ETHNOBIOLOGY AND CONSERVATION

RESEARCH ARTICLE

Ethnobiology and Conservation, 14:09 (2025)
doi:10.15451/ec2024-11-14.09-1-12
ISSN 2238-4782 **ethnobioconservation.com**

Seahorses as flagship species in the largest hypersaline lagoon in South America

Leonardo Lopes Costa[1,2,*], Caio Mendonça[1], and Danilo Freitas Rangel[3]

ABSTRACT

The flagship species concept is based on the perceived "charisma" of species. While certain attributes have been proposed to predict charisma, support for conservation of flagship species is often driven by local and context-specific factors. The largest hypersaline lagoon in South America has been considered for restoration programs after suffering from decades of urban development and pollution. Recently, the seahorse *Hippocampus reidi* was reported in the lagoon, generating significant public attention. Inspired by marketing theory, we conducted a study to evaluate people's preferences for various species inhabiting the lagoon. In a choice experiment, participants were shown high-resolution photographs of ten species, including the seahorse, and asked to rank their top three preferred species (most preferred = 3, second most preferred = 2, and third most preferred = 1), as well as their three least preferred species (least preferred = -3, second least preferred = -2, and third least preferred = -1). We calculated a flagship score for each species based on these rankings and compared them using ANOVA. The seahorse had a significantly higher flagship score than all other species, with its intrinsic aesthetic beauty being the main reason for its preference according to participants. This interest in seahorses presents a unique opportunity to apply the flagship species concept as a conservation fundraising strategy, promoting a biocentric perspective on the largest hypersaline lagoon in South America.

Keywords: Surrogate; Conservation; Environmental education; Charisma; Bioindicator.

1 Laboratório de Ciências Ambientais, Universidade Estadual do Norte Fluminense Darcy Ribeiro, Av. Alberto Lamego #2000, Parque Califórnia, Campos dos Goytacazes, RJ, 28013-602, Brazil.

2 Instituto Solar Brasil de Desenvolvimento Saúde e Pesquisa, 21 de Abril Street #160, Centro, Campos dos Goytacazes, RJ, 28010-170, Brazil.

3 Instituto do Mar, Universidade Federal de São Paulo, Praça Oswaldo Cruz #124, Paraíso, São Paulo, SP, 04004-903, Brazil.

* Corresponding author ✉. E-mail address: LLC (lopes.bio.mp.sfi@pq.uenf.br), CM (caiodossantosmb@gmail.com), DFR (danilofreitasr@gmail.com)

SIGNIFICANCE STATEMENT

We tested the hypothesis that seahorses are more positively regarded by people than other species in Araruama Lagoon, the largest hypersaline lagoon in South America. Based on visual stimuli, people (n= 132) ordered different species among their preferred and least preferred species, and justified their choices. This choice experiment was based on marketing theory and was applied to support marketing conservation strategies. Based on our results, we strongly recommend that the positive message framing and biodiversity popularization must be prioritized in conservation and environmental education actions in the Araruama Lagoon. Some biological groups are threatened by human stressors related to urban development and pollution, but they have not been regarded in social media and face-to-face scientific outreach by conservationists and practitioners. Our research outcomes are innovative and can be decisive for the conservation and environmental education on tropical coastal ecosystems.

INTRODUCTION

Researchers have tried to alert the scientific community and society on the collapse that natural ecosystems have suffered. Within a bulk of studies in the conservation biology field performed in the last decades, those targeting optimized cost-benefit have gained prominence (Caro 2010; Rodrigues and Brooks 2007; Simberloff 1998). In the real-world context, when time and funding are often limited, conservation researchers, practitioners and decision-makers usually rely on conservation shortcuts, whereby efforts are directed to one or few species (Simberloff 1998). Species surrogacy is also a conservation fundraising strategy, particularly when flagship species are marketed to the general public, generating interest and revenue (Veríssimo et al. 2011). The cornerstone of the flagship species concept is based in their perceived "charisma", craving that this attribute serves as ambassadors by drawing attention to more complex conservation concerns that go beyond single "cute" species (Caro 2010).

The extrapolation of attributes that define species as flagships has been considered a flawed strategy. Large-scale approaches even predict species "charisma" from attributes such as conservation status, body size and phylogenetic proximity to humans (Berti et al. 2020; Miralles et al. 2019). However, popular engagement around a species is often local and context-specific (Mulder et al. 2009). Factors such as endemism, detectability, familiarity, population size, exceptionality, distinctiveness, perceived historical, commercial and ecological importance, exuberance and eccentricity can suddenly disrupt expected patterns of empathy and compassion toward species (Caro, 2010). Thus, the local context must always be studied, aiming to satisfy the preferences of contributors and ensure effectiveness of conservation marketing (Veríssimo et al. 2011).

