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Seahorse ecology and conservation in Brazil: a systematic review

Anna Karolina Martins Borges[1,2*], Rômulo Romeu Nóbrega Alves[1,3] and Tacyana Pereira Ribeiro Oliveira[1,2,3,4]

ABSTRACT

Seahorses are unique, charismatic, and threatened fish that inhabit some of the most vulnerable marine environments. In Brazil, three seahorse species are recognized as threatened with extinction; however, knowledge of their ecology and conservation is unsystematized and patchy. Using the PRISMA protocol, we performed a systematic review of the existing literature on Brazilian seahorses to assess the current knowledge on their distribution, life history aspects, threats, and conservation efforts, while also identifying research gaps and proposing future priorities. By accessing 289 studies, we found significant knowledge gaps on distribution, population ecology, and habitat preferences, particularly for extitHippocampus patagonicus and *H.* aff. *erectus*, including critical taxonomic uncertainties for the latter. Despite being the most studied species in the country, *H. reidi* lacks updated large-scale studies. We evidenced three major threats to seahorse conservation in Brazil: fisheries (both targeted and incidental), trade, and habitat destruction. Furthermore, we highlight emerging anthropogenic disturbances, such as tourism-related activities, as potential stressors to seahorse populations. Weaknesses in the conservation framework, particularly regarding the regulation and monitoring of these threats, require attention. Our findings provide important insights to direct future management and conservation actions for seahorses in Brazil. We emphasize the need for comprehensive studies to address taxonomic uncertainties, clarify distribution patterns, and understand the life history of seahorses in Brazilian waters. This is especially crucial for populations facing human-induced pressures. Given the complex and multi-stakeholder nature of seahorse threats, a multifaceted conservation approach is essential to ensure their long-term protection in Brazil.

Keywords: *Hippocampus*; Syngnathids; Life-history; Threatened species; Marine conservation.

1 Programa de Pós-Graduação em Etnobiologia e Conservação da Natureza, Universidade Federal Rural de Pernambuco, Recife, PE 52171-900, Brazil.

2 LAPEC - Laboratório de Peixes e Conservação Marinha, Universidade Estadual da Paraíba, João Pessoa, PB 58071-160, Brazil.

3 Centro de Ciências Biológicas e Sociais Aplicadas, Universidade Estadual da Paraíba, João Pessoa, PB 58071-160, Brazil.

4 Seahorse, Pipefish and Seadragon Specialist Group, International Union for Conservation of Nature (IUCN) Species Survival Commission, Gland, Switzerland.

* Corresponding author ✉. E-mail address: AKMB (karolm26@hotmail.com), RRNA (romulo_nobrega@yahoo.com.br), TPRO (tproliveira@yahoo.com.br)

SIGNIFICANCE STATEMENT

Here, we present the first comprehensive systematic review of Brazilian seahorses using the PRISMA protocol, providing crucial insights into the ecology and conservation of the the three threatened species. We identified significant knowledge gaps, particularly regarding the distribution, population ecology, and habitat preferences of *Hippocampus patagonicus* and *H.* aff. *erectus*, emphasizing the need for updated and standardized, large-scale studies. Our study identifies fisheries, trade, and habitat destruction as the main threats, while also highlighting the impact of other recent anthropogenic disturbances, such as tourism. We reveal weaknesses in current conservation frameworks and advocate for a multifaceted approach to address these challenges. By underscoring the need for comprehensive research to resolve taxonomic uncertainties and understand life history traits, our study lays the foundation for targeted management and conservation actions. Our findings are essential for shaping future strategies to protect Brazilian seahorse populations from human-induced pressures.

INTRODUCTION

Habitat destruction, overfishing, pollution, and climate change are major threats to marine and coastal biodiversity (Halpern et al. 2008, 2015; Smale et al. 2019). Human activities have led to several changes in marine biodiversity, including global extinctions and the degradation of ecosystem services (Bland et al. 2018; Riera et al. 2020). This scenario is particularly concerning for species whose life-history traits (e.g., high site fidelity, low adult mobility, high habitat vulnerability) render them particularly vulnerable to these pressures (Vincent et al. 2011a).

Effective biodiversity conservation measures require sufficient data to provide a good understanding of the distribution, abundance, and habitat preferences of species (Zhang and Vincent 2018). However, most marine species lack this sort of data, which is much more significant when it comes to vulnerable species (Stirling et al. 2016). Indeed, rare and threatened species pose a challenge from a conservation perspective due to significant gaps in data regarding their distribution and the threats they face, which are essential for developing practical conservation measures (Menon et al. 2010).

Seahorses (*Hippocampus* Rafinesque, 1810, family Syngnathidae) represent an excellent example of rare and vulnerable marine species with peculiar life-history traits. These iconic fish exhibit distinctive traits, such as limited mobility, sexual fidelity in most species studied, low reproduction rate, prolonged parental care, high site fidelity, in addition to patchy distribution and low densities (Foster and Vincent 2004). These features and the fact that seahorses live in historically disturbed environments (e.g., mangroves, coral reefs, and estuaries) render them especially sensitive to impacts caused by human activities (Foster and Vincent 2004). Furthermore, many seahorse species have been extensively exploited as ornamental fish and traditional medicines (Rosa et al. 2011; Vincent et al. 2011b; Foster et al. 2022). As a result, at least 15 seahorse species are considered threatened with extinction on the Red List compiled by the International Union for Conservation of Nature (IUCN). In addition, the entire genus *Hippocampus* is listed in Additional File 2 of the Convention for Illegal Trade of Endangered Species (CITES 2022), which requires all seahorse exports to comply with sustainability, legality, and rigorous monitoring.

Brazil has played a prominent role in seahorse conservation issues. For decades, the country was considered a leading exporter of live seahorses for the aquarium sector (Rosa et al. 2005; Foster et al. 2022), besides being an important reference for the use of seahorses in traditional medicines, as curios and for magical-religious purposes (Alves et al. 2007; Alves and Rosa 2010; Rosa et al. 2011). The three recognized seahorse species occurring in Brazil (Lourie et al. 2016; Silveira et al. 2014) - *Hippocampus reidi* Ginsburg, 1933; *Hippocampus erectus* Perry, 1810; and *Hippocampus patagonicus* Piacentino and Luzzatto, 2004 - are listed as "Vulnerable" in the Brazilian National Red List (Brazilian Ministry of Environment – MMA 2022). Moreover, the three species figure in the IUCN Red List: *H. reidi* classified as "Near Threatened" (Oliveira and Pollom 2017); *H. patagonicus* (Wei et al. 2017) and *H. erectus* (Pollom 2017) as "Vulnerable".

Although Brazilian seahorses are threatened with extinction, there is no current specific action plan for their conservation in the country. The most recent proposal for the sustainable use of seahorses in Brazil was put forth in 2011 (Dias-Neto 2011); however, it has not been fully implemented and remains unreviewed by the Brazilian government. Furthermore, studies on wild populations may be challenging because of the cryptic and rare nature of these fish, and as a result, several knowledge gaps make conducting comprehensive conservation evaluations difficult (Vincent et al. 2011a).

Despite the evident need to describe measures applied for seahorse conservation in Brazil, it is necessary to analyze whether the currently available data is sufficient to do so successfully. Summarizing current information on a topic is an excellent opportunity to identify potential gaps and prospects for further-

ing this knowledge (Roberts et al. 2020). This approach is especially valuable in the case of seahorses, as it enables a better understanding of the amount of data available and what is still needed to advance their conservation. Indeed, systematic reviews on seahorses have been published in recent years in some countries (Lourie et al. 2016; Pierri et al. 2022; Vincent et al. 2011a; Woodall et al. 2018). Herein, we applied a systematic review approach to summarize the existing information on the three seahorse species reported to the Brazilian coast, focusing on distributional records, ecological aspects, and conservation concerns. Our review identifies information gaps and provides a comprehensive overview of the available data, which will support efforts to enhance seahorse conservation in Brazil.

MATERIAL AND METHODS

Literature search

We performed a systematic literature review following the main principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement, an approach used to identify and select relevant studies and to collect and summarize data from a systematic review (Moher et al. 2010; Page et al. 2020). The bibliographic search was performed using the Web of Science (`www.webofknowledge.com`), Scopus (`www.scopus.com`), and Google Scholar (`scholar.google.com`) search engines and included peer-reviewed literature, theses, dissertations, books, book chapters, and other related scientific reports published until 2024. Several combinations of the following search words were used to locate relevant publications: "seahorse", "hippocampus", "reidi", "erectus", "patagonicus" and "brazil". As our focus was on studies carried out in Brazil, our searches were not limited to publications in English, so we added a systematic search using the same words in Portuguese ("*cavalo-marinho*", "*cavalos-marinhos*", "hippocampus", "reidi", "erectus", "patagonicus" and "*brasil*"). We also added pertinent publications that did not appear in the search but were recognized by the authors throughout the process through reference and citation tracking from the studies.

Publications screening

The selection of the publications for the review was performed using a two-step process. First, the publications were screened based on their titles and abstracts. Second, the full text of the selected publications was evaluated for eligibility. Most publications eliminated in the selection process did not refer to studies on seahorses developed in Brazil or were published in a modality not included in our eligibility criteria (i.e., not peer-reviewed records, congress abstracts). The following types of information were retrieved from each publication when available: (1) year of publication; (2) publication perspective (e.g., ecology, aquaculture, behavior, genetics, checklist, local ecological knowledge, conservation); (3) sampling method applied in the study; (4) seahorse species; (5) general location of the study (Brazilian state); (6) location points of the seahorses found in the study (geographic coordinates); (7) habitat type (e.g., estuary, mangrove, reef environments); (8) population parameters (e.g., abundance, density, sex ratio); (9) environmental variables (i.e., depth); (10) habitat use (holdfasts used by seahorses; home range); and (11) conservationist aspects (i.e., threats, protective measures).

The results of our search strategy yielded 1684 publications (including records from database searches and additional records identified by the authors), which, after removing duplicates, resulted in 875 publications for further analysis (Figure 1). Following the PRISMA flow chart, we excluded 587 publications from our dataset because they did not comprise studies performed in Brazil. Finally, our final dataset consisted of 288 publications after applying all filters (Additional File 2).

Next, the abstracts of all reviewed publications were used to create a word cloud that displayed the top 50 most frequent words to identify prevalent research topics. Before the analysis, numbers, punctuation, common stop words (i.e., pronouns, common verbs), and words with generic meanings were excluded (Additional File 3). The 'wordcloud' (Fellows et al. 2018), 'tm' (Feinerer and Hornik 2019), and 'stringr' (Wickham and Wickham 2019) R packages were used.

Data verification and validation

Species identification and occurrence were checked based on three criteria:

1. Photographs and/or illustrations: when available in the publications, they were checked using specific seahorse taxonomic guides (Lourie et al. 2004; 2016), Brazilian studies on seahorse taxonomy (Barros 2005; Silveira et al. 2014) and confirmed by seahorse experts (T.P.R. Oliveira; Rosa I.L).

2. Distribution range: extension and limits of distribution recognized in technical documents published by Brazilian environmental agencies (Dias-Neto 2011; ICMBio 2018).

3. Taxonomic time frames: due to misidentification issues concerning specimens of the *H. erectus* complex in Brazil (i.e. *H. erectus* and *H. patagonicus;* Boehm et al. 2013), we established that

any record of *H. erectus* from before 2014 and within the range extension of *H. patagonicus* occurrence (southeastern-southern regions; SE-S) was treated as *H. patagonicus* records throughout this study. This approach is consistent with Barros (2005), Rosa et al. (2010), and Rosa et al. (2011), who reportedly identified all species treated as *H. erectus* from the SE-S in the seahorse trade in Brazil as *H. patagonicus* (Barros 2005) and *H.* cf. *patagonicus* (Rosa et al. 2010) or *H.* cf. *erectus* (Rosa et al. 2011), which was confirmed by Boehm et al. (2013) and Silveira et al. (2014).

Records were treated as dubious when they failed to meet one or more of the criteria above. Additionally, other factors were determinants of dubious records: i) unreliable georeferenced data (i.e., occurrence points incorrectly located, such as those located on land); ii) lack of specification of how the species was identified (i.e., use of taxonomic guides); and/or iii) the use of out-of-date or non-seahorse-specific taxonomic identification keys (i.e. Figueiredo and Menezes 1980), due to misidentification concerns regarding *H. erectus* complex species. Dubious records were not considered in the elaboration of the range maps and ecological analyses.

We only considered the distribution and further ecological data based on wild seahorse populations. Species distribution was evaluated using 1) georeferenced information; and 2) seahorse occurrence data mentioned in the text/tables/supplementary material of the publications. To determine habitat types, we analyzed the habitat descriptions available in the studies. Unpublished data or personal communication mentioned in the publications were not considered due to the impossibility of verifying the data.

Furthermore, as per *H. erectus*, due to the unsolved taxonomic uncertainties, the species was treated as *H.* aff. *erectus* by the Instituto Chico Mendes de Conservação da Biodiversidade in the Brazilian Red Book of Threatened Species of Fauna (ICMBio 2018). Indeed, it is likely that the populations of *H. erectus* in the Brazilian and Caribbean Provinces differ (Araujo et al. 2022). Therefore, in this review, we refer to *H. erectus* as *H.* aff. *erectus* throughout the text.

RESULTS AND DISCUSSION

Overview of research trends on seahorses in Brazil

The first specific scientific work focusing on seahorses in Brazil dates back to 1982, comprising a monograph about chemical and physical parameters for seahorse maintenance in tanks (Carvalho 1982). The first peer-reviewed paper was published in 1998, focusing on the feeding and reproductive behavior of seahorses (Apolinário and Santos 1998). However, seahorse species have figured in fish inventories since 1964 (Carvalho 1964; Eskinazi 1972; Chao et al. 1982). The number of publications has increased considerably in recent years, with 175 (60%) of the 289 registered publications dating from the last twelve years (2012-2024; Figure 2a). Among all the publications, 51% are in Brazilian Portuguese (n = 147) and 49% in English (n = 142). Peer-reviewed papers make up the majority of publications (66%; n = 191), followed by theses/dissertations (28%; n = 81), books/book chapters (5%; n = 15), and technical bulletins (1%; n = 2).

We identified 11 general research topics (Table 1; Figure 2b), with most publications comprising fauna surveys (23%; n = 66) and studies focused on conservation (19%; n = 55), ecology (19%; n = 54), and ethnobiology (16%; n = 46). Most studies (58%; n = 168) were carried out *in situ* (i.e., conducted in the natural or original location or habitat of the subjects being studied), 36% (n = 103) were performed ex situ, and 6% (n = 17) of the studies utilized both approaches. The word cloud revealed the most frequent terms were "reidi" (frequency = 252), "population" (135), "male" (96), "juvenile" (81), "height" (69), "specimens" (64), "growth" (62), "conservation" (62), and "survival" (59) (Figure 3). Other notable terms included "habitat" (58), "feed" (53), "reproduction" (53), "behavior" (50), "trade" (49), and "estuary" (49).

Seahorse diversity and geographical distribution in Brazil

The Brazilian Environmental Agencies (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA –, and Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio) recognize the occurrence of three seahorse species in the Brazilian coast: *Hippocampus reidi*, *Hippocampus patagonicus,* and *Hippocampus* aff. *erectus.* In our review, we also found studies mentioning the species *Hippocampus hudsonius* DeKay, 1842 (Eskinazi 1972), *Hippocampus punctulatus* Guichenot, 1853 (Carvalho 1964), 1853, and *Hippocampus villosus* Günther, 1880 (Barros 2005), which, according to Lourie et al. (2016), are synonyms for *H.* aff. *erectus*. *Hippocampus reidi* is the most recorded seahorse species in the publications (Figure 2c), with most papers focusing only on this species (70%; n = 202).

