et al. 2011). These data have been used to make decisions for conservation programmes and planning management of threatened species and ecosystems (Lodh and Agarwala 2016).

Sepetiba Bay is an important economic and ecological site for Rio de Janeiro state, Brazil. It is a fragile system within several ecosystems, e.g. mangroves, rocky reefs and sandy beaches. It also comprises many ports and industries, which have a relevant impact over the state economy. The area is a *high priority site* of the Strategic National Plan of Protected Areas (2002) and attention should be drawn to the local threatened species. Guaíba Island is the largest island in the bay. There is only one report on the seahorse populations in the bay (Freret-Meurer 2010), indicating low density (0.005 ind $m^{-2}$), so the present study aims to make a rapid assessment of the seahorse species of Guaíba Island to determine the health of this data-poor and nationally threatened species. In a healthy population the following are expected: (1) sex ratios close to 1:1; (2) all life stages (juveniles to adults); (3) 'normal' length frequency distributions from individuals; (4) individuals are frequently found in sites; and (5) reproductively active individuals.

## Material and methods

Guaíba Island (22°59′–23°00′S, 044°01′–044°03′W) is located in Sepetiba Bay (Figure 1). The area is situated in the Mangaratiba Environmental Protected Area. Its coastal area is composed by rocky reefs and sandy beaches. The total surrounding perimeter is 9300 m long, and our study selected 3600 $m^2$ for the survey (divided in transects), according to diving security. Safe diving sites available for surveying seahorses tended to be facing north and towards the mainland. Only one safe site was southward facing. These sites were sheltered areas and presented some specific environments with lower wave action, current and no traffic of ships, once the Sepetiba Bay receives a very large number of them. In this area, eight sites were randomly chosen (Figure 1). The deepest site was 3 m in depth. Dives (snorkelling) were conducted in different days, during the morning period from 9.00 am to 12 pm.

The rapid assessment of the seahorse population around Guaíba Island was conducted by visual census method from May to August 2014. We made eight random transects with a measuring tape along each site around the island. Each transect was conducted on the rocky reef and had an area of 400 $m^2$ (length × width: 100 × 4 m) except for transect 2, which had 800 $m^2$ (length × width: 400 × 2 m). Three researchers conducted the transects by swimming one-way parallel from one side to the other of the belt transect (side-centre-side). This avoided sampling the same seahorse twice. The effort was 1.30 h search per transect. No seahorse out of the transects was considered.

During the transects, the seahorses were captured by hand and all the following procedures were carried out underwater. Seahorse species were identified according to Lourie et al. (1999) and Figueiredo and Menezes (1980), by number of trunk rings,