Marketing, as business philosophy or academic theory, can offer techniques not just for facilitating exchanges of goods and services, but also for shaping individual values and behaviors (Green et al. 2019). At conservation context, marketing can play a pivotal role in raising the profile of flagship species and reduce the possible disparity in fundraising performance and engagement toward less appealing species (Jarić et al. 2023). Thus, different species can serve as figureheads in conservation marketing, aiming to achieve funding and educational purposes, alongside setting up reserves, raising awareness, shaping public perceptions, and fostering connectivity of people with nature and environmental sciences (Caro 2010; Smith et al. 2010). The initial step in achieving this goal is comprehending people's relationships with species, without presuming that overarching patterns of public empathy and compassion toward flagship species mirror the local and regional context (Bowen-Jones and Entwistle 2002; Mulder et al. 2009).

Although considered extremophile ecosystems, hypersaline lagoons harbor a unique biodiversity. Especially the Araruama Lagoon, the largest hypersaline lagoon in South America, still offers appropriate habitats for a variety of migratory and resident coastal bird species and provides subsidies to humankinds by providing fisheries resources (Tavares and Siciliano 2013; Costa et al. 2023). However, this unique ecosystem has been threatened for decades, being predominantly surrounded by densely populated urban infrastructures and receiving litter and domestic sewage in several areas (Kjerfve et al. 1996; Costa et al. 2023). For years, the lack of basic sanitation led to the loss of water quality, making the lagoon unsuitable for bathing in various parts. This has become a concern of the population mainly because the Araruama Lagoon is an important tourist and fishery asset in southeastern Brazil; tourism and fishing industries represent together 70% of the region economy (Pereira and Barreto 2009).

The conception of multi-stakeholder organizations to promote sustainable management, the implementation of new sewerage treatment infrastructure (that has reduced wastewater discharge by 75%), and the dredging of silted up entrance to the Araruama Lagoon to restore the exchange of water with the sea, have improved water quality in the last years (Pereira and Barreto, 2009). The greater transparency of water

is notorious and this marks the content of the media and social networks. More recently, the appearance of seahorses has been also marketed in social media as the main indicative of improved water quality, while this public perception lacks scientific evidence.

The seahorse *Hippocampus reidi* Ginsburg, 1933 was recently recorded in the Araruama Lagoon, and individuals can now be observed by visitors (Freret-Meurer et al. 2023). The female-biased sex ratio in the population might indicate recent colonization (Freret-Meurer et al. 2023). This is the unique evidence that the recent improvement in the lagoon's water quality favored the species (and its observation by citizens), consistent with seahorses' recognized role as condition indicator species (Delunardo et al. 2015). This emergence sparked interest on social media, fostering citizen involvement in research efforts (Freret-Meurer et al. 2023). Seahorses are already considered globally recognized flagship species (Delunardo et al. 2015; Shokri et al. 2007; Vincent et al. 2011). However, from now on, the seahorse can become symbols of popular engagement toward conservation initiatives by outreaching a more biocentric view of the largest hypersaline lagoon in South America.

We aimed to explore whether the increased reporting of seahorses translates into a preference for this species compared to others that have been more prominently visible in the Araruama Lagoon for a longer period. Moreover, while seahorses have already been perceived as flagship species, this assumption requires validation at regional and local scales. The literature on flagship species extensively documents the subjective and location-dependent nature of species' charismatic appeal (Bowen-Jones and Entwistle 2002; Mulder et al. 2009). Therefore, our approach capitalizes on the first scientific record of seahorses in the Araruama Lagoon in recent decades and the associated current heightened visitor engagement with these animals. If seahorses really engage the public as expected, this opens up a new opportunity for translating this engagement into social media message framing and environmental education initiatives (Wu et al. 2018).

The objective of the present study was to evaluate the level of preference of people for various species that inhabit the largest hypersaline lagoon in South America. We include the seahorse *H. reidi* in a choice experiment, hypothesizing that people prefer it compared to typical resident species despite of being small and erratic animals in the lagoon. We also tested whether the participant's profile affected preferences with seahorses, including their familiarity with the Araruama Lagoon and other sociodemographic attributes.

MATERIAL AND METHODS

Choice experiment

The selection of species of the Araruama Lagoon with the highest potential for use as flagship species was conducted using a choice experiment (Koemle and Yu 2020). A choice experiment is a survey in which respondents are required to choose between multiple goods, aiming to elicit consumer preferences based on hypothetical markets (Koemle and Yu 2020). At market context, this choice relies on attributes of the different goods available and a researcher then tries to infer the "latent utility function" from a series of observed choices (Koemle and Yu 2020). Within conservation marketing, choice experiments with different designs have been applied to predict affective responses of people toward a wide range of animals and thus their willingness to support conservation actions (latent utility function).