Seahorses are found along the entire Brazilian coast; however, their distribution differs regarding the species. It is important to note that many studies with an ecological focus do not provide proper records of the occurrence of the species (29%; i.e., correct geographic coordinates). *Hippocampus reidi* is found in all

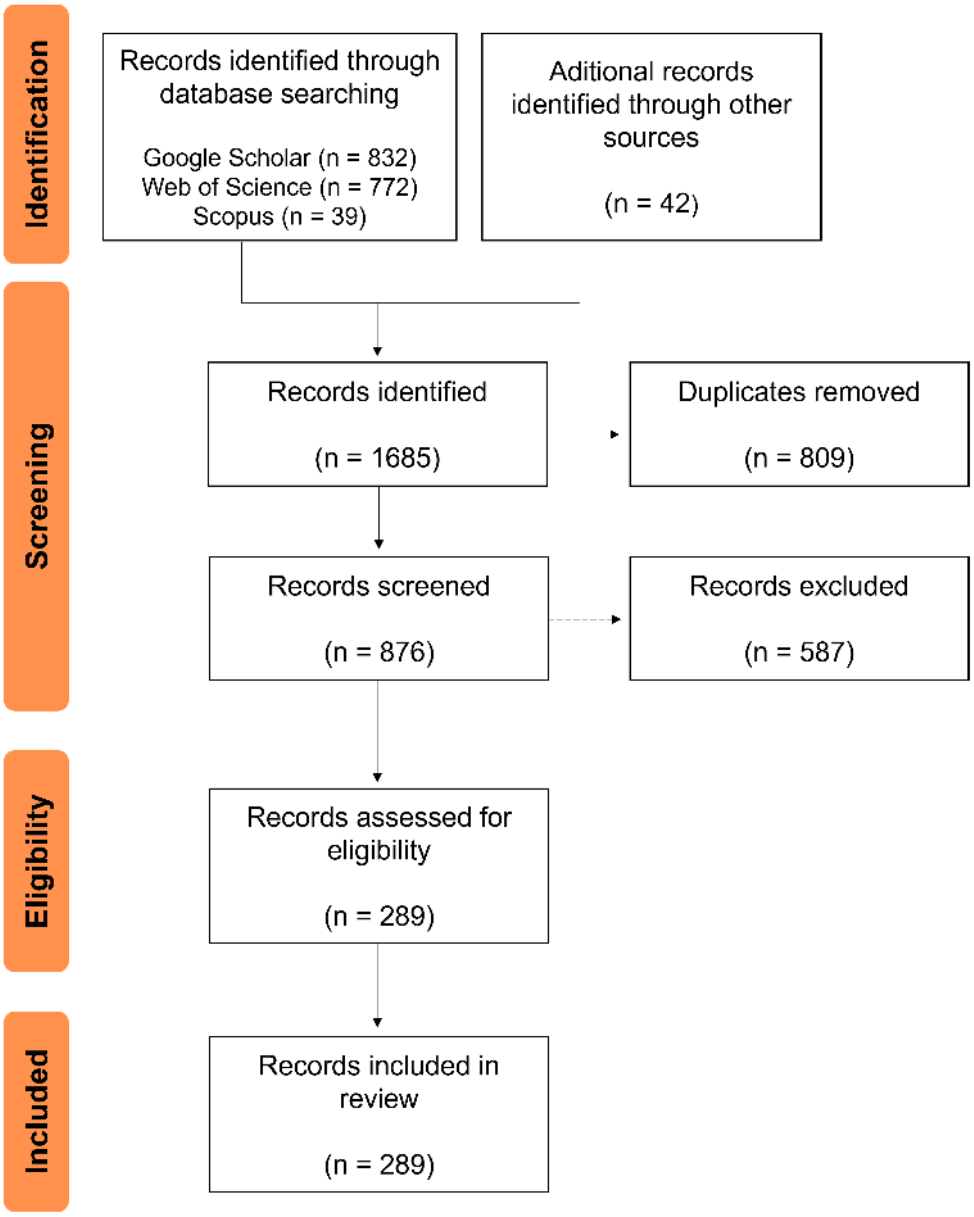

Figure 1. PRISMA flow chart for the methodology undertaken for the identification, screening, and eligibility of relevant literature based on Moher et al. (2010).

Brazilian regions, and *H. patagonicus* distribution is restricted to the SE-S. The distribution of *Hippocampus* aff. *erectus* is generally associated with the NE and SE-S regions. However, caution is advised regarding its occurrence in the SE-S due to potential misidentification issues with *H. patagonicus*. The detailed aspects of the species taxonomy and distribution follow below. For reference, the states included in each region are detailed in the legend of Figure 4.

Hippocampus reidi Ginsburg, 1933

The longsnout (or slender) seahorse, *H. reidi*, is the most common species in Brazil, with occurrences reported along the country's coast (Figure 4). In our review, we found 198 non-dubious locality points for *H. reidi* in 15 of the 17 Brazilian coastal states. The northern limit of distribution for the species is the Brazilian state of Pará (Hercos and Giarizzo 2007; Rosa et al. 2005), and the southern limit is the state of Rio Grande do Sul (Chao et al. 1982). In the most recent revision of the genus, Lourie et al. (2016) referred

Table 1. Classification of the research topics and the respective number of published studies on seahorses in Brazil from 1964 to 2024. As some of the studies fall into more than one category, the sum does not reflect the total number of studies included in the review.

Topic	Criteria	Total number of studies	Studies focusing on seahorses only
Aquaculture	Studies concerning seahorse rearing and breeding	35	34
Biology	Studies referring to general biological aspects, such as behavior, growth, bioacoustics, genetics, and reproduction	36	36
Conservation	Studies approaching conservation issues regarding seahorses (e.g., threats, conservation status evaluation, management proposal)	55	24
Ecology	Studies related to ecological aspects, such as distribution, habitats, population structure and dynamics, and feeding	54	51
Ethnobiology	Studies concerning traditional knowledge about seahorses, traditional medicines, magical-religious and other uses, trade, and ethnotaxonomy	46	9
Fauna survey	Studies referring to fauna surveys that mention seahorses	66	0
Morphology	Studies referring to the description and function of body parts and morphological development	3	3
Pharmacology	Studies concerning extracts and compounds such as peptides, glycoproteins, and antioxidants	2	2
Physiology	Studies concerning seahorse metabolism, biochemistry, and general physiology, including studies of ecotoxicology	11	10
Taxonomy	Studies referring to species description and identification, including phylogeny works	3	2
Tourism	Studies concerning tourism-related activities involving seahorses	5	3

to *H. reidi* occurring on the coast of Amapá state using records from the Global Biodiversity Information Facility (GBIF; https://www.gbif.org), which is not surprising, as the species is distributed from the US to Brazil (Lourie et al. 1999, 2016). The species distribution map in the most recent version of the Brazilian National Red List book (ICMBio 2018) requires updating, as its occurrence in the northern states is missing.

Hippocampus patagonicus Piacentino & Luzzatto, 2004

The Patagonian seahorse *H. patagonicus* has been confirmed in Argentina, Brazil, and Uruguay (Lourie et al. 2016). Until 2014, only two seahorse species were recognized in Brazil: *H. reidi* and *H. erectus*. A thesis on the taxonomy of seahorse species in Brazil in 2005 showed through morphological analysis that the specimens previously identified in Brazil as *H. erectus* were, in fact, *H. patagonicus* (Barros 2005). Later publications treated *H. erectus* as *H.* cf. *erectus* (Rosa et al. 2011) or *H.* cf. *patagonicus* (Rosa et al. 2010), and in 2013, Boehm et al. (2013) suggested that *H. patagonicus* distribution could be extended to Brazil based on nuclear DNA (nDNA) and mitochondrial DNA (mtDNA) analyses. Molecular analysis of mtDNA published in 2014 confirmed the previous findings that specimens from SE-S were recognized as *H. patagonicus,* and a third species, *H. erectus*, was also identified (Silveira et al. 2014).

H. patagonicus is known to be distributed from Argentina to the southern coast of the Brazilian state of Rio de Janeiro (Freret-Meurer et al. 2022; Luzzatto et al. 2012). In this review, we found valid records for the following states in the SE-S: Rio de Janeiro and São Paulo (SE region), Paraná, Santa Catarina, and Rio Grande do Sul (S region) (Figure 4), with only 10 non-dubious localization points. Likely due to current misunderstandings in its distribution, *H. patagonicus* has also been considered to occur from Pernambuco state (NE Brazil) to southern Brazil in the Brazilian National Red List book (ICMBio 2018) and in the most recent IUCN Red List assessment (Wei et al. 2017).

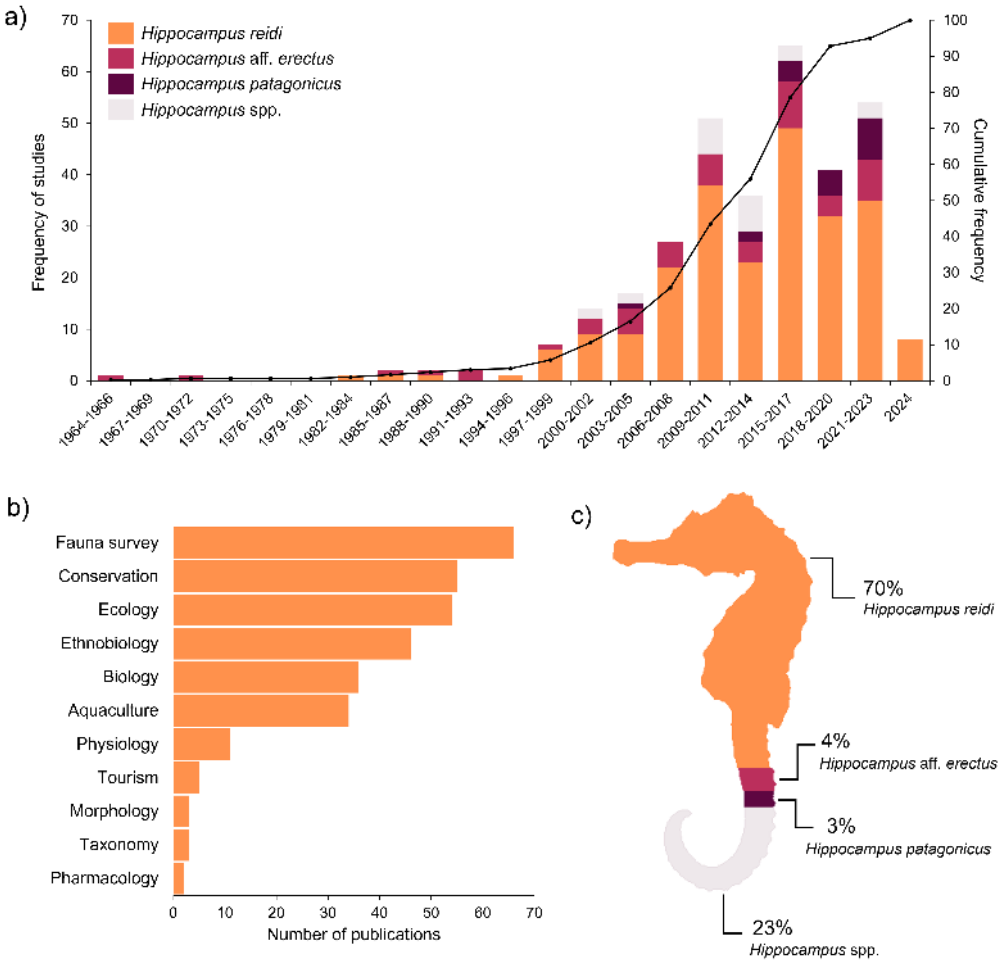

Figure 2. Trends on seahorse-related studies in Brazil. (a) Temporal trend of publications, per species. (b) Research topics of publications (each of the 288 publications were classified in one or more of these topic categories; topic definitions are given in Table 1). (c) Number of publications per species.

We indeed found three records of *H. patagonicus* in the northeastern region; however, these records and, therefore, the northern limit of the species distribution are questionable and require further investigation.

The first record refers to four specimens listed as material examined by Silveira et al. (2014); however, the original collection data is not available, and there is no information on those specimens in the article text. The second record refers to specimens obtained from a public market in Recife, Pernambuco (Silveira et al. 2018). However, this record was considered uncertain by the study's authors, as it does not necessarily reflect the species' original collection area. The third reported record of *H. patagonicus* in Pernambuco is from a sighting in a natural habitat (Pereira et al. 2021). However, there was no accompanying photograph of the animal, nor a description of the procedures used to verify the species identification or a voucher, making the record dubious. It is also important to note that there is a mention of the occurrence of *H. patagonicus* in the state of Espírito Santo (Rosa et al. 2010), which would expand the northern limit of the species distribution. However, this record refers to animals obtained from seahorse dried trade samplings and their original collection data cannot be verified. Therefore, in this review, we considered the distribution of the species according to the studies that present unquestionable records, meaning the southern limit of distribution in Rio Grande do Sul and a northern limit in Rio de Janeiro (Figure 4).

Hippocampus aff. *erectus* Perry, 1810

The lined seahorse, *H.* aff. *erectus*, was evaluated as a valid species in the Brazilian National Red List but is still under taxonomic uncertainty (ICMBio 2018). As previously stated, the occurrence of *H.*

Figure 3. Word cloud representing the most frequently mentioned words mentioned in abstracts of seahorse publications in Brazil. Word size is proportional to its frequency in publication abstracts (n = 288).

erectus in Brazil has been questioned in several studies, with some confirming the existence of mistakenly identified specimens that were indeed *H. patagonicus* (Barros 2005; Silveira et al. 2014). The occurrence of *H.* aff. *erectus* in Brazil is still considered valid due to the existence of a third morphotype found in Brazilian waters, which is distinct from *H. reidi* and *H. patagonicus* (Barros 2005; Defavari 2016; Silveira et al. 2014). This third morphotype has been treated as *H. villosus* in some publications (Barros 2005; Kuiter 2009), which, according to Lourie et al. (2016), is a synonym for *H. erectus*. *Hippocampus* aff. *erectus* found in Brazilian waters represents a genetically distinct clade from specimens found in the Caribbean waters, but they are nonetheless regarded as the same species because the genetic distance between these two clades is below the threshold used (Lourie et al. 2016; Silveira et al. 2014). Hence, further systematic molecular analysis is pivotal for more precise taxonomic recognition of those isolated populations of *H. erectus* in Brazil (Araujo et al. 2022).

Moreover, the distribution of this species also requires further evaluation. According to Lourie et al. (2016), the southern limit of *H. erectus* is in NE Brazil (probably Bahia state). Its distribution in the IUCN assessment (Pollom 2017) extends to southern Brazil. According to the Brazilian National Red List (ICMBio 2018), *H.* aff. *erectus* distribution extends to the SE-S coast, with a southern distribution limit in the Brazilian state of Rio Grande do Sul and a northern limit in the state of Piauí (NE region). Hence, the current information on the species distribution is controversial and inconsistent. In this revision, we found non-dubious records of *H.* aff. *erectus* in three NE Brazilian states based on only three studies: Bahia (Rosa et al. 2006), Pernambuco (Vasconcelos and Oliveira

1999; Silveira et al. 2014), and Rio Grande do Norte (Garcia Júnior 2006) (Figure 4). Other studies allude to the presence of *H.* aff. *erectus* in additional Brazilian states; however, these records were found to be misidentifications (specifically *H. patagonicus*) or were regarded as uncertain due to the reliance on outdated identification keys (pre-dating the acknowledgment of *H. patagonicus* in Brazil) and lacking evidence for confirmation. Therefore, there are still many uncertainties regarding the occurrence of *H.* aff. *erectus* in Brazil as well as a significant need for in-depth studies to clarify its distribution and taxonomic status.

Seahorse ecology in Brazil

Habitats

Seahorses inhabit estuarine and marine shallow waters in Brazil and are commonly found in three main habitat types: mangroves, rocky shores, and reefs (e.g., Freret-Meurer and Andreata 2008; Freret-Meurer et al. 2018a,b; Mai and Rosa 2009; Rosa et al. 2007, 2010). Most studies in NE Brazil have focused on seahorses in mangrove estuaries (e.g., Aylesworth et al. 2015; Dias and Rosa 2003; Rosa et al. 2007; Schwarz Junior et al. 2021); meanwhile, studies in the SE-S are more related to rocky shores and reef habitats (Carmo et al. 2022; Freret-Meurer and Andreata 2008; Freret-Meurer et al. 2018a; Rosa et al. 2007). Most records of seahorses using seagrasses as holdfasts are sporadic (Dias 2002; Dias and Rosa 2003; Mai and Rosa 2009; Rosa et al. 2007), despite those being assigned as major habitats for seahorses in general (Foster and Vincent 2004). Only one study based on participatory monitoring of fisheries in Bahia recorded seagrass as a primary habitat where seahorses were captured (Reis-Filho 2023).

As the most studied species in Brazil (Figure 2c), the majority of data available on seahorse ecology in the country refers to *Hippocampus reidi*; proportionally, there is a dearth of information on the ecology and life history of *H. patagonicus* and *H.* aff. *erectus*. *Hippocampus reidi* is mainly found in shallow and coastal habitats such as mangroves, rocky shores, reefs, sandy beaches, and seagrasses (Dias and Rosa 2003; Freitas and Velastin 2010; Freret-Meurer et al. 2018a; Rosa et al. 2007, 2010; Figure 5). Indeed, shallow depths have been shown to be a critical habitat component for *H. reidi* in mangrove estuaries (Aylesworth et al. 2015; Borges et al. 2023; Valentim et al. 2023). The species is typically found from 0 to 8m depth in Brazil, which may vary according to the habitat: 0 – 6m in mangrove estuaries in NE Brazil (Borges et al. 2023; Dias 2002; Oliveira 2007; Rosa et al. 2007; Schwarz Junior et al. 2021; Silveira 2005; Valentim et al. 2023) and 0.10 – 8m in reef/rocky shore habitats in the SE (Carmo et al. 2022; Freret-Meurer et al. 2018b; Oliveira and Freret-Meurer 2012). In contrast, Vari (1982) documented that *H. reidi* can be found at depths ranging from 15 to 55m across its entire distribution.

Furthermore, warm temperatures and calm waters have also been identified as key components for the occurrence of *H. reidi* in mangrove estuaries (Aylesworth et al. 2015) and rocky shores (Oliveira and Freret-Meurer 2012). A variety of holdfast types has been described as used by *H. reidi*, including mangrove structures (such as roots, fallen branches, and leaves of the mangrove species *Rhizophora mangle, Laguncularia racemosa* and *Avicennia* spp.), invertebrates such as oysters, bryozoans, sponges, tunicates, gorgonian, stone corals and other cnidarians, macroalgae, and artificial structures such as piers (Aylesworth et al. 2015; Borges et al. 2023; Carmo et al. 2022; Dias and Rosa 2003; Mai and Rosa 2009; Rosa et al. 2005, 2007; Oliveira 2007; Valentim et al. 2023).