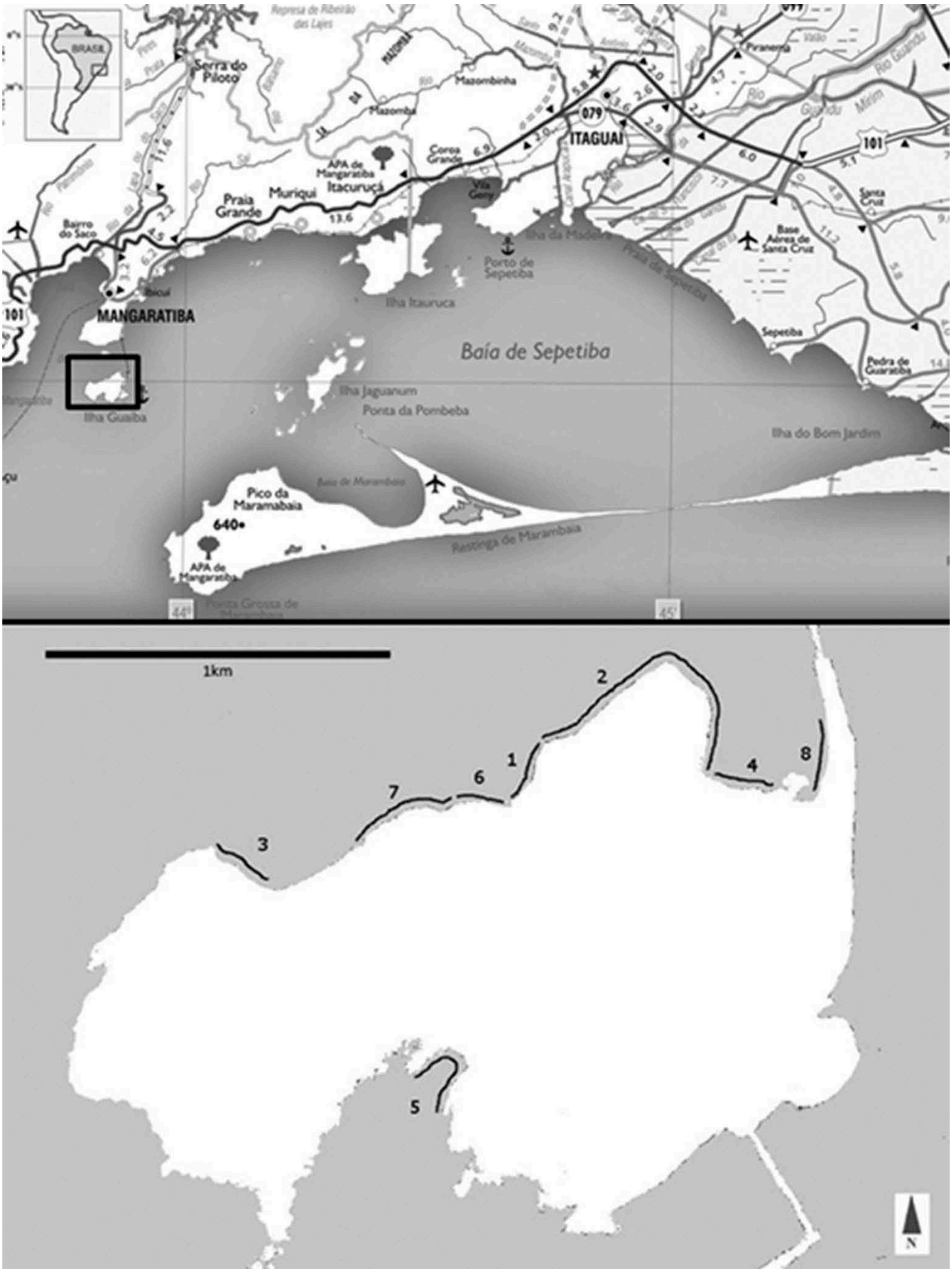


**Figure 1.** The eight sites selected for the seahorse survey conducted around Guaíba Island, Rio de Janeiro, RJ.

coronet shape and snout size. Sex was recognized by the presence (male) or absence (female) of the brood pouch. Sex was only confirmed for adults (> 60 mm length) Freret-Meurer et al. forthcoming (2018) or smaller individuals with brood pouches or cloacal elevation. Length was measured from the tip of the coronet to the tip of the stretched tail (Lourie 2003). Reproductive state was identified according to Lourie (2003), where for males: 0 = just given birth, pouch flabby; 1 = pouch empty, pouch flat; 2 = pregnant, pouch rounded; 3 = about to give birth, pouch extremely rounded and shiny, and for females: 0 = eggs just given away, belly sunken; 1 = no mature eggs, belly flat; 2 = bearing mature eggs, belly slightly raised; 3 = hydrated eggs, belly distended.

Other data, such as depth, behaviour and holdfast were also recorded. Behaviour was categorized as Foraging (seahorse hunting and/or making suction), Courting (changing colour to another, tail tangled, synchrony in swimming) and Inactive (lack of movement). Holdfast was identified in field and when it could not be identified, a sample of it was collected and taken to laboratory for identification according to Ruppert and Barnes (1996), Muricy and Hajdu (2006) and Joly (1967). In the present study, we did not assess availability of holdfasts. All seahorses were tagged by photo-identification of the coronet according to Freret-Meurer et al. (2013) to avoid counting the same individual multiple times.

Data were represented by means ± standard deviation. Density was represented by individuals $m^{-2}$. Frequency of occurrence was calculated to verify the association with habitat. We established the probability to find seahorses in Guaíba Island by the following formula: P(sgi) = (n/N) × 100, where P(sgi) = probability to find a seahorse in Guaíba Island; n = number of sites with the presence of seahorses; N = number of sites surveyed. The Kruskall–Wallis test was applied in order to investigate differences between seahorse lengths among populations and size difference between males and females was analysed by *t* test. The tests followed normality and homoscedasticity.

## Results

Only the seahorse species *H. reidi* was recorded around Guaíba Island. The probability to randomly (P(sgi)) find seahorses in Guaíba Island was 100% ($n$ = 8). The seahorses apparently had a patchy distribution, composing sub-populations with particular characteristics.