We performed an experiment following four steps of the systematic framework developed by Veríssimo et al. (2011) and Veríssimo et al. (2014) to select flagship species. First, we identified the conservation issues to be tackled as the first record of seahorses in largest hypersaline lagoon in South America that is in the process of recovering water quality. In the second phase, we delineated two primary audience segments: individuals familiar with the lagoon, actively impacting its ecosystem through diverse activities, and the general public. This division serves the aim of discerning whether the resonance regarding the seahorse pertains to a prevailing consensus of its "charisma" or is locally contingent upon recent documented occurrences of the species in the Araruama Lagoon. Third, we investigated animals that embody typical activities within the lagoon, notably tourism and fishing, and that encompass a range of attributes influencing the charisma perceived by individuals. This exploration involved reviewing prior research conducted in Araruama Lagoon (Bertucci et al. 2016), alongside the firsthand empirical knowledge of authors engaged in scientific activities around the lagoon (CM and DFR). Fourth, our attention turned to pinpointing the most suitable species to spearhead media content, constituting a fundamental element within the campaign's "marketing mix" ("four Ps"). To achieve this, we employed discrete-choice experiments, chosen for their robust basis in behavioral theory (Veríssimo et al. 2014).

The choice experiment was conducted by applying online semi-structured questionnaires to 132 people in the Google Forms tool between July 2022 and January 2023. A snowball sample method was used to recruit participants (Lyra-Neves et al. 2015). The initial participants comprised individuals from the social networks of one author (CM), including mainly

residents of municipalities nearby the Araruama Lagoon. Each participant was subsequently encouraged to share the questionnaire with individuals outside their immediate family circle. We refrained from encouraging the initial questionnaire recipients to solely target residents of areas nearby the Araruama Lagoon, because we seek to comprehend if interest in the seahorse extends beyond its recent appearance in this hypersaline lagoon. Therefore, people from other localities, unaware of seahorse occurrences in this hypersaline environment, were crucial for our choice experiment. More details on participant characteristics are available as supplementary material (Appendix 1). In accordance with Article 29 of Law No. 12,965 (Brasil, 2014), the responsibility for monitoring minors' access to online content and participation in surveys rests with their legal guardians. Since they were advised not to share with individuals under 18, only two minors responded to the questionnaire. The present study was approved by the Human Research Ethics Committee of the Federal Institute of Sergipe, Brazil (CAAE 58607422.5.1001.8042).

Before starting the anonymous questionnaire, participants had to provide their consent to take part in the research. They did not receive any direct benefit. The semi-structured online questionnaire encompassed open and multiple-choice questions, divided into five sections: "form description", "questionnaire participants' profile", "preference for species" (choice experiment), "reasons for choosing most and least preferred species" and "knowledge about seahorses". The description section of the form lacked information pertaining to the Araruama Lagoon, the seahorse, or any of the animals involved in the choice experiment. The participant profile encompassed inquiries regarding the mode of questionnaire access, their residing state, age, gender, educational level, and familiarity with the Araruama Lagoon. After responding to these queries, participants underwent the choice experiment, which included subsequent questions probing into the rationale behind the decisions they made. The final section about seahorses inquired if participants were aware of the species' presence in Araruama Lagoon. Additionally, it included an open-ended question prompting participants to share their knowledge about seahorses. To maintain the impartiality in the choice experiment, we strategically positioned these two questions at the end of the questionnaire to prevent any potential influence on participant responses.

Ten photographs of different species were presented to respondents (Medeiros et al. 2014). The list included birds (Southern Lapwing *Vanellus chilensis* (Molina, 1782), Great Egret *Ardea alba* (Linnaeus, 1758), Kelp Gull *Larus dominicanus* Lichtenstein, 1823, and Roseate Spoonbill (*Platalea ajaja* Linnaeus, 1758)), fisheries (Pink Shrimp: *Farfantepenaeus paulensis* (Pérez Farfante, 1967), Blue Crab *Callinectes sapidus* Rathbun, 1896, Trigonal Clam *Anomalocardia brasiliana* (Gmelin, 1791), and Mullet *Mugil liza* Valenciennes, 1836), a large-size species (Broad-Snouted Caiman *Caiman latirostris* (Daudin, 1802)) and the seahorse *Hippocampus reidi*. These ten animals were chosen following the third step of our systematic framework for selecting flagship species. The Google Forms tool displayed photographs of species simultaneously, eliminating the necessity to randomize the order of presentation of the images to participants.

After seeing the high-resolution photographs of all the aforementioned animals, participants ranked their three preferred species and their least preferred ones. We selected only 10 species and requested the choice of three preferred species and three least preferred species to maintain the concentration and engagement of participants.