Most of the information on *H. patagonicus* occurrence in Brazil is based on records of capture as bycatch in bottom-trawl and gill nets, suggesting that the species inhabits deeper waters off the Brazilian coast (Freret-Meurer et al. 2022a; Rosa et al. 2011; Silveira et al. 2020), but little is known about their habitat preferences. However, two *in situ* population surveys recorded its presence in shallow coastal environments (up to 1m depth), such as rocky reefs and coastal lagoons (Rosa et al. 2010; Vaccani et al. 2021), and the use of macroalgae (*Codium* sp. and *Ulva* sp.), bryozoans (*Bugula neritina* and *Schinozoporella* spp.), artificial structures, such as ropes and cables (Rosa et al. 2010) and turf seaweed (Vaccani et al. 2021) as holdfasts. In contrast to its typical occurrence in shallow waters in Argentina (up to 15m in depth; Piacentino and Luzzatto 2004), *H. patagonicus* appears to inhabit deeper waters in Brazil, extending to depths of up to 120m (Rosa et al. 2011). Studies indicate a preference for isobaths between 25m and 90m in the SE-S regions (Rosa et al. 2010; Silveira et al. 2023).

Knowledge about *H.* aff. *erectus* in Brazilian waters is almost non-existent. There are only two records of habitats used by the species: mangrove estuaries (Rio Grande do Norte – Garcia Junior 2006; Pernambuco – Vasconcelos and Oliveira 1999) and reef environments (Rio Grande do Norte - Garcia Junior 2006, Barros 2005; Bahia and Sergipe – Barros 2005). In addition, there is a mention of the species being found in 4-60m depth reef environments mainly composed of sponges, although this record refers to *H. villosus* (Barros 2005). Furthermore, one record reported the occurrence of *H.* aff. *erectus* at 100m deep in Rio de Janeiro (Freret-Meurer and Andreata 2011). However, this potentially refers to *H. patagonicus*, as there is no valid occurrence of *H.* aff. *erectus* in Rio de Janeiro according to our reports, and most of the published information regarding the species dates to before 2014, a

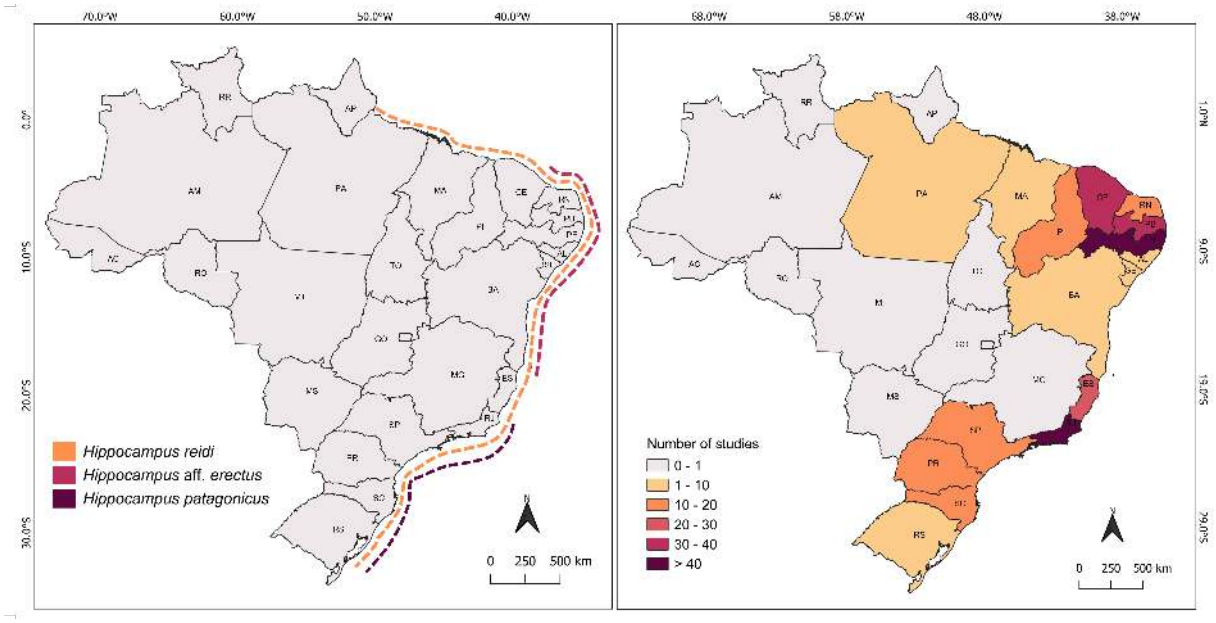

Figure 4. Distribution map of the three seahorse species along the Brazilian coast (a) and distribution map of publications on seahorses in Brazil (b). The distributions are based on a systematic review of all publications on seahorses in Brazil. Abbreviations of Brazilian state names: Northern states (N) – AC (Acre), AM (Amazonas), AP (Amapá), PA (Pará), RO (Rondônia), RR (Roraima), TO (Tocantins); Northeastern states (NE) – AL (Alagoas), BA (Bahia), CE (Ceará), MA (Maranhão), PB (Paraíba), PE (Pernambuco), PI (Piauí), RN (Rio Grande do Norte), SE (Sergipe); Southeastern states (SE) – ES (Espírito Santo), MG (Minas Gerais), RJ (Rio de Janeiro), SP (São Paulo); Central-Western states (CW) – GO (Goiás), MS (Mato Grosso do Sul), MT (Mato Grosso); Southern states (S) – PR (Paraná), RS (Rio Grande do Sul), SC (Santa Catarina).

period during which *H. patagonicus* was misidentified as *H. erectus* in Brazil.

Most syngnathids are known to have relatively small home ranges, meaning that they tend to occupy and remain within a limited area for most of their lives (Foster and Vincent 2004; Harasti et al. 2014). This tendency reflects their specialized life history traits and ecological requirements, including site fidelity, low mobility, and habitat preferences (Foster and Vincent 2004). In Brazil, studies on seahorse home ranges are restricted to *H. reidi* and are associated with estuarine habitats such as mangroves and artificial structures. These investigations have reported home ranges ranging between 1 (Dias 2002; Rosa et al. 2002) and 25m^2 for adults (Castro 2007), with a maximum displacement ranging from 137 (Castro 2007) to 260 m (Porto 2015). For juveniles, data from a single study suggest a home range varying from 1 to 4m^2, with smaller individuals showing less displacement rate than larger ones (Dias 2002).

Seahorse migration in Brazil remains largely understudied. Beyond localized movements reported in ecological studies, documented seasonal migrations are scarce and limited to *H. reidi* in NE Brazil. According to fishers (Rosa et al. 2005) and seahorse-watching operators (Ternes et al. 2016), this species migrates to high-salinity estuarine areas during the winter. However, no published information exists on the migration patterns of *H. patagonicus* and *H.* aff. *erectus* in Brazil.

Population parameters

Information on the population ecology of Brazilian seahorses retrieved in this review was mostly limited to *H. reidi*, with little data available for *H. patagonicus* It is based on 34 studies performed over a 22-year interval (from 2002 to 2024), and is mainly limited to mangrove estuaries, rocky shores, and reef environments (Additional File 4). The approach primarily used in these studies was underwater visual census, but one study used beach seines and bottom trawling as sampling methods for syngnathid fish (Hocama 2012). There is no data available for *H.* aff. *erectus* populations in Brazil.

The population density of *H. reidi* varied between 0.002 and 0.59 ind./m^2 along the Brazilian coast. The studies in mangrove estuaries registered densities ranging from 0.005 to 0.51 ind./m^2, while those in rocky reef environments showed densities ranging from 0.002 to 0.55 ind./m^2. Higher densities were found in Rio Grande do Norte, NE Brazil (0.51 ind./m^2; Dias and

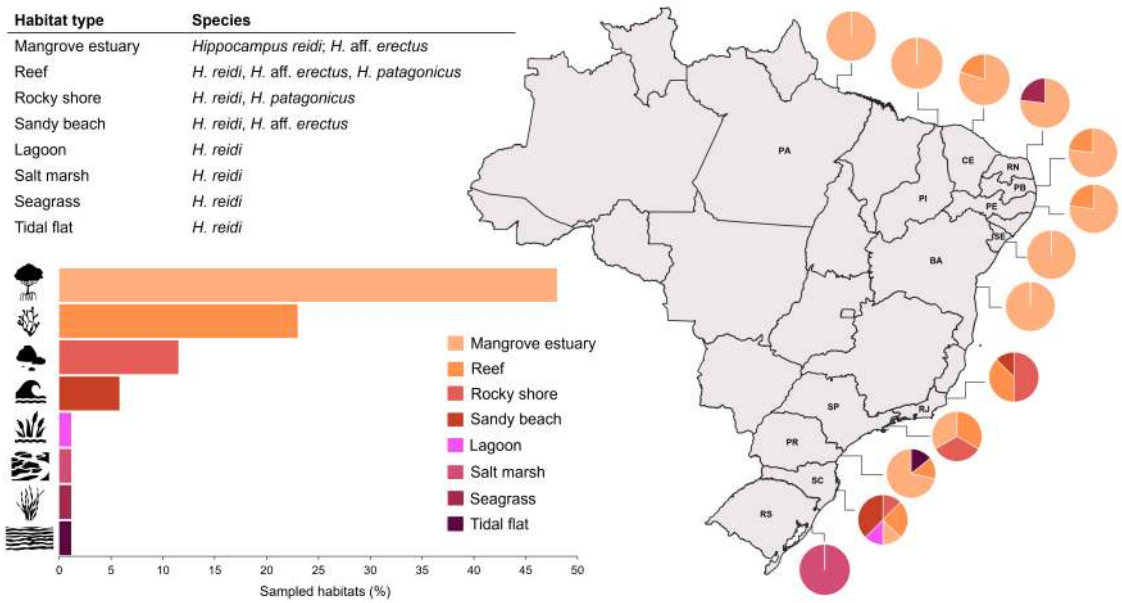

Figure 5. Seahorse habitats in Brazil, illustrating the species identified in each habitat type, the number of studies conducted for each habitat type, and highlighting the most prevalent habitat types studied in each Brazilian state.

Rosa 2003), and in Rio de Janeiro, SE Brazil (0.59 ind./m^2; Freret-Meurer et al. 2024). However, it is important to carefully evaluate density data, as comparisons across studies can be challenging due to significant variations in sampling design, techniques, and efforts used during data collection (Woodall et al. 2018). For instance, different studies have utilized random or fixed transects of varying sizes and areas (e.g., Aylesworth et al. 2015; Dias and Rosa 2003; Mai and Velasco 2012; Schwarz Junior et al. 2021; Freret-Meurer et al. 2018b; Freret-Meurer et al. 2022; Vaccani et al. 2021) even within the same habitat type, making meaningful comparisons among areas difficult. Indeed, the studies reporting the highest seahorse densities in NE (Dias and Rosa 2003) and SE Brazil (Freret-Meurer et al. 2024) were conducted at limited spatial and/or temporal scales and might not have accurately reflected actual density values for the entire study areas. Therefore, there is an urgent need to implement a consistent sampling protocol to ensure that seahorse density data from different studies can be reliably assessed and compared.

Only one study on *H. patagonicus* density has been documented in the literature, which mentions peaks during the summer months, specifically between January and March, on a rocky shore in a coastal lagoon in Rio de Janeiro, SE Brazil (Rosa et al. 2010). Furthermore, there is another record of the species based on the sightings of two individuals in a rocky reef in an estuarine environment, also in RJ, but no density data was provided (Vaccani et al. 2021).

Limited data is available on the reproductive ecology of seahorses in Brazilian waters, primarily focusing on *H. reidi* in the northeastern and southeastern regions. The available information indicates that the reproductive period extends throughout the year, considering males with fully developed pouches observed every month (NE Brazil: Mai and Velasco 2012; Oliveira 2007; Osório 2008; Rosa et al. 2007; Silveira et al. 2016; SE Brazil: Freret-Meurer et al. 2022). However, reproductive peaks may vary among sampling sites and within regions. For instance, most records of reproductive peaks in the northeast occurred in the dry/summer season (October-February, Oliveira 2007; Osório 2008; Rosa et al. 2007; May-November, Mai and Velasco 2012), but some studies reported peaks during the rainy season (Franco 2016; Silveira 2005; Santos 2017), or in some months of both dry and rainy seasons (Schwarz Junior et al. 2021). In NE Brazil, recruitment has been reported during the rainy season (between May and September; Oliveira 2007) or nearly year-round (from July to April; Mai and Velasco 2012). In the southeast, reproductive peaks were reported in February, June, August, November, and December (Rosa et al. 2007), coinciding with the dry season in this region. Recruitment in the southeast was reported during two annual peaks in May and November (Freret-Meurer et al. 2022). The sex ratios reported for *H. reidi* in Brazil were predominantly equivalent (1:1), which is consistent with observations in many syngnathid species (Lourie et al. 1999). However, female-biased sex ra-

tios have been documented in populations inhabiting rocky shores in Rio de Janeiro (Carmo et al. 2022; Freret-Meurer and Andreata 2008; Freret-Meurer et al. 2018). Information on the reproductive period of *H. patagonicus* is limited to by-catch data and indicates that reproduction occurs year-round in Rio de Janeiro (Silveira et al. 2023).

Conservation concerns

Threats

Several studies in Brazil have identified threats to seahorse conservation, which fall into three major categories: fisheries (targeted and incidental), trade, and habitat degradation / other anthropogenic disturbances (Figure 6).

According to Vincent et al. (2011), exploitation, whether targeted or incidental, is a key driver of global population decrease. Seahorse fishery in Brazil has been based on both intentional and incidental capture (by-catch). Targeted seahorse fisheries focus on specimens for the live animal trade, which is primarily intended for ornamental purposes. Data on the live seahorse fisheries and trade was compiled from 1997 to 2004, with records from at least 10 Brazilian states, the majority of which in NE Brazil and limited to *H. reidi* (Rosa et al. 2010, 2011). An estimated 715,000 live seahorses were collected in Brazil each year (Rosa et al. 2011). Live seahorses are destined for domestic trade, but primarily for exports (Rosa et al. 2011; Gurjão 2016); however, there are no current estimates of targeted seahorse captures for the live trade.

Most incidental seahorse captures occur in the SE-S Brazil, from Espírito Santo to Rio Grande do Sul states (Rosa et al. 2011; Silveira et al. 2018, 2020), while some occur in N-NE Brazil (Pará, Piauí, Ceará, Paraíba, and Pernambuco) (Rosa et al. 2011). *Hippocampus patagonicus* is the most frequently obtained seahorse species as by-catch in industrial shrimp trawls, and to a lesser degree in fish trawl/gill nets in the SE-S coast, but there are also records of captures of *H.* aff. *erectus* and *H. reidi* (Barcelos 2012; Silveira et al. 2018, 2020). According to Vincent et al. (2011), shrimp trawling is the most common fishing activity involving seahorse by-catch due to the size and habitat similarities between seahorses and shrimp. Catch data from 2002-2003, based on 54 logbooks from industrial shrimp trawlers' landings, led to the estimated volume of 1.2 million seahorses (mostly *H. patagonicus*) captured as industrial by-catch in SE-S (Rosa et al. 2011). Estimates obtained from monitoring incidentally captured seahorse landings in three Rio Grande do Sul state ports from 2011 to 2012 revealed that nearly 90 and 8,350 seahorses could be captured annually in gill nets and pair-trawls, respectively, operating on the Santa Catarina and Rio Grande do Sul coasts (Silveira et al. 2018). More recently, a study on *H. patagonicus* by-catch in SE-S Brazil, based on logbooks data from five trawlers from Rio de Janeiro, estimated a catch rate of 3.36 seahorses/day/vessel, which extrapolated an incidental removal of 2,282,515 seahorses annually (Silveira et al. 2023). However, these estimates should be interpreted with caution, particularly when generalized to the entire fleet operating within the species' range. Only *H. reidi* was captured in the N-NE regions, primarily in lobster nets or artisanal fisheries (Rosa et al. 2005, 2011; Reis-Filho 2023), and a participatory monitoring study in Bahia found that seahorses (measured as individuals caught per fishing trip/day) were captured more frequently in seagrass habitats compared to mangroves, sand, and mud bottoms (Reis-Filho 2023).

As of 2016, the seahorse trade was widespread in Brazil and classified into two categories: live trade and dried trade. Dried seahorses were mostly provided by incidental captures in shrimp trawls, mainly *H. patagonicus* (SE-S), but also *H. reidi* (N-NE) (Rosa et al. 2011). Data from 2002-2009 obtained from non-industrial by-catch suggested that at least 120,000 dried seahorses were traded annually by end-sellers in Brazil, accounting for 314 kg of domestic trade (Rosa et al. 2011), whereas there are no formal records of dried specimens being exported, but unreported exports may occur (Rosa et al. 2011). Incidental catches in artisanal fisheries also ended up fuelling the domestic trade, mostly on a local and sporadic scale (Rosa et al. 2011). Records indicated specimens sold for values ranging from $US 0.17 to US 3.50$ per unit (Franco 2016; Loiola 2017; Rosa et al. 2011). Dried seahorses have been used in Brazil as traditional medicines to treat more than 30 diseases, primarily asthma (Rosa et al. 2010, 2011). Herein, we found 23 publications (8.91%) that recorded the widespread use of seahorses in medicinal treatments in the country. Dried seahorses can also be used in magical-religious rituals and as charms, handicrafts, and curios (Rosa et al. 2010, 2011). As most of the artisanal incidental captures are related to illegal gear or non-selective small-scale fisheries, it is rather challenging to trace the trade of seahorses resulting from by-catch (Alfaro-Shigueto et al. 2022).

Live seahorses have been commercialized as ornamental fish in both domestic and international aquarium trade. Most live seahorses traded in Brazil come from wild populations in the northeastern states (Rosa et al. 2011). On the other hand, captive-bred specimens were primarily exported in the late 2000s (Rosa et al. 2011). Colorful (i.e., red, orange, and yellow) specimens are far more valued (Rosa et al. 2006, 2011). Brazil was once considered the largest exporter of wild live seahorses in Latin America and the main supplier of *H. reidi* (Baum and Vincent 2005; Dias Neto 2011;

Evanson et al 2011). Brazil remained a constant supplier of the wild live seahorse trade even after the effective seahorse listing on CITES in 2004 (Foster et al. 2022), but in much-reduced volumes (Rosa et al. 2011).