We found a total of 65 seahorses. The mean abundance was 7.8 ± 3.5 individuals for Guaíba Island, with a mean density of 0.21 ± 0.11 ind $m^{-2}$. The smaller densities were recorded in transects two and five, of 0.12 ind $m^{-2}$, while the higher density was recorded at transect four, of 0.42 ind $m^{-2}$ (Figure 2). The population presented a sex ratio of 1:1 at all sites, with reproductive partners being observed (Figure 3(a)). All individuals were at sexual stage 3, representing reproductive synchrony. Only three juveniles were recorded.

The mean length of the seahorses was 89 ± 16 mm. No significant differences between the length pattern of seahorses from each route were observed ($p$ = 0.176; KW = 10.221; df = 7) (Figure 3(b)). There was also no size difference between sexes ($p$ = 0.278; t = 1.095; n = 65), while males presented a mean length of 93 ± 02 mm and females 90 ± 02 mm. The mean depth in which seahorses were recorded was 1.04 ± 0.39 m, but transects two, five and eight were deeper, while site one was shallower (Figure 3(c)). Seahorses used nine types of holdfast, with the most common being turf algae (FO = 22%, $n$ = 14), *Sargassum* spp. C. Agardh (FO = 17%; $n$ = 11) and *Leptogorgia* spp. (Milne-Edwards) (FO = 14%; $n$ = 9) (Figure 4). Seahorses were mainly inactive (90.7%; $n$ = 59), but foraging and courtship were also observed (6.2%; n = 4; 3.1%; $n$ = 2, respectively).

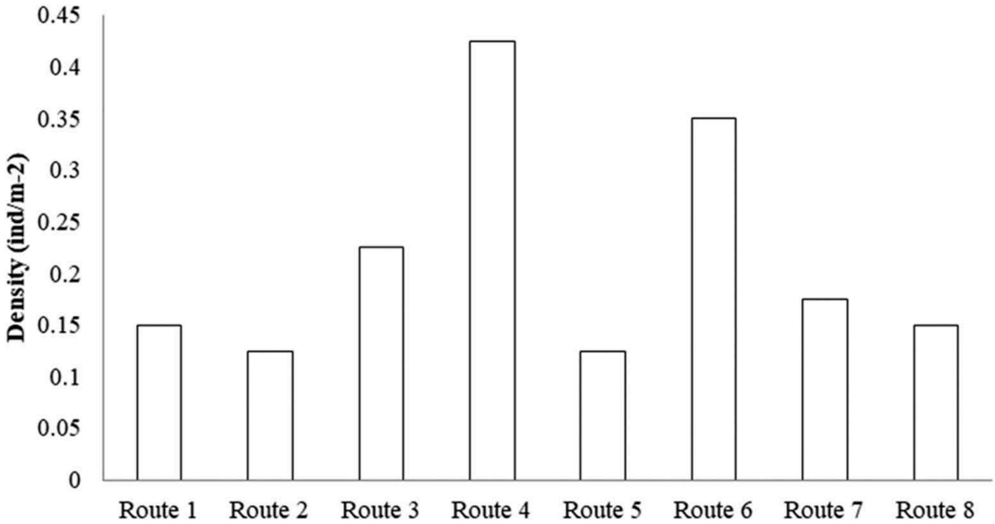


**Figure 2.** Density (ind $m^{-2}$) of the seahorse *H. reidi* at all eight sites around Guaíba Island, Mangaratiba, RJ.