Data analysis

Photographs were organized in order to provide each sample (participant) positive values for preferred species (most preferred = 3; second most preferred = 2; third most preferred = 1), and negative ones for least preferred species (least preferred = -3; second least preferred = -2; and third least preferred = -1). Species that were not mentioned by each participant were scored as zero. The higher the value on this scale, which ranged between -3 and 3, the higher the preference and the higher the potential of using the animals as a flagship species. The scores given by each participant (FP: flagship value) were compared using an Analysis of Variance (ANOVA) with a 95% confidence interval, including "species" as categorical predictive variables. Tukey's test was used a posteriori for the pair-wise comparison among species. The "agricolae" package in R software was used for these analyses (de Mendiburu 2020, R Core Team 2019). The ANOVA models met the premises of linearity, homoscedasticity, and normality without the need to transform the response variable.

The ANOVA was also used to test if the preference level for seahorses (flagship value) depended on the participants' profiles. To achieve this, five models were constructed, including "gender" (female and male), "age" ($\leq$9, 10-19, 20-29, 30-39, 40-49, 50-59 and $>$60 years old), "educational level" (Preschool Education, Incomplete Elementary Education, Completed Elementary Education, Incomplete High School Education, Completed High School Education, Incomplete College Degree, Completed College Degree, Postgraduate Student and did not attend school), "locality" (Acre, Espírito Santo, Minas Gerais, Rio de Janeiro, Rondônia and São Paulo), and "relationship with Araruama Lagoon" (Lives near the lagoon, Goes

to the lagoon every week, Goes to the lagoon a few times a year, Likes to go to the lagoon but lives far away, Goes not like to go to the lagoon and Has never been to the lagoon).

The reasons for a visitor's choice of preferred and least preferred species were used to build word clouds. To streamline the cloud analysis, responses were condensed into single-word summaries that encapsulated their essence. Specific word clouds were built for each species and were separated according to the reasons that led visitors to select them among the preferred species (positive score) and the least preferred ones (negative score). In this analysis, the larger the word, the greater the number of times that it was mentioned among the reasons to classify species between preferred and least preferred. For this analysis, the R software packages "wordcloud", "RColorBrewer", and "tm" were used (Feinerer and Hornik 2020, Ian Fellows 2018, Erich Neuwirth 2022, R Core Team 2019).

RESULTS

Participant's profile

The majority of participants accessed the questionnaire through social media (54%) and WhatsApp (42%). Nearly all respondents were from the coastal states of Rio de Janeiro (48%) and Espírito Santo (45%) in southeastern Brazil. Age groups between 20 and 29 years (55%), 30 and 39 years (22%), and 40 to 49 years (17%) were predominant, with the majority being women (63%). The prevalent educational levels in the sample included postgraduate students (34%), incomplete undergraduate (29%), completed undergraduate (22%), and completed high school (11%). Regarding familiarity with Araruama Lagoon, slightly over half either have no knowledge or have never visited the lagoon (54%), while the rest are divided among individuals living near the lagoon (22%), visiting the lagoon a few times a year (11%), liking go to the lagoon but living far away (10%), and those who go to the lagoon every week (3%). Finally, approximately 70% of participants did not know about the occurrence of the seahorse in the Araruama Lagoon.

Choice experiment

The seahorse *H. reidi* (FP = 1.27± 1.52) was the preferred species compared to all other species (Figure 1), with statistical support according to ANOVA (F= 25.15, p< 0.000) (Table 1). The Great Egret (FP= 0.61± 1.43), Roseate Spoonbill (FP= 0.46± 1.44) and Southern Lapwing (0.34± 1.68) were the second preferred species and received significant higher flagship scores compared to the other species (Table 1, Figure 1). All the other species have negative flagship values; thus, they were unpreferred by the participants.

In general, the flagship scores of the seahorse were not significantly affected by the variables "age", "educational level", "locality" and "relationship with Araruama Lagoon". However, women gave higher flagship scores to seahorse (FP= 1.6± 1.4) than men (0.7± 1.6); this difference had statistical support with 95% of confidence according to ANOVA (F= 11.29, p= 0.001). Fisheries such as Mullet, Blue Crab and Pink Shrimp received slightly higher scores from men (-0.16± 1.7) than from women (-0.35± 1.6), although without statistical support (F= 1.28, p= 0.258). The bodied Broad-snouted Caiman was scored worse among women (women= -1.0± 1.6; men= -0.4± 1.5, F= 4.63, p= 0.033). The level of preference for birds was very similar between women (0.33± 1.6) and men (0.32± 1.5).

The main reasons mentioned by participants for ranking seahorses and birds as their preferred species were beauty (31% and 34%, respectively) and personal like (31% and 16%, respectively) (Figure 2). Ecological importance (18%) was also a relevant reason for ranking seahorses as preferred species (Figure 2). The proportion of the aforementioned reasons for ranking the seahorse as the preferred species remained quite similar among participants who had previously visited the Araruama Lagoon (beauty and personal preference = 31% each) and those who had not visited (beauty and personal preference = 38% each). However, ecological importance was more frequently mentioned among participants who know the Araruama Lagoon (28%) than among those who did not know it (13%). In addition, when asked what they know about the seahorses, most participants mentioned the male's pregnancy (37%) and the potential role as bioindicator (17%).