Recent data show that the seahorse trade is still occurring in the country. Some evidence suggests that dried seahorses are still used as remedies (Brito et al. 2019), and live specimens have been traded domestically (Gurjão 2016; Gurjão et al. 2018). Furthermore, another modality of trade demands attention: the online trade. Records demonstrate that sellers sporadically offer seahorses to aquariums on social media (i.e. live seahorses for the ornamental trade in Facebook groups, Borges et al. 2021) and websites (Mercado Livre and OLX, Gurjão 2016). This raises special concerns since the online trade provides opportunities for illegal commercialization in a very challenging context for monitoring and tracing, especially as there has been no specific legislation to regulate the online animal trade (Borges et al. 2021; Sung and Fong 2018).

Other anthropogenic disturbances pose significant threats to seahorse populations and their habitats worldwide, most of which are related to physical damage to habitats, chemical pollutants, changes in water quality, noise pollution, invasive species, and climate change (Pollom et al. 2021; Vincent et al. 2011). Seahorse habitats in Brazil are threatened by coastal development (residential, commercial, and tourism), deforestation of mangrove areas, unsustainable fisheries, aquaculture ventures (shrimp farms), sedimentation, and pollution of estuaries, reef areas, and rocky shores. Moreover, several studies have already drawn attention to the negative effects of tourism on benthic and sedentary fish worldwide (de Brauwer et al. 2018, 2019; Giglio et al. 2019). Furthermore, data have indicated that heavy nautical traffic in Brazilian estuaries is a source of impact on seahorses and their habitats (Batista 2015; Bruto-Costa 2007; Oliveira 2005, 2007; Rosa et al. 2007). The impact of boat traffic on fish populations is well documented in the literature and is mostly related to noise, chemical pollution, and the physical effects of boat movement, such asboat wakes (Becker et al. 2013; Whitfield and Becker 2014). Noise pollution from heavy boat traffic was related to behavioral alterations in *H. capensis* in Knysna estuary, South Africa (Claassens and Hodgson 2017), and in *H. guttulatus* in Ria Formosa, Portugal (Palma et al. 2019).

Another tourism-related activity that has raised concerns about its impacts on seahorse conservation is "seahorse tours", which focus on *H. reidi* in NE Brazil. The tours consist of guided tours into estuaries to observe seahorses in their natural habitat, in which tourists visit mangrove areas aboard "jangadas" (traditional wooden boats) or canoes, and tourist guides collect seahorses at specific locations and place them into glass containers for observation (Ternes et al. 2016; Martins et al. 2022). This activity was implemented for the first time more than two decades ago in the Maracaípe estuary (state of Pernambuco, NE Brazil; Ternes et al. 2016), and currently takes place as registered guided tours in two more mangrove areas in NE Brazil: Jericoacoara National Park (state of Ceará) and Delta do Parnaíba Environmental Protection Area (state of Piauí) (Martins et al. 2022; Ternes et al. 2023). Despite the activity's significant socioeconomic value for local operators (Ternes et al. 2016, 2023), there is no information available on the direct effects of the exposure of seahorses in glass containers. However, evidence suggests that the activity is unsustainable and urgently requires evaluation (Melo et al. 2022), with some local operators themselves expressing concerns about its sustainability (Ternes et al. 2016, 2023). Furthermore, since this activity involves physical manipulation, it can cause increased stress in the animals, as well as adverse and unknown effects on populations (de Brauwer et al. 2019). Scuba diving tourism is another tourism-related activity that can affect seahorses. Giglio et al. (2019) demonstrated that divers using action cameras and extension poles can cause behavioral alterations in *H. reidi* seahorses, emphasizing that effective management is necessary to ensure the sustainability of this activity. In this context, it is critical to properly assess and mitigate the impacts of tourist activities, particularly those related to habitat destruction and disturbances to seahorse (Giglio et al. 2019).

Conservation measures for seahorse populations in Brazil

At the international level, concerns about seahorse conservation translates into the inclusion of nearly all species on The International Union for Conservation of Nature's Red List of Threatened Species (IUCN Red List), most of them assessed as threatened ("Endangered" or "Vulnerable"), "Near Threatened" or "Data Deficient" (Pollom et al. 2021). Globally, the Brazilian seahorse species are currently listed as "Near Threatened", for *H. reidi*, and as "Vulnerable", for *H.* aff. *erectus* and *H. patagonicus*. Furthermore, as the seahorse trade has been considered one of the greatest threats to the conservation of this group globally (Baum and Vincent 2005; Foster et al. 2022s), the entire genus *Hippocampus* is listed in Appendix II of CITES, which was implemented in 2004 (Foster et al. 2016; Vincent et al. 2014). As a signatory country, Brazil was compelled to monitor and control seahorse exports (Figure 7). More recently, the IUCN Resolution 95 has become a key instrument for syngnathid conservation, advising and urging for a number of conservation actions for

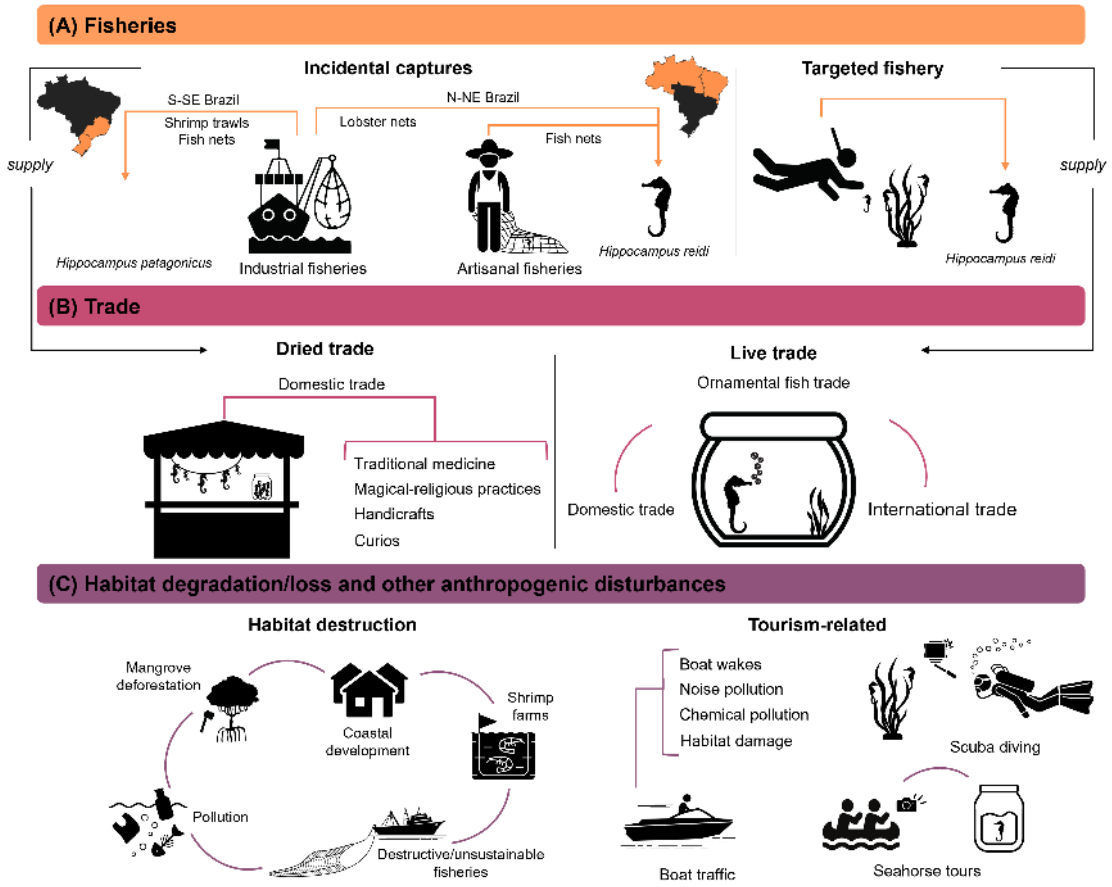

Figure 6. Major threats to seahorse conservation in Brazil. Data limited to *Hippocampus reidi* and *Hippocampus patagonicus*.

seahorses, pipefishes, and seadragons. These measures include ensuring that the status of all species is assessed and included in national and regional Red Lists; enforcing regulations on fisheries, area-based management, habitat protection, and illegal wildlife trade; using the IUCN Species Survival Commission guidelines for any reintroduction and translocation efforts; ensuring that any syngnathid aquaculture operations undergo careful risk assessments and are considered safe; and protecting and restoring critical habitats for syngnathid species (IUCN 2020).

At the national level, some measures – primarily legal instruments – have directly influenced seahorse conservation over the last two decades in Brazil (Figure 7). Many of these measures were created with a focus on regulating seahorse harvesting for the ornamental fish trade. The first regulatory measures for the exploitation of seahorses were implemented between 2000 and 2004, with the establishment of export quotas for the aquarium trade (Dias Neto 2011; Rosa 2011). Permits should be obtained from the Brazilian Institute of Environment and Natural Resources (IBAMA). These quotas were reassessed a few times during this period, changing from an initial quota of 5,000 specimens per year for each species (at the time, *H. reidi* and *H. erectus*) to an annual quota of 250 specimens per species for each authorized company (IBAMA 2004).

The National List of the Aquatic Invertebrates and Fish Species Overexploited or Threatened of Overexploitation was also released in 2004, which established that management plans should be developed for all listed species, including *H. reidi* and *H. erectus* – the only two recognized species in Brazil at that time (MMA 2004). As a result, a Proposal for a Management Plan for the Sustainable Use of the Brazilian Seahorse Species was published in 2011 (Dias Neto 2011). The proposal included general measures for both species, such as establishing no-take zones; programs to monitor/minimize the effects of incidental captures of seahorses; programs for mapping/monitoring/restoring seahorse populations and habitats; and community-based management initiatives. These measures should have been implemented through specific research, control, enforcement of fisheries/trade,

and education programs. However, no specific program was officially created/implemented, despite some significant measures taken after the proposal was published.

Regarding the international trade of live seahorses, specific licenses for the import, export, and re-export of CITES-listed species were implemented in 2006 through the "Integrated System of International Trade" (SISCOMEX) in articulation with the CITES/IBAMA authorities in Brazil. As a CITES-listed species, seahorse export permits should be issued by IBAMA through specific authorizations, which also monitored the export quotas (250 specimens/species/year per company). This initiative has placed Brazil as a pioneer in the informatization of ornamental fish export control (Rosa et al. 2010). However, data from Rosa et al. (2011) demonstrated that *H. reidi* was the only species exported, meaning that Brazilian companies were misidentifying *H. erectus* to increase *H. reidi* exports. Since the publication of these data and the management plan proposal (Dias Neto 2011), exports of *H. erectus* declined sharply and ceased in 2013 (Foster et al. 2022).

In 2008, seahorse captures and trade became regulated by Normative Instruction 202 (IBAMA 2008), which disciplined the catch, transportation, domestic trade, and exports of native marine fishes for ornamental and aquarium purposes. Later, seahorses were listed as threatened species as per Decree 445 (MMA 2014). This decree established the three seahorse species (*H. reidi*, *H.* aff. *erectu*s, and *H. patagonicus*) as "Vulnerable" in the Brazilian National Red List. Following the final amendments to the decree in 2018, the capture, trade, transport, and possession of seahorses (both live and dried) in Brazil were prohibited, except for purposes of research or conservation, provided specific authorization is obtained. This restriction remains in place unless the Brazilian government implements an action/recovery plan or specific fishery regulations for seahorses. The list was recently revised and the conservation status of the three seahorse species remained unchanged (MMA 2022). The ban does not apply to captive-bred specimens, as long as the legal source of the specimens is demonstrated, although there is no specific legislation in Brazil regulating aquaculture protocols or trade of captive-reared/bred seahorses in Brazil. Despite the ban, some studies have reported that seahorse capture and trade still occur in Brazil (Gurjão et al. 2018; Borges et al. 2021), demonstrating poor enforcement of regulations and lack of control/surveillance.

Regarding dried seahorses, as they are mostly derived from fishery by-catch (Rosa et al. 2011; Silveira et al. 2018, 2020), the regulations applied to this activity are critical for reducing its effects on seahorse populations. Although Brazil is a major shrimp producer, there is no specific and systematic governmental program that monitors commercial trawl fleet captures nor provides consistent by-catch data for the fished species (Rodrigues Filho et al. 2020). Recently, the *Monitora* Program, a government initiative for monitoring biodiversity in protected areas, has documented incidental captures of seahorses in shrimp fisheries on the northern coast of Brazil, but no data are available on captures along the SE-S (ICMBio 2024). This is concerning, as the studies performed in these regions clearly demonstrated that seahorses have been incidentally captured by industrial fisheries (Rosa et al. 2010, 2011; Silveira et al. 2018, 2020, 2023), and demonstrates that systematic and effective monitoring of by-catch, including seahorse captures, remains insufficient. As seahorses are listed as threatened species, incidentally caught specimens cannot be retained (except for research purposes, under specific authorization); they must be released (either dead or alive), and captures must be reported (MPA 2012). Reinforcing monitoring efforts and ensuring compliance with regulations are crucial steps for mitigating the impacts of by-catch and improving conservation outcomes (Branco et al. 2015; Cardoso et al. 2021). Furthermore, actions for conservation spatial planning should be implemented, including the enforcement of protected areas and the establishment of trawl-exclusion zones (Vaidyanathan et al. 2024).

Other measures might indirectly affect seahorse conservation in Brazil. For example, seahorse distribution areas in the country overlap with several protected areas, some of which have the protection of threatened and rare species as one of their main objectives. Another example is the national action plans for the conservation of threatened species (PAN), which are management instruments for the conservation of biodiversity and natural environments (MMA 2014). Two of those PAN directly focus on seahorse habitats: the National Action Plan for Coral Environments (PAN Corais, ICMBio 2016) and the Mangrove National Action Plan (PAN Manguezal, MMA 2019). However, neither plan has proposed specific measures for Brazilian seahorses. Even in PAN Corais, where all seahorse species in Brazil were listed as focal species due to their national threat status, targeted conservation actions were not established. Regarding PAN Manguezal, although mangroves are crucial habitats for seahorses in Brazil (Aylesworth et al. 2015; Borges et al. 2023), no seahorse species were designated as focal species in the plan. As a result, seahorses may have only benefited indirectly from this PAN. However, following the PAN Manguezal, the National Program for the Conservation and Sustainable Use of Mangroves in Brazil (Pro-Manguezal, Decree 12045, 2024) was officially instituted in 2024. This program is set to be implemented and prioritizes mangrove-associated species listed in

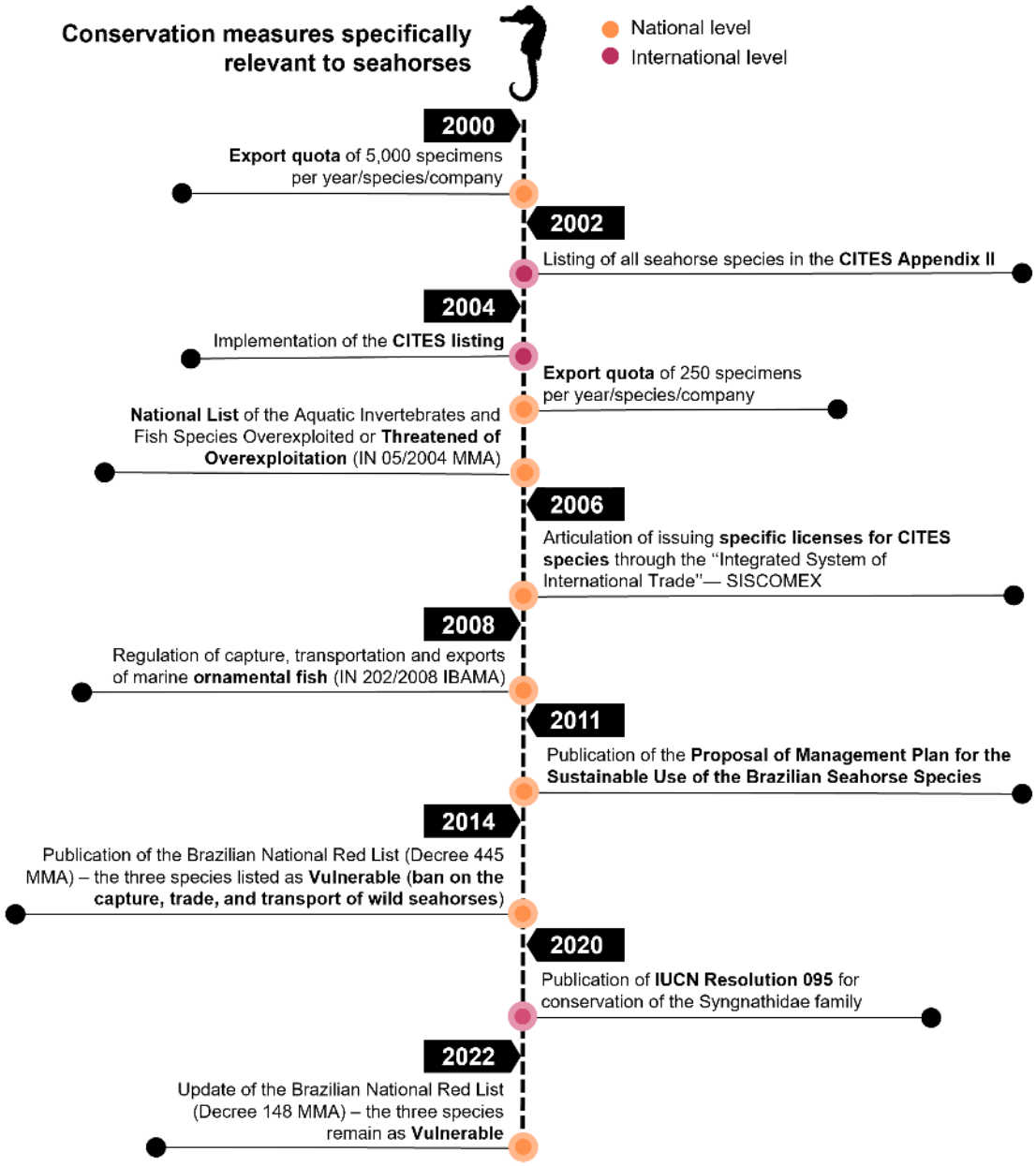

Figure 7. A timeline highlighting the major measures specifically relevant to seahorse conservation in Brazil. Legend: IN = Normative Instruction; MMA = Brazilian Ministry of Environment; IBAMA = Brazilian Institute for the Environment and Natural Resources).

the Brazilian Red List, making it a potentially valuable instrument for seahorse conservation, particularly for *Hippocampus reidi*.