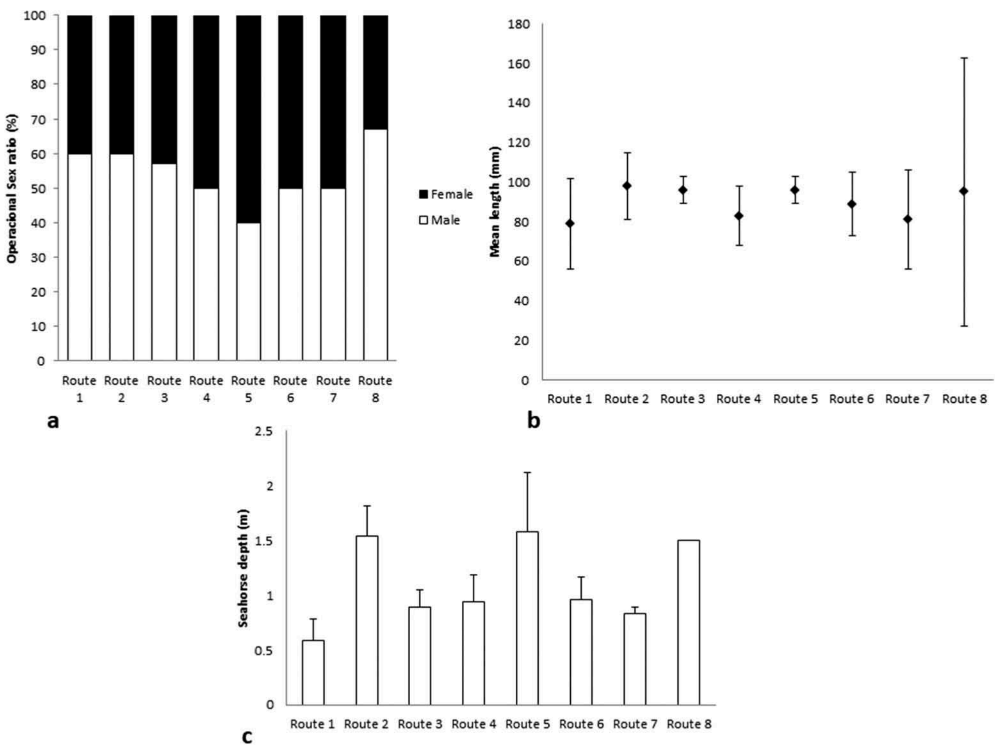


**Figure 3.** Population parameters of the seahorse *H. reidi* at all eight sites around Guaíba Island, Mangaratiba, RJ: (a) operational sex ratio; (b) mean heights (cm) and standard deviations; (c) depth (m).

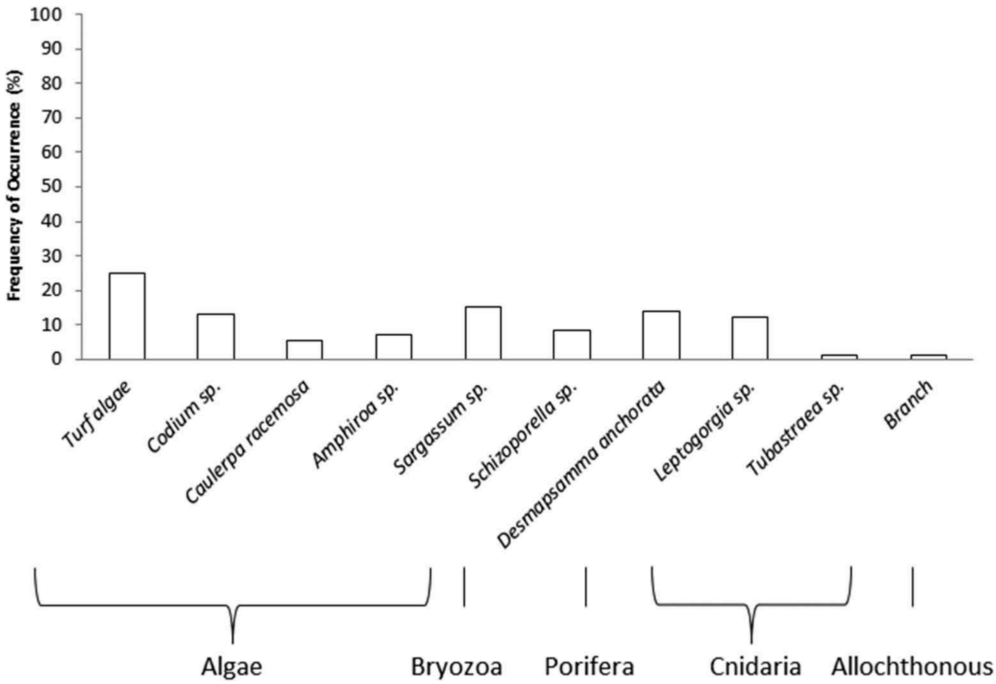


**Figure 4.** Frequency of occurrence of the seahorse *H. reidi* in different holdfasts in Guaíba Island, Mangaratiba, RJ.

## Discussion

The Rapid Assessment conducted in the current study presented limited but relevant data about the *H. reidi* population in Guaíba Island. The Rapid Assessment of Biodiversity has been used in many conservation studies and programmes around the world. Although this kind of study provides limited data, as it is short term research, it supplies useful baseline data that can be used when starting a conservation programme (Bennun et al. 2017). Usually supplementary information will be needed and the baseline data are used to guide the following research.