For the Blue Crab, Mullet and Pink Shrimp the commercial (13%, 23% and 33%) and ecological importance (13%, 23% and 33%) predominated as reasons to rank the species as preferred, but beauty was also an important reason for preferring the former (34%). Almost all species ranked as unpreferred were judged as ugly, indifferent or common (Figure 2), even those with the predominant higher flagship scores. Among the least preferred species, the Broad-snouted Caiman frequently arouses fear (41%) in respondents (Figure 2).

DISCUSSION

The hypothesis that people prefer seahorses compared to typical resident species of the Araruama Lagoon was corroborated. This contradicts most studies that indicate that attributing charisma to various forms of life depends (although not exclusively) on fea-

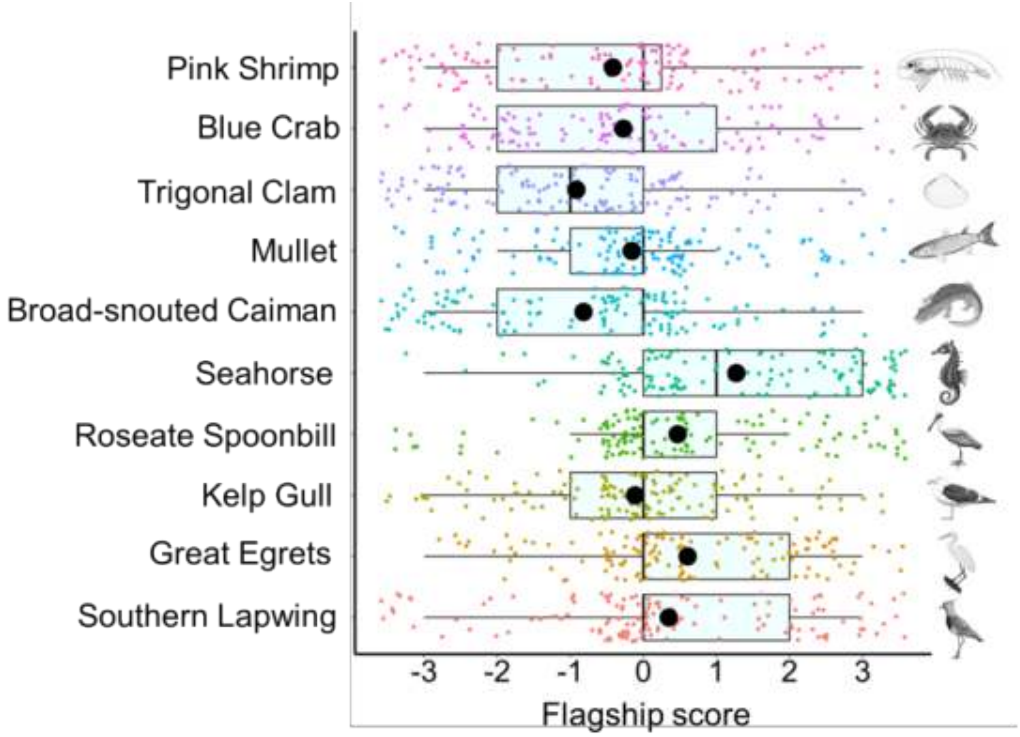

Figure 1. Flagship potential of various species (n = 132 participants) of Araruama Lagoon, southeastern Brazil. Dots represent the scores given by each people who answered the online questionnaire and ranked their three preferred species (1, 2, and 3) and least preferred ones (-3, -2, and -1) in ascending order of preference. Species that were not mentioned were scored as zero. The large dot within the boxes represents the mean score, the vertical line within the boxes represents the median value, and boxes represent interquartile intervals.

tures such as body size (Berti et al. 2020) and phylogenetic distance that separates humans from other species (Miralles et al. 2019). The seahorse is smaller and more evolutionarily distant from us than most species included in the choice experiment. Seahorses have already been widely acknowledged as flagship species on a global scale (Shokri et al. 2007; Vincent et al. 2011; Zhang and Vincent 2019). Also, the flagship score of the seahorse did not vary according to location and relationship of participants with the Araruama Lagoon. Thus, we cannot argue that the engagement towards this species is only due to recent records of occurrence in the lagoon and media coverage, but mainly because of its already consecrated charisma.

Despite that, the sudden media coverage and citizen engagement surrounds the seahorse at regional context is a unique opportunity to reinforce it as a flagship species and a symbol for stimulating the continuity of the restoration of the highest hypersaline in South America, where the species has only recently appeared (Freret-Meurer et al. 2023). For instance, the interest in the seahorse could support the establishment of protected areas in Araruama Lagoon, allowing further fundraising (e.g., via ecological fiscal transfers) for the municipality to invest even more in conservation initiatives (Busch et al. 2021; Yasué et al. 2012). However, dealing with an endangered species in a threatened ecosystem demands caution to prevent the proliferation of hunting culture, animal trafficking, and the potential adverse effects of tourist activities that might arise from unplanned marketing campaigns (Lim et al. 2017).