Future perspectives

Knowledge gaps and research opportunities

Seahorse research in Brazil is relatively recent (less than 30 years) and spatially concentrated in some regions/areas, which, besides unresolved taxonomic uncertainties, makes seahorse conservation planning in Brazil challenging. In this review, we have identified significant gaps and uncertainties in our understanding of Brazilian seahorses. Addressing these knowledge gaps can provide valuable guidance for future research and management development, as well as aid in setting conservation priorities for this unique and threatened fish group.

There is a general lack of standardized data regarding the biology and ecology of Brazilian seahorse

species. More in-depth studies are needed on their distribution, habitat preferences and use, movement, population structure and fluctuations, and overall biological aspects for all species. To address this, it is essential to ensure that the research approaches are suitable for gathering data accurately, reproducibly, and reliably. Studies should adopt rigorous methodologies and clearly present their findings. Ensuring accurate taxonomic identification is also crucial, requiring consultation with specialists, the use of reliable identification keys, and the incorporation of precise morphological and/or genetic data. Furthermore, attention should also be given to the accuracy of geographical data presented in the studies to prevent uncertainties in species distribution records.

Knowledge gaps are even more critical for *H.* aff. *erectus*, highlighting the urgent need to solve taxonomical uncertainties regarding Brazilian seahorses. It is crucial to investigate and confirm seahorse species diversity in Brazil, and address the taxonomic issues concerning *H.* aff. *erectus* and clarify the distribution of this species and *H. patagonicus* in the country. This includes examining specimens in museums and other institutions that hold seahorses in their collections to promote a revision of these two species to correct misidentifications. Moreover, new research approaches, such as using environmental DNA (Claassens et al. 2022), studies on population genomics (Li et al. 2021), and species distribution modelling (Zhang and Vincent 2018), can provide essential tools for addressing this issue and should be considered in future research. Local ecological knowledge can also provide a valuable approach to filling the gaps in seahorse knowledge in Brazil (Rosa et al. 2005; Ternes et al. 2016). Furthermore, several other topics must be considered for future research on seahorses in Brazil, including climate change effects on populations (Freret-Meurer et al. 2022b; Monteiro et al. 2023), current fisheries estimates (both targeted and incidental, across industrial and artisanal sectors), trade trends (including the online trade), and the sustainability of tourism practices.

Recommendations for conservation

Seahorse conservation in Brazil requires a multifaceted approach that addresses the main threats to their populations (e.g., habitat destruction, fisheries, tourism, and trade) and the engagement of all the relevant stakeholders. There is an urgent need to fill knowledge gaps regarding the taxonomy and ecology of Brazilian seahorses through sound research to guide future management and conservation actions. In this sense, long-term monitoring of wild seahorse populations in different habitats in which species can be found is crucial for understanding their fluctuations and the factors affecting them. Clarifying the diversity and distribution of Brazilian seahorses is essential to assess the efficacy of ongoing conservation measures.

Despite the ban on seahorse capture and trade in Brazil, there has been no assessment of the effectiveness of this measure, as the information gathered in this review suggests that illegal captures and commercialization of seahorses persist in the country. Therefore, it is crucial to assess the effectiveness of the legal measures aiming at eliminating threats to seahorse populations. Furthermore, long-term monitoring of fishery activities in critical by-catch areas is essential to track and report illegal, unreported, and unregulated (IUU) fishing, as well as illegal trade (Alfaro-Shigueto et al. 2022). With the shift in international trade from wild-caught to captive-bred seahorses, there is an urgent need for regulations that ensure that aquaculture facilities monitor their production and comply with the non-detriment findings (NDF) and legal acquisition findings (LAF) required under CITES regulations. Proper oversight will help ensure that seahorse populations are not adversely affected and that trade practices align with international conservation standards (Foster et al. 2022). Moreover, the sustainability of tourism activities involving seahorses must be assessed to establish ethical and ecologically sustainable standards for developing these practices (Claassens et al. 2022).

Maintaining seahorse key habitats in Brazil – such as estuaries, mangroves, reefs, and rocky shores – is critical for their survival, especially as these habitats are among the most threatened globally. Hence, it is essential to prioritize conservation efforts to restore degraded habitats and enforce their protection to promote seahorse conservation, including enhancing the effectiveness of protected areas. Seahorses are flagship species that can draw attention to broader conservation issues and inspire practical solutions that benefit not only their populations but also their ecosystems and associated biodiversity (Vincent et al. 2011). Seahorse conservation must be incorporated into national and regional legislation, environmental policies, and educational initiatives to promote stakeholder engagement (e.g., communities, resource managers, policymakers, and the general public; Vincent et al. 2011) in habitat protection, sustainable fishing practices, and responsible trade.

CONCLUSION

In this review, we provide an overview of the current knowledge on seahorses in Brazil to support future management and conservation efforts in the country. Protecting their habitats, increasing awareness of the impact of fisheries, trade, and other anthropogenic disturbances on their populations, and enhancing our un-

derstanding of their biology and ecology are key strategies for preventing their extinction. Efforts to enforce regulations and promote stakeholder collaboration are also essential. By addressing these challenges, we can work towards a sustainable future for seahorse populations and their habitats in Brazil.

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DATA AVAILABILITY

All information presented in this text was derived from secondary data obtained through our systematic review. The documents included in the review are detailed in the Add File 2.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: AKMB, RRNA, TPRO. Carried out the data analysis: AKMB, TPRO. Wrote the first draft of the manuscript: AKMB, TPRO.
Reviewed and wrote the final version of the manuscript: AKMB, RRNA, TPRO.

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Additional Files

Add File 1. PRISMA Checklist reporting the page which contains the information of the systematic review (NA = not applicable).

Section/topic	Item	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	2-3
Objectives	4		3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	3-4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	3
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	3-4
Selection process	8	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4

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Section/topic	Item	Checklist item	Reported on page #
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	4
Data items	10	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Study risk of bias assessment	11	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	NA
Effect measures	12	State the principal summary measures (e.g., risk ratio, difference in means) used in the synthesis or presentation of results.	NA
Synthesis methods	13	Describe the methods of handling data and combining results of studies.	4-5
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	NA
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	4-4
RESULTS			
Study selection	16	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	4-6
Study characteristics	17	Cite each included study and present its characteristics.	Add File 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	NA
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	NA
Results of syntheses	20	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA

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Section/topic	Item	Checklist item	Reported on page #
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Summary of evidence	23	Provide a general interpretation of the results in the context of other evidence.	6-23
Limitations	24	Discuss any limitations of the evidence included in the review or of the review processes used.	NA
Conclusions	25	Discuss implications of the results for practice, policy, and future research.	22-23
OTHER INFORMATION			
Funding	26	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	NA
Registration and protocol	27	Provide registration information for the review, including register name and registration number, or state that the review was not registered	NA
Competing interests	28	Declare any competing interests of review authors.	24
Availability of data, code and other materials	29	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	NA

Add File 2. List of studies included in this systematic review.