The present study identified the highest seahorse population of *H. reidi* ever reported (Rosa et al. 2007; Freret-Meurer and Andreata 2008; Mai and Rosa 2009; Gutierrez; Oliveira and Freret-Meurer 2012; Freret-Meurer 2010). Seahorses were recorded all around Guaíba Island, showing that this location presents a suitable and healthy environment for the species. These animals usually have patchy distribution with long distances between them and have never been reported continuously in such a large rocky reef area (Freret-Meurer and Andreata 2008; Freret-Meurer 2010). The patchy distribution naturally reduces the probability of observing seahorses, because sampling might occasionally not reach the patch, especially with small populations. Studies with random transects also may underestimate the population size, because usually they do not sample the whole seahorse patch in rocky reefs. The patch may have many designs (Okada et al. 2015) according to substrate availability, rocky reef structure and biological features such as food and partner availability. So the number of transects and dimensions must be planned according to each environment and population density (Curtis et al. 2004). In the present study, even using a method that could possibly underestimate population size, we found a high density population. This is a highlight for the Rio de Janeiro state coast, which has been reported as a low density site by several studies (Rosa et al. 2007; Freret-Meurer and Andreata 2008; Freret-Meurer 2010; Pereira 2010; Oliveira and Freret-Meurer 2012).

The density recorded by the present study was considerably larger than reported by any other study conducted with the longsnout seahorse in rocky reefs. Mean densities have been recorded ranging from 0.002 to 0.008 ind $m^{-2}$ in several sites along the Brazilian coast (Silveira 2005; Rosa et al. 2007; Freret-Meurer and Andreata 2008; Freret-Meurer 2010), while the present study reported a range of 0.12–0.42 ind $m^{-2}$. Other seahorse species, such as *Hippocampus capensis* Boulenger and *Hippocampus comes* Cantor, present even lower densities, of 0.0089 ind $m^{-2}$ (Bell et al. 2003) and 0.00143 ind $m^{-2}$ (Morgan and Vincent 2007), respectively. All these species are under threat of capture for the aquarium market or to be dried and sold in the international market or for habitat loss. Some studies relate high capture rates of seahorses in their natural environment with their low densities. Guaíba Island is barely explored by tourists and the local community, due to the access restrictions created by the iron company that operates in the area. It is possible that these restrictions reduce human interference on the marine environment and the natural seahorse population, avoiding, for example, their capture for the aquarium market. The lack of capture might be one condition for the large population of the seahorse. Another could be the environmental conditions. Although no specific measurement has been made, the rocky reef presented a benthic structure similar to other sites in Sepetiba Bay and Ilha Grande Bay, as reported by Freret-Meurer (2010), Coelho (1980), Pedrini (1980) and Pires (1979), with several algae including *Sargassum* sp., *Padina* sp., *Dictyota* sp., *Acanthophora* sp. and turf algae. Although it seemed similar, it would be interesting to determine any features that could explain this high density population.

The population structure indicated that the seahorses are well adjusted to the environment, with all adults reproducing and presenting reproductive synchrony. This fact has already been reported by other studies on the same species (Rosa et al. 2007; Freret-Meurer and Andreata 2008). The sex ratio was the expected 1:1, but the mean length (89 mm) was smaller than usually reported for the species (175mm, 135mm, 119mm, 153mm) (Lourie et al. 1999; Rosa et al. 2007; Oliveira and Freret-Meurer 2012; Freret-Meurer et al. 2018). Although in several species larger individuals tend to occur in deeper sites, Oliveira and Freret-Meurer (2012) reported no difference in size until 10 m deep. Freret-Meurer et al. (2018) found no correlation between size and depth and also reported larger animals at a mean depth of 1.41 m. So, in this case an ecomorphism might be suggested. The habitat characteristics are a relevant trend in the divergence process of the population phenotype (Smith and Skúlason 1996). The available niches will apply selective pressure over the phenotypic evolution (Kawecki and Ebert 2004), which will make the same species present different phenotypes, depending on the habitat. This factor does not suggest that one habitat is better than the other; it simply explains that the species is able to adapt to different conditions. The seahorse has physiological skills that allow it to change colour and develop dermic appendages (Lourie et al. 1999), and can possibly suffer selective pressure according to its holdfast.

In this case, turf algae would play an important role, but more studies are necessary to further understand this.

The Rapid Assessment allowed us to identify a healthy structured population of *H. reidi* in Guaíba island, following all patterns usually found for seahorses. It was also possible to record the largest population ever recorded throughout the Brazilian coast, but this kind of assessment is a snapshot and requires further studies. It is important to highlight that this large population might be a good model to understand better the population dynamics of this species and deserves more attention. This Rapid Assessment worked well to check for the health population of the seahorse.

## Acknowledgements

We would like to acknowledge Vale S.A. and Santa Úrsula University for the logistic and financial support. This study was conducted under Brazilian governmental license number 44409-2.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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