Beauty and personal like were mentioned as the main reason for ranking the seahorse as preferred species, irrespective of participants' familiarity with the Araruama Lagoon. This indicates that choice for the seahorse was mediated by its intrinsic aesthetic charisma, as reported in other studies (Lundberg et al. 2019). Perception of rarity (because seahorses were not previously reported in the lagoon) and risk of extinction, frequently cited as important factors in flagship species choice experiments and selection (Veríssimo et al. 2009; Wosnick et al. 2021), were not mentioned among participants. Future studies should investigate whether the lack of mention of extinction risk reflects a lack of public awareness about the status of seahorses as threatened species or if there are other factors influencing this perception.

The perceived higher "ecological importance"

Table 1. Analysis of Variance comparing the flagship scores among various species of Araruama Lagoon, southeastern Brazil.

ANOVA	**Df**	**SS**	**MS**	**F**	**p**
Species	9	544.5	60.5	25.15	$2 \cdot 10^{-16}$
Residuals	1310	3151.5	2.41		
Species		**Flagship score**		**Tukey test**	
Seahorse		1.27 ± 1.52		a	
Great Egrets		0.61 ± 1.43		b	
Roseate Spoonbill		0.46 ± 1.44		bc	
Southern Lapwing		0.34 ± 1.68		bcd	
Kelp Gull		-0.11 ± 1.40		cde	
Mullet		-0.15 ± 1.47		de	
Blue Crab		-0.27 ± 1.61		ef	
Pink Shrimp		-0.42 ± 1.75		efg	
Broad-snouted Caiman		-0.81 ± 1.62		fg	
Trigonal Clam		-0.91 ± 1.54		g	

Legend: Different letters represent the Tukey statistical support with a 95% confidence interval. Flagship score is represented by mean ± standard deviation.

of seahorses among participants residing near the Araruama Lagoon might emphasizes the emotional connection and biocentric view of local residents with the lagoon's biodiversity and conservation. In fact, environmental knowledge and connectedness to nature are usually related to ecological behavior (Lundberg et al. 2019; Otto and Pensini 2017). Finally, the more favorable assessment of seahorses by women might underscore their pro-conservation behavior and higher perception of regulating and supporting ecosystem services (Martino 2008; Yang et al. 2018). Men generally have a greater perception of provisioning services, which justifies the higher score they gave to fishery in this study (Martino 2008; Yang et al. 2018).

When asked about specific knowledge on seahorses, most people mentioned the male pregnancy. This corroborates the "hypothesis of anthropomorphic stimulus" that predicts that our human ability to emotionally connect with other species depends on the number of attributes that can be perceived as homologous to that of humans (Miralles et al. 2009). The incubation of eggs by male seahorses can be interpreted as analogous to human pregnancy. Nevertheless, in most viviparous or ovoviviparous species in nature, pregnancy occurs in females rather than males. Thus, male pregnancy, frequently highlighted in media, underscores the unique nature of the species, possibly serving as an important driver of public interest in seahorses (Preston et al. 2021).

Among other species tested as flagship species, resident birds ranked highly among preferred species. Similar to seahorses, beauty was the primary reason for these preferences, highlighting their intrinsic aesthetic appeal. Veríssimo et al. (2009) delved into the idea of "tourism flagship species" among tropical island birds in the Seychelles. Their objective was to pinpoint the key attributes of these species that could attract funding from international tourists. Their findings emphasized that appearance stood out as a crucial factor, affirming the belief that visual appeal can often outweigh other factors in flagship species selection, thus supporting the use of charismatic animals in ecotourism initiatives (Veríssimo et al. 2009).

As the bird species are not as erratic as seahorses, we recommend that birds are prioritized in ecotourism activities in Araruama Lagoon, including birdwatching. Birdwatching has been underexplored as an activity although it is capable of disseminating a biocentric vision of ecosystems with high tourist and recreational appeal (Castilho and Gomes 2017; Barbosa et al. 2021). As Kelp Gulls were the unique bird species with flagship scores as lower as other unpreferred species, we propose the implementation of specific marketing strategies that highlight its eccentric

Figure 2. Word clouds built using the reasons mentioned by participants (n = 132) for choosing the most and least preferred species. Each species is represented by a panel with words that motivated preference (+) or rejection (-). The size of the words represents the frequency mentioned and is comparable within each panel (positive and negative) not between them.

behavior and a more positive message framing regarding this synanthropic species. Unfortunately, people's connection with seagulls often centers on feeding them at beaches (Duhem et al. 2003; Maciusik et al. 2010), despite it being a prohibited activity in the region. This activity has resulted in aggressive behavior by seagulls and negative interactions with tourists (de Faria et al. 2021), further challenging positive message framing and public perception change.