Author/s	Title	Year	Type	doi	Seahorse focused	Language
Alcantâra	Ictiofauna do estuário do Rio Sergipe	2006	Book chapter		No	Portuguese
Almeida and Alburquerque	Uso e conservação de plantas e animais medicinais no estado de Pernambuco (Nordeste do Brasil): um estudo de caso	2002	Article		No	Portuguese
Almeida	Ethnoichthyology of fishermen community from the Praia da Penha, in João Pessoa City, Paraíba, Brazil	2014	Article		No	English
Alves et al.	The role of animal-derived remedies as complementary medicine in Brazil	2007	Article	10.1641/B571107	No	English
Alves et al.	Commercialization of animal-derived remedies as complementary medicine in the semi-arid region of Northeastern Brazil	2009	Article	10.1016/j.jep.2009.04.049	No	English
Alves et al.	An ethnozoological survey of medicinal animals commercialized in the markets of Campina Grande, NE Brazil	2010	Article		No	English
Alves et al.	The role of animal-derived remedies as complementary medicine in Brazil	2012	Book chapter		No	English
Alves et al.	Animals for the gods: magical and religious faunal use and trade in Brazil	2012	Article	10.1007/s10745-012-9516-1	No	English
Alves et al.	Fisheries and Uses of Coastal Aquatic Fauna in the Northernmost Brazilian Atlantic Forest	2023	Book chapter	10.1007/978-3-031-21287-1_14	No	English
Alves and Rosa	From cnidarians to mammals: the use of animals as remedies in fishing communities in NE Brazil	2006	Article	10.1016/j.jep.2006.03.007	No	English
Alves and Rosa	Zootherapy goes to town: the use of animal-based remedies in urban areas of NE and N Brazil	2007	Article	10.1016/j.jep.2007.07.015	No	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Alves and Rosa	Zootherapeutic practices among fishing communities in North and Northeast Brazil: a comparison	2007	Article	10.1016/j.jep.2006.10.033	No	English
Alves and Rosa	Trade of animals used in Brazilian traditional medicine: trends and implications for conservation	2010	Article	10.1007/s10745-010-9352-0	No	English
Anderson et al.	Brazilian tropical fishes in their southern limit of distribution: checklist of Santa Catarina's rocky reef ichthyofauna, remarks and new records	2015	Article	10.15560/11.4.1688	No	English
Andrade	Assembleia de peixes juvenis que habitam raízes do mangue no estuário do rio Vaza-Barris em Aracaju, SE	2014	Thesis		No	Portuguese
Andreata et al.	Composição da assembleia de peixes da Baía da Ribeira, Angra dos Reis, Rio de Janeiro, Brasil	2002	Article	10.1590/S0101-81752002000400019	No	Portuguese
Apolinário and Santos	Comportamento do cavalo-marinho Hippocampus reidi Ginsburg, 1933 (Pisces: Syngnathidae), com referência ao hábito alimentar e reprodução	1998	Article		Yes	Portuguese
Aquino	Alguns aspectos da cadeia produtiva de peixes ornamentais marinhos no estado do Ceará e suas implicações legais	2010	Thesis		No	Portuguese
Araujo et al.	The Amazon-Orinoco Barrier as a driver of reef-fish speciation in the Western Atlantic through time	2022	Article	10.1111/jbi.14398	No	English
Araújo et al.	Ictiofauna marinha do estado do Ceará, Brasil	2000	Article		No	Portuguese
Armesto and Freret-Meurer	Testing for camouflage of the Brazilian seahorse Hippocampus reidi (Syngnathidae) using the territorial damselfish Stegastes fuscus (Cuvier) (Pomacentridae)	2012	Article		Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Arruda Júnior	Ichthyoplankton community in tropical estuaries of the Brazilian semiarid coast during extreme events: drought and heavy rainfall	2023	Thesis		No	English
Arruda Júnior et al.	Analysis of a hypersaline drought-prone estuary reveals low density and diversity of fish eggs and larvae	2023	Article	10.1016/j.marpolbul.2022.114503	No	English
Asêvedo	Estresse agudo em Hippocampus reidi (Teleostei: Syngnathidae) em resposta a playback de ruído antrópico	2022	Thesis		Yes	Portuguese
Attademo et al.	Fauna marinha (mamíferos, aves, quelônios e peixes) ameaçadas de extinção no estado de Pernambuco (Brasil): uma revisão para subsidiar a avaliação de espécies ameaçadas de extinção	2022	Article	10.5281/zenodo.7325271	No	Portuguese
Aylesworth et al.	Regional-scale patterns of habitat preference for the seahorse Hippocampus reidi in the tropical estuarine environment	2015	Article	10.1007/s10452-015-9542-3	Yes	English
Barbosa and Perinotto	Trilha ecológica do cavalo-marinho: Ecoturismo em Barra Grande/PI	2010	Article		Yes	Portuguese
Barbosa and Aguiar	Utilização místico-tradicional da fauna no Semiárido Paraibano	2012	Article		No	Portuguese
Barboza et al.	Aspectos culturais da zooterapia e dieta alimentar de pescadores artesanais do litoral paraense	2014	Article	10.18224/frag.v24i2.3309	No	Portuguese
Barcelos	Cavalos-marinhos (Syngnathidae: Hippocampus) como fauna acompanhante na pesca costeira de média escala no litoral norte do Rio Grande do Sul, Brasil	2012	Thesis		Yes	Portuguese
Barros	Taxonomia e análise da estrutura populacional comercializada de cavalos-marinhos (Syngnathidae: Teleostei: Hippocampus) no Brasil	2005	Thesis		Yes	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Batista	Peixes tropicais no seu limite de distribuição: dinâmica temporal da ictiofauna recifal no sul do Brasil	2016	Thesis		No	Portuguese
Batista	Tráfego e ruído náuticos em um ambiente estuarino e seus efeitos no comportamento de Hippocampus reidi	2015	Thesis		Yes	Portuguese
Batista	Levantamento da ictiofauna no afluente de uma fazenda de camarão: composição, distribuição e aspectos bioecológicos	2004	Thesis		No	Portuguese
Begossi and Ramires	Fish folk medicine of Caiçara (Atlantic Coastal Forest) and Caboclo (Amazon Forest) communities	2013	Book chapter	10.1007/978-3-642-29026-8_6	No	English
Bitencourt et al.	Comércio e uso de plantas e animais de importância mágico-religiosa e medicinal no Mercado Público do Guamá, Belém do Pará	2014	Article		No	Portuguese
Borges et al.	Caught in the (inter)net: Online trade of ornamental fish in Brazil	2021	Article	10.1016/j.biocon.2021.109344	No	English
Borges et al.	Mapping seahorses in a Brazilian estuary: mangrove structures as key predictors for distribution and habitat preference	2023	Article	10.7717/peerj.15730	Yes	English
Braga et al.	Ictiofauna acompanhante da pesca de camarões com rede-de-arrasto na zona costeira do município de Fortaleza, estado do Ceará, Brasil	2001	Article	10.32360/acmar.v34i1-2.11652	No	Portuguese
Branco et al.	Bycatch fauna of seabob shrimp trawl fisheries from Santa Catarina State, southern Brazil	2015	Article	10.1590/1676-06032015014314	No	English
Brito	Panorama da exportações de peixes ornamentais marinhos brasileiros de 2006 a 2013	2015	Thesis		No	Portuguese
Brito et al.	Environmental influence on the choice of medicinal animals: a case study from Northeastern Brazil	2019	Article		No	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Bruto-Costa	Efeito de marolas produzidas por embarcações a motor em cavalos-marinhos (Syngnathidae: Hippocampus) no Estuário do Rio Ariquindá, PE	2007	Thesis		Yes	Portuguese
Cardoso	Diversidade genética do cavalo-marinho Hippocampus reidi no litoral do nordeste do Brasil	2016	Thesis		Yes	Portuguese
Carmo	Estrutura populacional do cavalo-marinho Hippocampus reidi em dois estuários do Rio de Janeiro	2019	Thesis		Yes	Portuguese
Carmo et al.	Population structure of the seahorse Hippocampus reidi in two Brazilian estuaries	2022	Article	10.1590/2675-2824070.21016tfdc	Yes	English
Carmo et al.	Do longsnout seahorses Hippocampus reidi (Syngnathiformes: Syngnathidae) have a holdfast preference?	2024	Article	10.1590/1982-0224-2023-0074	Yes	English
Carmo and Freret-Meurer	Análise comparativa de dois métodos amostrais no levantamento do cavalo-marinho Hippocampus reidi Ginsburg, 1933 em recifes rochosos	2015	Article		Yes	Portuguese
Carvalho	Comentários sobre os peixes mencionados na obra "História dos animais e árvores do Maranhão" de Frei Cristovão de Lisboa	1964	Article		No	Portuguese
Carvalho	Pesca marinha para aquariofilia: captura e comércio com fins ornamentais não reportados no Brasil	2020	Thesis		No	Portuguese
Carvalho	Algumas informações sobre cavalos-marinhos (Hippocampus sp) e sua manutenção em aquários	1982	Thesis		Yes	Portuguese
Carvalho-Filho	Fishes of the Brazilian coast	2023	Book		No	English
Carvalho et al.	The marine ornamental market in Brazil (Southwestern Atlantic) frequently trades prohibited and endangered species, and threatens the ecosystem role of cleaning mutualism	2022	Article	10.1016/j.marpol.2022.105305	No	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Carvalho et al.	Integrating of the seahorse Hippocampus reidi in multitrophic organic farms of oysters and shrimp: Effects of density and diet	2019	Article	10.22370/rbmo.2019.54.1.1465	Yes	English
Castro	Alimentação e características populacionais de Hippocampus reidi Ginsburg, 1933 (Teleostei: Syngnathidae) no Estuário do Rio Mamanguape, Paraíba	2007	Thesis		Yes	Portuguese
Castro	Cultivo, desenvolvimento morfológico, crescimento e sobrevivência de Hippocampus reidi (Teleostei: Syngnathidae): nascimento ao 63º dia	2012	Thesis		Yes	Portuguese
Castro et al.	Assessing diet composition of seahorses in the wild using a non destructive method: Hippocampus reidi (Teleostei: Syngnathidae) as a study-case	2008	Article	10.1590/S1679-62252008000400012	Yes	English
Cattani et al.	Fish species richness in shallow environments of the Island of Santa Catarina, Southern Brazil	2018	Article	10.37002/revistacepsul.vol7.729e2018001	No	English
Castro et al.	Feeding longsnout seahorse Hippocampus reidi broodstock at different frequencies influences production of eggs and quality of the offspring	2024	Article	10.1007/s10499-023-01364-5	Yes	English
Chao et al.	Relação preliminar dos peixes estuarinos e marinhos da Lagoa dos Patos e região costeira adjacente, Rio Grande do Sul, Brasi	1982	Article	10.1590/S0101-81751988000400002	No	Portuguese
Chaves and Feitosa	Impactos diretos e indiretos das atividades humanas sobre ambientes recifais e a ictiofauna associada	2018	Book chapter		No	Portuguese
Chaves and Corrêa	Composição ictiofaunística da área de manguezal da Baía de Guaratuba, Paraná, Brasil	1998	Article		No	Portuguese
Cohen	Aquicultura, conservação e comercialização de cavalos-marinhos no cenário internacional	2017	Thesis		Yes	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Cohen et al.	First insights on the bacterial fingerprints of live seahorse skin mucus and its relevance for traceability	2018	Article	10.1016/j.aquaculture.2018.04.020	Yes	English
Cohen, and Valenti	Opportunities and constraints for developing low-cost aquaculture of seahorses in mangrove estuaries	2019	Article	10.1016/j.aquaculture.2018.12.031	Yes	English
Corrêa et al.	Catálogo dos peixes marinhos da coleção da divisão de Zoologia e Geologia da Prefeitura Municipal de Curitiba - I	1986	Article	10.5380/RN.V1I1.41017	No	Portuguese
Costa et al.	Desenvolvimento de juvenis de cavalos-marinhos Hippocampus reidi (Gynsburg, 1933) (Actinopterygii: Gasterosteiformes) após a postura do macho em cativeiro	2022	Article	10.47385/cadunifoa.v17.n48.3566	Yes	Portuguese
Costa MDP	Ictioplâncton da baía da Babitonga: isntrumento para a definição de áreas prioritárias para a conservação	2011	Thesis		No	Portuguese
Costa et al.	Ichthyofauna of Ceará-Mirim River basin, Rio Grande do Norte State, northeastern Brazil	2017	Article	10.3897/zookeys.715.13865	No	English
Costa-Neto	Healing with animals in Feira de Santana City, Bahia, Brazil	1999	Article	10.1016/s0378-8741(98)00158-5	No	English
Costa-Neto	Restrições e preferências alimentares em comunidades de pescadores do Município de Conde, estado da Bahia, Brasil	2000	Article	10.1590/S1415-52732000000200006	No	Portuguese
Costa-Neto and Marques	Faunistic resources used as medicines by artisanal fishermen from Siribinha Beach, state of Bahia, Brazil	2000	Article		No	English
Costa-Neto and Motta	Animal Species Traded as Ethnomedicinal Resources in the Federal District, Central West Region of Brazil	2010	Article	10.2174/1876391X01002010024	No	English
Cunha	Óleo essencial de Lippia alba como anestésico para peixes	2011	Thesis		No	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Cunha et al.	Anesthetic induction and recovery of Hippocampus reidi exposed to the essential oil of Lippia alba	2011	Article	10.1590/S1679-62252011000300022	Yes	English
Defavari	Genética da Conservação de cavalos-marinhos (Hippocampus spp.) no Brasil	2016	Thesis		Yes	Portuguese
Delunardo	Efeitos subletais da contaminação pela fração solúvel do óleo diesel em cavalo-marinho (Hippocampus reidi)	2017	Thesis		Yes	Portuguese
Delunardo et al.	Genotoxic and morphological damage in Hippocampus reidi exposed to crude oil	2013	Article	10.1016/j.ecoenv.2012.09.029	Yes	English
Delunardo et al.	Seahorse (Hippocampus reidi) as a bioindicator of crude oil exposure	2015	Article	10.1016/j.ecoenv.2015.03.016	Yes	English
Delunardo et al.	Effects of water-accommodated fraction of diesel fuel on seahorse (Hippocampus reidi) biomarkers	2019	Article	10.1016/j.aquatox.2019.105353	Yes	English
Delunardo et al.	Morphological and histopathological changes in seahorse (Hippocampus reidi) gills after exposure to the water-accommodated fraction of diesel oil	2019	Article	10.1016/j.marpolbul.2019.110769	Yes	English
Dias Neto	Proposta de plano de gestão para o uso sustentável de cavalos-marinhos do Brasil	2011	Technical document		Yes	Portuguese
Dias	Ecologia populacional de Hippocampus reidi Ginsburg, 1933 (Teleostei: Syngnathidae) no estado do Rio Grande do Norte, Brasil	2002	Thesis		Yes	Portuguese
Dias et al.	Threatened fishes of the world: Hippocampus erectus Perry, 1810 (Syngnathidae)	2002	Article		Yes	English
Dias and Rosa	Habitat preferences of a seahorse species, Hippocampus reidi (Teleostei: Syngnathidae) in Brazil	2003	Article	10.1590/2675-2824070.21016tfdc	Yes	English
Diniz	Preferência alimentar de Hippocampus reidi Ginsburg, 1933 (Teleostei: Syngnathidae) em ambiente natural (estuarino e recifal) no Nordeste brasileiro	2011	Thesis		Yes	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Duarte et al.	Disruptive coloration and habitat use by seahorses	2019	Article	10.1590/1982-0224-20190064	Yes	English
Dubiaski-Silva and Masunari	The fish assemblage associated to the phytal of Sargassum cymosum C. Agardh, 1820, at Ponta das Garoupas, Bombinhas, Santa Catarina	2004	Article		No	English
Eskinazi	Peixes do Canal de Santa Cruz - Pernambuco - Brazil	1972	Article		No	Portuguese
Fagundes Netto et al.	Associações de peixes bentônicos e demersais na região do Cabo Frio, RJ, Brasil	1991	Article	10.5380/rn.v6i1-2.85029	No	Portuguese
Favero et al.	Structure of the fish assemblage and functional guilds in the Estuary of Maracaípe, Northeast Coast of Brazil	2018	Article	10.20950/1678-2305.2019.45.1.417	No	English
Feitosa et al.	A rapid new method for assessing sustainability of ornamental fish by-catch from coral reefs	2008	Article	10.1071/MF08054	No	English
Felicio et al.	Feeding behavior of the longsnout seahorse Hippocampus reidi Ginsburg, 1933	2006	Article	10.1007/s10164-005-0189-8	Yes	English
Ferreira et al.	Levantamento inicial das comunidades de peixes recifais da região de Tamandaré - PE	1995	Article		No	Portuguese
Ferreira	Efeito do uso de probiótico e diferentes enriquecedores na Artemia sp. no cultivo de juvenis de cavalo-marinho Hippocampus reidi	2017	Thesis		Yes	Portuguese
Ferreira et al.	The trade in medicinal animals in Northeastern Brazil	2012	Article	10.1155/2012/126938	No	English
Fonseca et al.	Technical and economic feasibility of integrating seahorse culture in shrimp/oyster farms	2017	Article	10.3390/app122311920	No	English
Franco	Monitoramento e conservação de cavalos-marinhos (Syngnathidae – Hippocampus reidi (Ginsburg, 1933)) no Estuário do Rio Vaza-Barris - SE	2016	Thesis		Yes	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Freitas	Ictiofauna do Parque Estadual Marinho da Pedra da Risca do Meio (Ceará - Brasil): composição, estrutura e contexto biogeográfico	2009	Thesis		No	Portuguese
Freitas and Velastin	Ictiofauna associada a um cultivo de mexilhão Perna perna (Linnaeus, 1758) Norte Catarinense, Sul do Brasil	2010	Article	10.4025/actascibiolsci.v32i1.2515	NO	Portuguese
Freitas	Anomalocardia brasiliana Gmelin, 1791 (Mollusca Bivalvia): rendimento, composição química e dados etnobiológicos das marisqueiras de Barra Grande, Cajueiro da Praia, Piauí	2011	Thesis		No	Portuguese
Freret-Meurer et al.	Opercular beat: A non-invasive and rapid method to detect stress in seahorses	2020	Article	10.1080/10454438.2020.1810841	Yes	English
Freret-Meurer and Andreata	Field studies of a brazilian seahorse population, Hippocampus reidi Ginsburg, 1933	2008	Article	10.1590/S1516-89132008000400012	Yes	English
Freret-Meurer et al.	Padrão de atividade diurna do cavalo-marinho Hippocampus reidi no estado do Rio de Janeiro	2009	Article	10.4257/oeco.2009.1301.07	Yes	Portuguese
Freret-Meurer et al.	Activity rate of the seahorse Hippocampus reidi Ginsburg, 1933 (Syngnathidae)	2012	Article	10.1007/s10211-012-0125-1	Yes	English
Freret-Meurer et al.	Seahorse fingerprints: a new individual identification technique	2013	Article	10.1007/s10641-013-0118-6	Yes	English
Freret-Meurer et al.	Thanatosis in the Brazilian seahorse Hippocampus reidi Ginsburg, 1933 (Teleostei: Syngnathidae)	2016	Article	10.1007/s10211-016-0247-y	Yes	English
Freret-Meurer et al.	Population dynamics of the endangered seahorse Hippocampus reidi Ginsburg, 1933 in a tropical rocky reef habitat	2018	Article	10.32800/ABC.2018.41.0345	Yes	English
Freret-Meurer et al.	A snapshot of a high density seahorse population in a tropical rocky reef	2018	Article	10.1080/00222933.2018.1478459	Yes	English
Freret-Meurer et al.	Evidence of feminization in seahorses from a tropical estuary	2021	Article	10.1111/jfb.14759	Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Freret-Meurer et al.	Agonistic behaviour in the long-snout seahorse: A gentlemanly challenge	2021	Article	10.1111/eth.13216	Yes	English
Freret-Meurer et al.	Range extension of the Patagonian seahorse in Brazil: a biological treasure hauled up by local fishermen	2022	Article	10.5281/zenodo.6826983	Yes	English
Freret-Meurer et al.	Influence of the Atlantic Ocean thermal anomaly on the Longsnout Seahorse Hippocampus reidi in a Brazilian estuary	2022	Article	10.1111/jfb.15156	Yes	English
Freret-Meurer et al.	Baseline study of the seahorse Hippocampus reidi Ginsburg, 1933 population in a tropical hypersaline lagoon	2024	Article	10.1007/s10452-023-10039-5	Yes	English
Freret-Meurer and Alves	Personality in the longsnout seahorse, Hippocampus reidi Ginsburg, 1933: Are males shyer than females?	2018	Article	10.1016/j.beproc.2018.09.006	Yes	English
Freret-Meurer and Andreata	First record of Hippocampus erectus Perry, 1810 (Pisces, Syngnathidae, Actinopterygii) at 100 meters deep	2011	Article	10.1111/j.1095-8649.2009.02371.x	Yes	English
Furtado et al.	Exposição e observações comportamentais de cavalos-marinhos no Aquário Paraíba, região nordeste do Brasil	2018	Article		Yes	Portuguese
Furtado	Comunicação acústica e química no reconhecimento de parceiro em cavalo-marinho Hippocampus reidi Ginsburg, 1933	2015	Thesis		Yes	Portuguese
Garcia Junior	Inventário das espécies de peixes da costa do Estado do Rio Grande do Norte e aspectos zoogeográficos da ictiofauna recifal do Oceano Atlântico	2006	Thesis		No	Portuguese
Gasparini et al.	Marine ornamental trade in Brazil	2005	Article	10.1007/s10531-004-0222-1	No	English
Giglio et al.	Scuba diving and sedentary fish watching: effects of photographer approach on seahorse behavior	2018	Article	0.1080/14724049.2018.1490302	Yes	English
Gomes	Peixes recifais de ocorrência no Brasil: ameaças, atributos bioecológicos e percepção humana para a conservação	2010	Thesis		No	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Gurjão	A explotação de espécies ornamentais marinhas no Brasil, com ênfase no estado do Ceará	2016	Thesis		No	Portuguese
Gurjão et al.	Illegal trade of aquarium species through the Brazilian postal service in Ceará State	2018	Article	10.1071/MF16257	No	English
Hercos and Giarrizzo	Pisces, Syngnathidae, Hippocampus reidi: Filling distribution gaps	2007	Article	10.15560/3.4.287	Yes	English
Hocama	Parâmetros populacionais e distribuição de Syngnathidae (Pisces: Actinopterygii) do Complexo Estuarino de Paranaguá, Brasil	2012	Thesis		Yes	Portuguese
Hora	Cultivo de cavalo-marinho, Hippocampus reidi (Teleostei: Syngnathidae) até a maturidade sexual	2007	Thesis		Yes	Portuguese
Hora	Influência da salinidade na mortalidade e crescimento de juvenis de cavalo-marinho Hippocampus reidi	2011	Thesis		Yes	Portuguese
Hora	Determinação de condições bióticas e abióticas ideais durante o estágio inicial de desenvolvimento de juvenis de cavalo-marinho Hippocampus reidi em cultivo	2015	Thesis		Yes	Portuguese
Hora et al.	Tolerance and growth of the longsnout seahorse Hippocampus reidi at different salinities	2016	Article	10.1016/j.aquaculture.2016.05.003	Yes	English
Hora et al.	Effect of photoperiod and tank colour on growth and survival of pelagic-phase seahorse Hippocampus reidi	2017	Article	10.1111/are.13252	Yes	English
Hora et al.	Stocking density for the seahorse Hippocampus reidi in the pelagic phase and insights on the benthic phase in culture conditions	2018	Article	10.1016/j.aquaculture.2017.11.022	Yes	English
Hora and Joyeux	Closing the reproductive cycle: Growth of the seahorse Hippocampus reidi (Teleostei, Syngnathidae) from birth to adulthood under experimental conditions	2009	Article	10.1016/j.aquaculture.2009.03.023	Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
ICMBIO	Livro Vermelho da Fauna Brasileira Ameaçada de Extinção	2018	Technical document		No	Portuguese
Ikebata	Efeito da privação alimentar sobre a sobrevivência e atividade enzimática das larvas de Hippocampus reidi	2018	Thesis		Yes	Portuguese
Lamas et al.	Checklist of the fish fauna of the Araçá Bay, São Sebastião Channel, northern coast of São Paulo, Brazil	2016	Article	10.15560/12.6.2004	No	English
Lehmann et al.	Avaliação da reprodução e alevinagem do cavalo-marinho, Hippocampus reidi (Ginsburg, 1933) em sistema de circulação fechada	2015	Article	10.21439/conexoes.v9i3.835	Yes	Portuguese
Leite	Reavaliação da estrutura populacional e uso de habitat por Hippocampus reidi, no estuário de Itapessoca, Pernambuco	2022	Thesis		Yes	Portuguese
Leite et al.	A Baía de Guanabara é um ambiente importante para a conservação neotropical? Uma abordagem ictiológica	2018	Article		No	Portuguese
Léo-Neto and Alves	A Natureza sagrada do candomblé: análise da construção mística acerca da natureza em terreiros de candomblé no Nordeste de Brasil	2010	Article		No	Portuguese
Lima e Carlos	Avaliação do desempenho reprodutivo do cavalo-marinho Hippocampus reidi (Ginsburg 1933) do Estuário do Rio Potengi (Rio Grande do Norte, Brasil) com vistas ao seu cultivo em bases sustentáveis	2010	Thesis		Yes	Portuguese
Lima	Catálogo de peixes costeiros de Pernambuco, Nordeste do Brasil	2018	Thesis		No	Portuguese
Lines et al.	A large scale temporal and spatial environmental DNA biodiversity survey of marine vertebrates in Brazil following the Fundão tailings dam failure	2023	Article	10.1016/j.marenvres.2023.106239	No	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Loiola	Conhecimento empírico de pescadores artesanais sobre o cavalo-marinho Hippocampus reidi (Teleostei: Syngnathidae) no Estuário do Rio Pacoti (Ceará, Brasil)	2017	Thesis		Yes	Portuguese
Lopes	Catálogo dos peixes marinhos do Laboratório de lctiologia da Universidade Federal do Rio de Janeiro	1989	Article	10.1590/S0101-81751989000200004	No	Portuguese
Lopes et al.	Contribuição ao conhecimento da ictiofauna do Manguezal de Cacha Pregos, Ilha de Itaparica, Baía de Todos os Santos, Bahia	1998	Article	10.1590/S0101-81751998000200005	No	Portuguese
Lopes et al.	Fauna acompanhante da pesca camaroeira no litoral do estado de São pPaulo, Brasil	2002	Article	10.20950/1678-2305.2016v42n4p819	No	Portuguese
Macêdo and Ramos	O desenvolvimento do turismo em Barra Grande, Piauí (Brasil) e seu significado para a comunidade local	2012	Article		No	Portuguese
Machado et al.	Rocky reef fish biodiversity and conservation in a Brazilian Hope Spot region	2022	Article	10.1590/1982-0224-2022-0032	No	English
Maganhe et al.	Transport conditions in the planktonic phase for seahorses Hippocampus reidi Ginsburg, 1933 (Teleostei: Syngnathidae)	2023	Article	10.3856/vol51-issue3-fulltext-2996	Yes	English
Mai and Loebmann	Size and number of newborn juveniles in wild Hippocampus reidi broods	2009	Article		Yes	English
Mai and Rosa	Aspectos ecológicos do cavalo-marinho Hippocampus reidi no estuário Camurupim/Cardoso, Piauí, Brasil, fornecendo subsídios para a criação de uma Área de Proteção Integral	2009	Article	10.1590/S1676-06032009000300007	Yes	Portuguese
Mai and Velasco	Population dynamics and reproduction of wild longsnout seahorse Hippocampus reidi	2012	Article	10.1017/S0025315411001494	Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Mantelatto et al.	Host species of the non-indigenous brittle star Ophiothela mirabilis (Echinodermata: Ophiuroidea): an invasive generalist in Brazil?	2016	Article	10.1186/s41200-016-0013-x	No	English
Marceniuk et al.	Peixes teleósteos da costa norte do Brasil	2021	Book		No	Portuguese
Marceniuk et al.	Peixes marinhos da Paraíba	2023	Book		No	Portuguese
Marques and Barreiros	Camouflage of the seahorse Hippocampus reidi with plastic debris: an unusual type of protective resemblance	2015	Article	10.1007/s12526-015-0372-2	Yes	English
Martins et al.	Trajetória e perspectivas do turismo com cavalos-marinhos no Parque Nacional de Jericoacoara, Ceará	2022	Article	10.37002/biobrasil.v12i3.1988	Yes	Portuguese
Martins	Cultivo do cavalo marinho Hippocampus reidi (Ginsburg, 1933) em laboratório: reprodução e procedimentos	2015	Thesis		Yes	Portuguese
Martins et al.	Isolation and experimental infection with Vibrio alginolyticus in the sea horse, Hippocampus reidi Ginsburg, 1933 (Osteichthyes: Syngnathidae) in Brazil	2010	Article	10.1590/s1519-69842010000100028	Yes	English
Masih Neto	Captura, transporte e quarentena de peixes marinhos tropicais de grande porte destinado a aquários públicos	2017	Thesis		No	Portuguese
Massucato	Influência do copépodo Acartia sp. e uso de probiótico nos estágios iniciais de cultivo do cavalo-marinho Hippocampus reidi	2016	Thesis		Yes	Portuguese
Mastrangelli et al.	First report of Lepidochelys olivacea feeding on Hippocampus patagonicus in Brazil	2019	Article		No	English
Mattos	Entendendo as interações entre povos pesqueiros, manguezal e área protegida: RDS Estadual Pontad o Tubarão	2011	Thesis		No	Portuguese
Mattos et al.	Etnoconhecimento e percepção dos povos pesqueiros da Reserva Ponta do Tubarão acerca do ecossistema manguezal	2012	Article		No	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Medeiros	Padrões de distribuição e organização trófica da assembleia de peixes no estuário do Rio Mamanguape, Paraíba, Brasil	2016	Thesis		No	Portuguese
Medeiros et al.	Distribution patterns of the fish assemblage in the Mamanguape River Estuary, North-eastern Brazil	2018	Article	10.1080/17451000.2018.1459724	No	English
Melo et al.	Use of the microalga Nannochloropsis oculata in the rearing of newborn longsnout seahorse Hippocampus reidi (Syngnathidae) juveniles	2016	Article	10.1111/are.12843	Yes	English
Melo et al.	The practice of (un)sustainable tourism in a National Park: An empirical study focusing on structural elements	2022	Article	10.1016/j.jort.2022.100548	No	English
Mohr et al.	Ilhas Oceânicas Brasileiras	2009	Book		No	Portuguese
Monteiro-Neto et al.	Analysis of the marine ornamental fish trade at Ceara State, northeast Brazil	2003	Article	10.1023/A:1023096023733	No	English
Monteiro-Neto et al.	Associações de peixes na região costeira de Itaipu, Niterói, RJ	2008	Article	10.1590/S0073-47212008000100007	No	Portuguese
Monteiro-Neto et al.	Checklist of marine fishes from coastal islands of Rio de Janeiro, with remarks on marine conservation	2016	Article	10.1017/S1755267213000973	No	English
Montes et al.	Genetic diversity and populational structure of the seahorse Hippocampus reidi (Syngnathidae) in north-eastern Brazil: A conservationist approach	2018	Article	10.1002/aqc.2919	Yes	English
Muto et al.	Demersal fish assemblages of São Sebastião, southeastern Brazil: structure and environmental conditioning factors (summer 1994)	2000	Article		No	English
Nakaiama	Variação temporal e espacial da compoição da ictiofauna demersal do infralitoral raso da Baia de Paranaguá, PR, Brasil	2004	Thesis		No	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Nascimento	Análise da diversidade genética voltada a conservação do cavalo-marinho Hippocampus patagonicus no litoral do Brasil	2019	Thesis		Yes	Portuguese
Negreiros et al.	Effects of hypoxia and petroleum on the genotoxic and morphological parameters of Hippocampus reidi	2011	Article	10.1016/j.cbpc.2011.02.001	Yes	English
Okada et al.	Caracterização do padrão de distribuição do cavalo-marinho Hippocampus reidi Ginsburg, 1933 em nove praias do litoral do estado do Rio de Janeiro	2015	Article		Yes	Portuguese
Oliveira	The medicinal animal markets in the metropolitan region of Natal City, north-eastern Brazil	2010	Article	10.1016/j.jep.2010.04.010	No	English
Oliveira	Comportamento e produção de som em Hippocampus reidi em ambientes estuarinos no nordeste brasileiro	2014	Thesis		Yes	Portuguese
Oliveira	Cultivo de juvenis recém nascidos do cavalo-marinho Hippocampus reidi com diferentes protocolos de alimentação e manejo	2010	Thesis		Yes	Portuguese
Oliveira	Caracterização populacional e habitats preferenciais de cavalos-marinhos (Syngnathidae: Hippocampus) em diferentes substratos no estuário de Itapessoca, PE	2005	Thesis		Yes	Portuguese
Oliveira	Ecologia populacional de Hippocampus reidi (Teleostei: Syngnathidae) em dois estuários do Estado de Pernambuco, Brasil	2007	Thesis		Yes	Portuguese
Oliveira	Produção de som, sensibilidade auditiva e comunicação acústica em Hippocampus reidi (Teleostei: Syngnathidae)	2011	Thesis		Yes	Portuguese
Oliveira et al.	Novel sex-related characteristics of the longsnout seahorse Hippocampus reidi Ginsburg, 1933	2010	Article	10.1590/S1679-62252010000200017	Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Oliveira and Freret-Meurer	Distribuição vertical do cavalo-marinho Hippocampus reidi Ginsburg, 1933 na região de Arraial do Cabo, Rio de Janeiro, Brasil	2012	Article	10.5007/2175-7925.2012v25n2p59	Yes	Portuguese
Osório	Estudo populacional do cavalo-marinho HIPPOCAMPUS REIDI Ginsburg, 1933 (Teleostei: Syngnathidae) em dois estuários cearenses	2008	Thesis		Yes	Portuguese
Osório et al.	Ictiofauna associada às raízes de mangue do estuário do Rio Pacoti – CE, Brasil	2011	Article	10.1590/S1676-06032011000100038	No	Portuguese
Osório et al.	Characterization of seahorse trade Hippocampus spp. in the state of Ceará – Brazil	2024	Article	10.32360/acmar.v57i2.91763	Yes	English
Paiva	Ecologia de peixes estuarinos-recifais e caracterização ambiental dos estuário de Pernambuco	2009	Thesis		No	Portuguese
Pereira et al.	Ecologia alimentar de Hippocampus patagonicus Piacentino & Luzzatto, 2004 e a conservação de cavalos-marinhos (Teleostei: Syngnathidae) no sul do Brasil	2016	Thesis		Yes	Portuguese
Pereira et al.	New records of Hippocampus patagonicus Piacentino & Luzzatto, 2004 (Teleostei: Syngnathidae) from the coast of Paraná, southern Brazil	2016	Article	10.15560/12.1.1822	Yes	English
Pereira et al.	Feeding habits of the seahorse Hippocampus patagonicus (Actinopterygii: Syngnathiformes: syngnathidae) on the Southern Coast of Brazil	2018	Article	10.3750/AIEP/02379	Yes	English
Pereira et al.	Medicinal and mystical-religious uses of seahorses in Southern Brazilian Coast	2021	Article		No	English
Pereira et al.	Reef fishes biodiversity and conservation at the largest Brazilian coastal Marine Protected Area (MPA Costa dos Corais)	2021	Article	10.1590/1982-0224-2021-0071	No	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Perinotto et al.	Comunicação turística no munícipio de Cajueiro da Praia-Piauí/Brasil	2017	Article		No	Portuguese
Pinto	Caracterização socioambiental e uso de animais por comunidades tradicionais do litoral do estado do CE	2012	Thesis		No	Portuguese
Pinto et al.	Ethnotaxonomical considerations and usage of ichthyofauna in a fishing community in Ceará State, Northeast Brazil	2013	Article	10.1186/1746-4269-9-17	No	English
Pinto et al.	Use of ichthyofauna by artisanal fishermen at two protected areas along the coast of Northeast Brazil	2015	Article	10.1186/s13002-015-0007-5	No	English
Pinto et al.	How do artisanal fishermen name fish? An ethnotaxonomic study in Northeastern Brazil	2016	Article	10.2993/0278-0771-36.2.348	No	English
Pinto	Mudanças a longo prazo na comunidade de peixes de uma baía tropical do sudeste do Brasil (1987-2013): perda gradativa da biodiversidade da zona interna para a zona externa	2015	Thesis		No	Portuguese
Pontes	Descrição morfológica da ontogenia de Hippocampus reidi	2010	Thesis		Yes	Portuguese
Porto	Padrões de movimentação de cavalos-marinhos (Syngnathidae, Hippocampus reidi, Ginsburg, 1933) no Estuário do Rio Vaza-Barris, SE	2015	Thesis		Yes	Portuguese
Queiroz et al.	Caracterização da ictiofauna demersal de duas áreas do Complexo Estuarino de Paranaguá, Paraná, Brasil	2006	Article		No	Portuguese
Queiroz et al.	A ictiofauna demersal de áreas com diferentes níveis de ocupação humana, no Estuário de Paranaguá	2007	Article		No	Portuguese
Queiroz-Brito et al.	Population structure of long-snout seahorse Hippocampus reidi in Southwestern Atlantic and implications for management	2024	Article	10.1590/1982-0224-2024-0027	Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Reis-Filho	The participatory actions of artisanal fishers reveal spatial–temporal trends of seahorse catches as basis for future management	2023	Article	10.1007/s12562-023-01677-7	Yes	English
Ribeiro et al.	Marine ichthyofauna of Santa Catarina Island, Southern Brazil: checklist with comments on the species	2019	Article	10.1590/1676-0611-BN-2018-0684	No	English
Ribeiro et al.	Avaliação ecológica rápida da ictiofauna estuarina da área de preservação ambiental do Rio Mundaú	2022	Book chapter		No	Portuguese
Rocha et al.	Peixes recifais da costa da Paraíba, Brasil	1998	Article	10.1590/S0101-81751998000200017	No	Portuguese
Rodrigues Neto	Aspectos morfológicos do trato digestório do cavalo–marinho Hippocampus reidi (Ginsburg, 1933) [Percomorpha, Gasterosteiformes, Syngnathidae]	2000	Thesis		Yes	Portuguese
Rosa	National report	2005	Book chapter		Yes	English
Rosa et al.	Cavalos-marinhos - Hippocampus spp.	2010	Book chapter		Yes	Portuguese
Rosa et al.	Threatened fishes of the world: Hippocampus reidi Ginsburg, 1933 (Syngnathidae)	2002	Article	10.1023/A:1016152528847	Yes	English
Rosa et al.	Fishers' knowledge and seahorse conservation in Brazil	2005	Article	10.1186/1746-4269-1-12	Yes	English
Rosa et al.	Collaborative monitoring of the ornamental trade of seahorses and pipefishes (Teleostei: Syngnathidae) in Brazil: Bahia State as a case study	2006	Article	10.1590/S1679-62252006000200010	Yes	English
Rosa et al.	Population characteristics, space use and habitat associations of the seahorse Hippocampus reidi (Teleostei: Syngnathidae)	2007	Article	10.1590/S1679-62252007000300020	Yes	English
Rosa et al.	Dados populacionais de cavalos-marinhos Hippocampus reidi Ginsburg, 1933 (Teleostei: Syngnathidae) capturados para fins de aquarismo no Nordeste do Brasil	2010	Article		Yes	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Rosa et al.	Bioecologia de cavalos-marinhos (Teleostei: Syngnathidae: Hippocampus) na visão de pescadores do Norte e Nordeste do Brasil	2010	Book chapter		Yes	Portuguese
Rosa et al.	Entre o corpo e o espírito: uso medicinal e mágico-religioso de cavalos-marinhos no Brasil	2010	Book chapter		Yes	Portuguese
Rosa et al.	Fisheries and trade of seahorses in Brazil: historical perspective, current trends, and future directions	2011	Article	10.1007/s10531-011-0068-2	Yes	English
Rosa et al.	Seahorses in traditional medicines: a global overview	2012	Book chapter	10.1007/978-3-642-29026-8_10	Yes	English
Rosa and Alves	Pesca e comércio de cavalos-marinhos no norte e nordeste do Brasil: subsídios para conservação e manejo	2007	Book chapter		Yes	Portuguese
Rossi-Wongtschowski and Paes	Padrões espaciais e temporais da comunidade de peixes demersais do litoral norte do Estado de São Paulo - Ubatuba, Brasil	1993	Article		No	Portuguese
Ruenes et al.	Marine wildlife in Brazilian zoohandicrafts: assessing the expansion of na uncontrolled trade	2023	Article	10.3389/fmars.2023.1238053	No	English
Sales et al.	Production and use of a flocculated paste of Nannochloropsis oculata for rearing newborn seahorse Hippocampus reidi	2016	Article	10.1016/j.algal.2016.04.024	Yes	English
Sales	Cultivo de juvenis de cavalos-marinhos Hippocampus reidi usando uma pasta da microalga Nannochloropsis oculata produzida por floculação	2015	Thesis		Yes	Portuguese
Salvador	Perfil bacteriano intestinal de cavalo-marinho Hippocampus reidi (Ginsburg, 1993) capturados no litoral sul do Espírito Santo, Brasil	2023	Thesis		Yes	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Santana	Efeito da triiodotironina exógena no desenvolvimento de larvas do Hippocampus reidi (Ginsburg, 1993)	2021	Thesis		Yes	Portuguese
Santana	Levantamento da ictiofauna marinha da Praia de Ponta de Areia, Ilha de Itaparica, Bahia	2021	Thesis		No	Portuguese
Santana	Padrões de ocorrência de cavalos marinhos (Syngnathidae, Hippocampus reidi, Ginsburg, 1932) no Estuário do Rio Vaza-Barris, SE	2015	Thesis		Yes	Portuguese
Santos	Comunidade de peixes demersais e ciclo reprodutivo de quatro espécies da família Sciaenidae na plataforma interna entre Superagui e Praia de Leste, PR	2006	Thesis		No	Portuguese
Santos et al.	Genotoxic effects of the diesel water-soluble fraction on the seahorse Hippocampus reidi (Teleostei: Syngnathidae) during acute exposure	2010	Article	10.1590/S1984-46702010000600017	Yes	English
Santos et al.	Ictiofauna acompanhante da pesca de arrasto para embarcações acima de 45 hp no Litoral do Paraná, Brasil	2016	Article	10.20950/1678-2305.2016v42n4p816	No	Portuguese
Santos	Padrões de ocorrência de cavalos-marinhos (Syngnathidae, Hippocampus reidi (Ginsburg, 1933)) em um rio de maré do estuário do Rio Vaza-Barris, Sergipe	2017	Thesis		Yes	Portuguese
Schroeder et al.	Análise espaço-temporal da composição da captura da pesca com emalhe de fundo no Sudeste/Sul do Brasil	2014	Article		No	Portuguese
Schwarz Junior et al.	Ecological and growth patterns of the longsnout seahorse Hippocampus reidi inferred by mark-recapture techniques in a tropical estuary	2021	Article	10.1590/1676-0611-BN-2020-1130	Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Silva	Avaliação de biomarcadores em Hippocampus reidi (Ginsburg, 1933) exposto ao efluente setorial não tratado de uma fábrica de celulose Espírito Santo, Brasil	2009	Thesis		Yes	Portuguese
Silva	Etnobiologia como ferramenta para gestão dos recursos naturais em reserva de desenvovlimento sustebtável	2015	Thesis		No	Portuguese
Silva	Aspectos químicos, citotóxicos e imunofarmacológicos do cavalo marinho, Hippocampus reidi	2015	Thesis		Yes	Portuguese
Silva	Manguezal em áreas costeiras e urbanizadas: diagnose da condição ambiental da vegetação e interações antrópicas	2019	Thesis		No	Portuguese
Silva	Caracterização da população de Hippocampus reidi no Estuário do Rio Pacoti, Ceará	2018	Thesis		Yes	Portuguese
Silva et al.	Hippocampus reidi, a marine natural product reduces TH2 cytokine levels and attenuates NFKB expression	2017	Article	10.1016/j.jaci.2016.12.280	Yes	English
Silva et al.	A zooterapia no Recife (Pernambuco): uma articulação entre as práticas e a história	2004	Article		No	Portuguese
Silveira	Desenvolvimento osteológico de Hippocampus reidi Ginsburg (Pisces, Syngnathiformes, Syngnathidae), em laboratório. I. Período embrionário	2000	Article	10.1590/S0101-81752000000200020	Yes	Portuguese
Silveira	Desenvolvimento osteológico de Hippocampus reidi Ginsburg (Pisces, Syngnathiformes, Syngnathidae), em laboratório. II. Período juvenil	2000	Article	10.1590/S0101-81752000000200021	Yes	Portuguese
Silveira	Dinâmica populacional do cavalo-marinho Hippocampus reidi no manguezal de Maracaípe, Ipojuca, Pernambuco, Brasil	2005	Thesis		Yes	Portuguese