All the candidate flagship species that make up part of the fishing resources in the region surrounding the Araruama Lagoon received negative flagship scores. This corroborates the argument that people tend to value species by their aesthetic charisma rather than value of use (Veríssimo et al. 2009; Lundberg et al. 2019). However, this pattern is context- and local-specific, since food commerce and subsistence can overcome aesthetic charisma as determinant factors for engaging people in biodiversity protection (Mulder et al. 2009). Interestingly, the ecological importance was al-

most frequently mentioned by the participants to justify their choices, including the seahorse, birds and all fishery species such as the Trigonal Clam, Pink Shrimp, Mullet and Blue Crab. This might be linked to the participant profile, primarily consisting of undergraduate and postgraduate students. Anyway, the conservation marketing and scientific outreach publicities should reinforce this notion of ecological importance, which for most people is still an ambiguous concept and strongly related with the provision of ecosystem services (Klain et al. 2014).

The large-bodied Broad-snouted Caiman was ranked as one of the least preferred species (mainly among women) along with much smaller animals like the Trigonal Clam, Pink Shrimp and Blue Crab. This provides clear evidence that body size is not always a strong proxy for charisma as suggested by Berti et al. (2020). When large-bodied animals do not have many anthropomorphic attributes and a primary "cute" appearance, this can even generate a perception of risk for people, evidenced by the fact that “fear” was the most mentioned word to justify preterition. As crocodilians can indeed attack humans, message framing must focus on encouraging protective management for the Broad-snouted Caiman outside urban areas, reinforcing the ecological importance and positive attributes of this species. An argument that could help avoiding deeper socio-ecological conflicts is the maintenance of natural areas to preclude the displacement of alligators to cities and associated risk to humans. Both charismatic and less charismatic species possess the potential to significantly impact public preferences and engagement with conservation (Home et al. 2009; Veríssimo et al. 2017). Thus, marketing efforts should focus on reshaping public perceptions, emphasizing both appealing attributes and behaviors of the overlooked species (Veríssimo et al. 2017).

We acknowledge that the predominance of participants with higher educational backgrounds is a significant limitation of our study. This demographic bias may affect the generalizability of our findings, as it may not fully represent the perspectives and knowledge of key local stakeholders, such as fishermen and riverside communities. However, we believe that this limitation does not undermine the validity of our findings, as our focus was specifically on individuals who utilize social networks more intensively. This choice allows us to explore a segment of the population that actively engages with conservation issues. However, by recognizing these constraints, we emphasize the importance of inclusive approaches in future studies to capture the diverse viewpoints essential for effective conservation efforts.

CONCLUSION

In conclusion, we verified that the seahorse has an intrinsic aesthetic charisma that makes it a potential flagship species at local and regional scales. This charisma possibly reinforced by seahorses' eccentricity, superimposed classical hypotheses about which attributes of animals motivate humans to protect them. Resident birds were also well evaluated; because they are less erratic than seahorses, they can be powerful tools for ecotourism, especially birdwatching. Our findings reinforce that the choice of flagship species to symbolize conservation actions and raise funds should be based on local studies of the target audience. Certainly, we acknowledge that the predominant participation of individuals with higher educational backgrounds represents a key limitation. Therefore, future research endeavors should actively involve vital local stakeholders, such as fishermen and riverside communities. In the context of ecology, relating the presence of seahorses to water quality would be an interesting approach, as well as confirming whether people realize this possible relationship. Anyway, the appearance of the seahorse coincided with the improvement in the water quality of Araruama Lagoon, thus the seahorse can become a symbol in marketing campaigns regarding the restoration of the largest hypersaline lagoon in South America in the last years after appropriate science-based investigations.

ACKNOWLEDGMENTS

LLC is supported by Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro - FAPERJ (E-26.210.384/2022 and E-26.200.620/2022). CM and DFR are supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES.

DATA AVAILABILITY

ThThe datasets generated during and/or analyzed during the current study are available at: https://doi.org/10.17632/tfcjmr8p8f.1

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to the publication of this manuscript.

CONTRIBUTION STATEMENT

Conceived of the presented idea: LLC, CM.
Carried out the experiment: LLC, CM.
Carried out the data analysis: LLC, CM, DFR.
Wrote the first draft of the manuscript: LLC.

Review and final write of the manuscript: LLC, CM, DFR.
Supervision: LLC, CM.

REFERENCES

Barbosa, K.V. De C., Develey, P.F., Ribeiro, M.C. and Jahn, A.E. 2021. **The Contribution of Citizen Science to Research on Migratory and Urban Birds in Brazil.** Ornithology Research 29(1):1–11.

Berti, E., Monsarrat, S., Munk, M., Jarvie, S. and Svenning, J.C. 2020**. Body Size Is a Good Proxy for Vertebrate Charisma.** Biological Conservation 251:108790.