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Silveira	Sobre o comportamento sexual do cavalo-marinho Hippocampus reidi Ginsburg, 1933 (Pisces: Synganthidae) em laboratório	2009	Article		Yes	Portuguese
Silveira	Registros de cavalos-marinhos (Syngnathidae: Hippocampus) ao longo da costa brasileira	2011	Article	10.4257/oeco.2011.1502.09	Yes	Portuguese
Silveira et al.	Morphological and molecular evidence for the occurrence of three Hippocampus species (Teleostei: Syngnathidae) in Brazil	2014	Article	10.11646/zootaxa.3861.4.2	Yes	English
Silveira et al.	Reproductive period, average height for the development of the brood pouch and sexual maturation of the seahorse Hippocampus reidi (Syngnathidae) in the Northeast of Brazil	2016	Article		Yes	English
Silveira et al.	Evaluation of population parameters of seahorses in areas with and without tourism in federal marine protected areas in Northeast Brazil	2022	Article	10.37002/biodiversidadebrasileira.v12i4.2278	Yes	English
Silveira et al.	Records of bycatch of Hippocampus patagonicus (Pisces: Syngnathidae) in commercial fishing in southern Brazil	2018	Article	10.3856/vol46-issue4-fulltext-12	Yes	English
Silveira et al.	Biology of Hippocampus patagonicus (Syngnathidae) in Brazilian waters	2020	Article	10.3856/vol48-issue1-fulltext-2307	Yes	English
Silveira et al.	Magnitude of bycatch of Hippocampus patagonicus, an endangered species, in trawl fisheries in Southeast and South Brazil	2023	Article	10.3389/fmars.2023.1116459	Yes	English
Silveira et al.	First record of malformation in seahorses attributed to the oil spill off the Brazilian coast in 2019	2024	Article	10.1002/etc.5932	Yes	English
Silveira et al.	Feeding ecology of seahorses (Syngnathidae: Hippocampus) on the coast of Rio de Janeiro state, Brazil	2022	Article	10.1016/j.rsma.2022.102692	Yes	English

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Author/s	Title	Year	Type	doi	Seahorse focused	Language
Silveira and Fontoura	Fecundity and fertility of the longsnout seahorse, Hippocampus reidi (Teleostei: Syngnathidae), in tropical Brazil	2010	Article		Yes	English
Silveira and Silva	Growing the threatened seahorse Hippocampus erectus Perry 1810 in the laboratory	2016	Article		Yes	English
Silveira and Silva	Early success using larval stages of white shrimp Litopenaeus vannamei as seahorse feed: indicative for a simultaneous mariculture?	2020	Article	10.24966/AAF-5523/100025	Yes	English
Silveira and Silva	Presence of the seahorse Hippocampus reidi (Pisces: Syngnathidae) in diet of marine fish in Northeastern Brazil	2020	Article	10.19080/OFOAJ.2020.12.555830	Yes	English
Siqueira et al.	Estimating population parameters of longsnout seahorses, Hippocampus reidi (Teleostei: Syngnathidae) through mark-recapture	2017	Article	10.1590/1982-0224-20170067	Yes	English
Soares et al.	Gestão de unidades de conservação marinhas: o caso do Parque Estadual Marinho da Pedra da Risca do Meio, NE – Brasil	2011	Article	10.5894/rgci261	No	Portuguese
Sousa	Estresse oxidativo em Hippocampus reidi: estudo comportamental	2015	Thesis		Yes	Portuguese
Sousa et al.	Hydrogen peroxide in seahorse aquaculture: determining safe exposure levels using non-invasive biomarkers of stress	2023	Article	10.1016/j.aquaculture.2022.739052	Yes	English
Souto-Neto	Doenças associadas ao cavalo-marinho Hippocampus reidi em sistema de cultivo experimental, com ênfase em infecções bacterianas	2016	Thesis		Yes	Portuguese
Souto-Neto et al.	Light-specific wavelengths differentially affect the exploration rate, opercular beat, skin color change, opsin transcripts, and the oxi-redox system of the longsnout seahorse Hippocampus reidi	2024	Article	10.1016/j.cbpa.2023.111551	Yes	English

to be continued...

Author/s	Title	Year	Type	doi	Seahorse focused	Language
Souza	Percepção de turistas sobre o tráfego de embarcações em uma unidade de conservação	2022	Thesis		No	Portuguese
Souza et al.	Use of Artemia supplemented with exogenous digestive enzymes as sole live food increased survival and growth during the larviculture of the longsnout seahorse Hippocampus reidi	2020	Article	10.1111/anu.13054	Yes	English
Souza-Conceição et al.	Comparação de três redes para identificar a estrutura de assembléias de peixes em praias estuarinas de São Francisco do Sul, Santa Catarina	2013	Article		No	Portuguese
Souza-Santos et al.	Prey selection of juvenile seahorse Hippocampus reidi	2013	Article	10.1016/j.aquaculture.2013.04.017	Yes	English
Spach et al.	Temporal variation in fish assemblage composition on a tidal flat	2004	Article	10.1590/S1679-87592004000100005	No	Portuguese
Tenório	Estrutura da comunidade e uso do habitat pela ictiofauna recifal e estuarina no Nordeste Brasileiro (PB e PE), com ênfase na estrutura populacional de Hippocampus reidi Ginsburg, 1933	2011	Thesis		Yes	Portuguese
Ternes	Conhecimento ecológico local dos jangadeiros sobre o cavalo-marinho (Hippocampus reidi) e sua relação com a atividade turística no Estuário de Maracaípe, Pernambuco, Brasil	2013	Thesis		Yes	Portuguese
Ternes et al.	Seahorses in focus: local ecological knowledge of seahorse-watching operators in a tropical estuary	2016	Article	10.1186/s13002-016-0125-8	Yes	English
Ternes et al.	Local ecological knowledge provides important conservation guidelines for a threatened seahorse species in mangrove ecosystems	2023	Article	10.3389/fmars.2023.1139368	Yes	English
Vaccani et al.	Shining in the dark: first record of biofluorescence in the seahorse Hippocampus reidi	2019	Article	10.1371/journal.pone.0220561	Yes	English

to be continued...

Author/s	Title	Year	Type	doi	Seahorse focused	Language
Vaccani et al.	First record of the Patagonian seahorse Hippocampus patagonicus Piacentino & Luzzatto, 2004 in Brazilian estuarine shallow waters	2021	Article	10.26028/cybium/2021-454-009	Yes	English
Valentim et al.	Population structure of the seahorse Hippocampus reidi (Syngnathiformes: Syngnathidae) in a Brazilian semi-arid estuary	2023	Article	10.1590/1982-0224-2023-0004	Yes	English
Vasconcelos Filho and Oliveira	Composição e ecologia da ictiofauna do Canal de Santa Cruz (Itamaracá – PE, Brasil)	1999	Article	10.5914/tropocean.v27i1.2775	No	Portuguese
Vasconcelos Filho	Influência da qualidade do habitat para a produção pesqueira: o papel dos manguezais sobre a ictiofauna de um estuário do Ceará - Brasil	2021	Thesis		No	Portuguese
Vasconcelos	Evidências genéticas da ocorrência de monogamia para Hippocampus reidi Ginsburg, 1933 (Syngnathidae: Teleostei) no Estuário do Rio Mamanguape Paraíba, Brasil)	2015	Thesis		Yes	Portuguese
Viana and Almeida	Bony fish bycatch in the Southern Brazil pink shrimp (Farfantepenaeus brasiliensis and F. paulensis) fishery	2005	Article	10.1590/S1516-89132005000500014	No	English
Vilar et al.	Fish fauna of Baía da Babitonga (southern Brazil), with remarks on species abundance, ontogenic stage and conservation status	2011	Article	10.11646/zootaxa.2734.1.3	No	English
Waechter et al.	The aesthetic value of Brazilian reefs: from species to seascape	2024	Article	10.1016/j.ocecoaman.2023.106882	No	English
Willadino et al.	Ingestion rate, survival and growth of newly released seahorse Hippocampus reidi fed exclusively on cultured live food items	2012	Article	10.1016/j.aquaculture.2012.06.025	Yes	English
Xavier	Uso de micro-habitats pela ictiofauna na área estuarino-recifal da APA Barra do Rio Mamanguape, Paraíba, Brasil	2009	Thesis		No	Portuguese

to be continued...

Author/s	Title	Year	Type	doi	Seahorse focused	Language
Xavier et al.	Fish assemblage of the Mamanguape Environmental Protection Area, NE Brazil: abundance, composition and microhabitat availability along the mangrove-reef gradient	2012	Article	10.1590/S1679-62252012000100011	No	English

Add File 3. Commonplace words removed from publications abstracts prior to word cloud analysis.

"according", "additionally", "aimed", "along", "also", "although", "among", "amongst", "analysis", "analyzed", "and", "animals", "applied", "approach", "are", "area", "average", "based", "Brazil", "Brazilian", "based", "can", "carried", "case", "characterized", "collected", "conducted", "considered", "data", "day", "differences", "different", "due", "effect", "estimated", "evaluated", "examining", "exposed", "extent", "first", "fish", "fishes", "for", "four", "found", "furthermore", "genus", "Ginsburg", "groups", "has", "have", "high", "higher", "hippocampus", "hours", "however", "identified", "important", "in", "individuals", "information", "instance", "known", "knowledge", "likely", "less", "low", "main", "mainly", "many", "may", "mean", "measures", "method", "more", "must", "need", "newly", "number", "often", "observed", "obtained", "one", "order", "our", "paper", "patterns", "period", "positive", "provide", "provides", "rate", "ratio", "recorded", "results", "revealed", "sea", "seahorse", "seahorses", "set", "should", "showed", "significant", "significantly", "similar", "specie", "specifically", "suggest", "state", "studies", "study", "test", "tested", "that", "the", "there", "therefore", "this", "three", "thus", "time", "total", "treatments", "two", "used", "using", "yet", "was", "water", "well", "were", "with", "within", "whether", "which", "work"

Add File 4: Studies on the population ecology of *Hippocampus reidi* included in this review. Only studies that collected in situ data were included. The densities shown are mean values reported in these studies. Due to variations in sampling designs, comparisons of densities across studies are not feasible. UVC = underwater visual census; M = male; F = female.

Study	Locality	Habitat type	Approach	Density (ind./m^2)	Sex ratio (M:F)
Northeast region					
Dias (2002)	Casqueira (RN)	Mangrove estuary	UVC	-	1.1:1
Silveira (2005)	Maracaípe (PE)	Mangrove estuary	UVC	0.23	01:01:00
Oliveira (2005)	Itapessoca (PE)	Mangrove estuary	UVC	-	01:01:00
Oliveira (2007)	Rio Formoso (PE)	Mangrove estuary	UVC	13	1.71:1
Oliveira (2007)	Itapessoca (PE)	Mangrove estuary	UVC	21	1.13:1
Rosa et al. (2007)	Camurupim (PI)	Mangrove estuary	UVC	26	2.48:1
Rosa et al. (2007)	Ubatuba (PI)	Mangrove estuary	UVC	5	0.5:1
Rosa et al. (2007)	Pacoti (CE)	Mangrove estuary	UVC	21	0.88:1
Rosa et al. (2007)	Mal Cozinhado (CE)	Mangrove estuary	UVC	32	0.25:1
Rosa et al. (2007)	Tubarão (RN)	Mangrove estuary	UVC	66	1.66:1
Rosa et al. (2007)	Casqueira (RN)	Mangrove estuary	UVC	55	01:01:00
Rosa et al. (2007)	Mamanguape (PB)	Mangrove estuary	UVC	8	1.14:1
Rosa et al. (2007)	Itapessoca (PE)	Mangrove estuary	UVC	14	1.1:1
Rosa et al. (2007)	Ariquindá (PE)	Mangrove estuary	UVC	7	0.92:1
Osório (2008)	Pacoti/Mal Cozinhado (CE)	Mangrove estuary	UVC	8	01:01:00
Mai and Rosa (2009)	Camurupim (PI)	Mangrove estuary	UVC	0.04	1.46:1
Tenório (2011)	Paraíba North Coast	Reef environment	UVC	1	01:01:00
Tenório (2011)	Paraíba North Coast	Mangrove estuary	UVC	17	1:1.8
Tenório (2011)	Paraíba South Coast	Reef environment	UVC	0.0003	-

to be continued...

Study	Locality	Habitat type	Approach	Density (ind./m^2)	Sex ratio (M:F)
Tenório (2011)	Paraíba South Coast	Mangrove estuary	UVC	18	2.3:1
Tenório (2011)	Rio Formoso (PE)	Reef environment	UVC	1	1.3:1
Tenório (2011)	Rio Formoso (PE)	Mangrove estuary	UVC	59	1:1.4
Mai and Velasco (2012)	Camurupim (PI)	Mangrove estuary	UVC	-	-
Okada et al. (2015)	Rio de Janeiro (multiple sites)	Rocky reef	UVC	56	Several
Aylesworth et al. (2015)	Ceará (multiple sites)	Mangrove estuary	UVC	-	1:1.07
Aylesworth et al. (2015)	Paraíba (multiple sites)	Mangrove estuary	UVC	-	1:1.09
Aylesworth et al. (2015)	Pernambuco (multiple sites)	Mangrove estuary	UVC	-	1:0.95
Santana (2015)	Vaza-Barris (SE)	Mangrove estuary	UVC	53	-
Porto (2015)	Vaza-Barris (SE)	Mangrove estuary	UVC	-	-
Franco (2016)	Vaza-Barris (SE)	Mangrove estuary	UVC	0.035 – 0.113	01:03:00
Santos (2017)	Vaza-Barris (SE)	Mangrove estuary	UVC	0.1 – 0.34	01:01:00
Silva (2018)	Pacoti (CE)	Mangrove estuary	UVC	5	1:1.4
Schwarz Junior et al. (2021)	Vaza-Barris (SE)	Mangrove estuary	UVC	0.035 – 0.113	01:03:00
Silveira et al. (2022)	Camurupim (PI); Guriú (CE)	Mangrove estuary	UVC	0.054 – 0.087	-
Leite (2022)	Itapessoca (PE)	Mangrove estuary	UVC	0 – 0.022	0.8:1
Borges et al. (2023)	Rio Formoso (PE)	Mangrove estuary	UVC	0 – 0.34	-
Valentim et al. (2023)	Rio Pacoti (CE)	Mangrove estuary	UVC	0.004 – 0.104	01:01:00
South and Southeast Regions					
Rosa et al. (2007)	Andorinhas (RJ)	Rocky shore	UVC	0.01	05:01:00
Rosa et al. (2007)	Itaipu (RJ)	Sandy beach	UVC	45	1.4:1
Rosa et al. (2007)	Penha (SC)	Rocky shore	UVC	2	-
Freret-Meurer and Andreata (2008)	Araçatiba (RJ)	Rocky shore	UVC	0.18	01:03:00
Oliveira and Freret-Meurer (2012)	Arraial do Cabo (RJ)	Rocky reef	UVC	0.01	01:01:00

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Study	Locality	Habitat type	Approach	Density (ind./m^2)	Sex ratio (M:F)
Hocama (2012)	Paranaguá (SC)	Mangrove estuary	Beach seines/bottom trawling	-	1:1.87
Carmo and Freret-Meurer (2015)	Rio de Janeiro (multiple sites)	Rocky reef	UVC	0.008 – 0.033	-
Siqueira et al. (2017)	Sepultura Beach (RJ)	Rocky shore	UVC	-	01:01:00
Freret-Meurer et al. (2018a)	Rio de Janeiro (multiple sites)	Rocky reef	UVC	0.01 – 0.06	1:2; 1:1; 2:1
Freret-Meurer et al. (2018b)	Guaíba Island (RJ)	Rocky reef	UVC	0.21	01:01:00
Carmo (2019)	Guanabara and Sepetiba Bays (RJ)	Rocky reef	UVC	0.7 – 0.8	1:1; 3:2
Freret-Meurer et al. (2022b)	Guaíba Island (RJ)	Rocky reef	UVC	0.55	01:01:00
Carmo et al. (2022)	Guanabara and Sepetiba Bays (RJ)	Rocky shore	UVC	0.7 – 0.8	1:1; 3:2
Carmo et al. (2024)**	Guanabara and Sepetiba Bays (RJ)	Rocky shore	UVC	0.7 – 0.8	1:1; 3:2
Freret-Meurer et al. (2024)	Lagoa de Araruama (RJ)	Coastal lagoon	UVC	593	01:03:00

* For full references of cited studies, see Add File 2.
** Same data presented in Carmo *et al.* (2022).