Bertucci TCP, Silva EP, Marques JR AN, Monteiro-Neto C (2016) **Tourism and urbanization: environmental problems of the Araruama Lagoon, state of Rio de Janeiro, Brazil**. Ambiente e Sociedade 19:59–80.

Bowen-Jones E, Entwistle A (2002) **Identifying appropriate flagship species: The importance of culture and local contexts**. Oryx 36:189–195.

Brasil. 2014. Lei nº 12.965, de 23 de abril de 2014. **Dispõe sobre a proteção de dados pessoais na internet e dá outras providências**. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2014/lei/l12965.htm. Acesso em: 18 out. 2024.

Busch J, Ring I, Akullo M, Amarjargal O, Borie M, Cassola RS, Cruz-Trinidad A, Droste N, Haryanto JT, Kasymov U, Kotenko NV, Lhkagvadorj A, De Paulo FLL, May PH, Mukherjee A, Mumbunan S, Santos R, Tacconi L, Verde Selva G, Verma M, Wang X, Yu L, Zhou K (2021) **A global review of ecological fiscal transfers**. Nature Sustainability 4:756–765.

Caro, T. 2010. **Conservation By Proxy: Indicator, Umbrella, Keystone, Flagship, And Other Surrogates.** 2 Ed. Island Press, Washington, Covelo, London.

Castilho, C.T. and Gomes, C.L. 2017. **The Role of Professionals in Two Nature-Based Activities in Brazil for Visitors' Connection with Nature: Rock Climbing and Birdwatching.** Revista Brasileira De Ecoturismo. 10:93–112.

Costa, L.L., Rangel, D.F. and Zalmon, I.R. 2023. **The Presence of Covid-19 Face Masks in The Largest Hypersaline Lagoon of South America Is Predicted by Urbanization Level.** Marine Pollution Bulletin 189:114746.

de Faria JP, Paiva VH, Veríssimo S, Gonçalves AMM, Ramos JA (2021) **Seasonal variation in habitat use, daily routines and interactions with humans by urban-dwelling gulls**. Urban Ecosystems 24:1101–1115.

Delunardo FAC, Carvalho LR de, Silva BF da, Galão M, Val AL, Chippari-Gomes AR (2015) **Seahorse (Hippocampus reidi) as a bioindicator of crude oil exposure**. Ecotoxicology and Environmental Safety 117:28–33.

Duhem C, Vidal E, Legrand J, Tatoni T (2003) **Opportunistic feeding responses of the yellow-legged gull *Larus michahellis* to accessibility of refuse dumps.** Bird Study 50:61–67.

Erich Neuwirth. 2022. **Rcolorbrewer: Colorbrewer Palettes.** R Package Version 1.1-3.

Feinerer, I. and Hornik, K. 2020. **Tm: Text Mining Package.** R Package Version 0.7-8.

Freret-Meurer NV, do Carmo Fernández T, do Carmo Vaccani A (2023) **Baseline study of the seahorse Hippocampus reidi Ginsburg, 1933 population in a tropical hypersaline lagoon**. Aquatic Ecology 2023: 1-7.

Green KM, Crawford BA, Williamson KA, DeWan AA (2019) **A Meta-Analysis of Social Marketing Campaigns to Improve Global Conservation Outcomes**. Social Marketing Quarterly 25:69–87.

Home R, Keller C, Nagel P, Bauer N, Hunziker M (2009) **Selection criteria for flagship species by conservation organizations**. Environmental Conservation 36:139–148.

Ian Fellows. 2018. **Wordcloud: Word Clouds.** R Package Version 2.6.

Jarić I, Normande IC, Arbieu U, Courchamp F, Crowley SL, Jeschke JM, Roll U, Sherren K, Thomas-Walters L, Veríssimo D, Ladle RJ (2023) **Flagship individuals in biodiversity conservation**. Frontiers in Ecology and the Environment doi: 10.1002/fee.2599.

Kjerfve, B., Schettini, C.A.F., Knoppers, B., Lessa, G. and Ferreira, H.O. 1996. **Hydrology And Salt Balance in A Large, Hypersaline Coastal Lagoon: Lagoa De Araruama, Brazil.** Estuarine, Coastal and Shelf Science 42(6):701-725.

Klain, S.C., Satterfield, T.A. and Chan, K.M.A. 2014. **What Matters and Why? Ecosystem Services and Their Bundled Qualities.** Ecological Economics 107:310–320.

Koemle, D. and Yu, X. 2020. **Choice Experiments in Non-Market Value Analysis: Some Methodological Issues.** Forestry Economics Review 2(1):3–31.

Lim FKS, Carrasco LR, McHardy J, Edwards DP (2017) **Perverse market outcomes from biodiversity conservation Interventions**. Conservation Letters 10:506–516.

Lyra-Neves, RM, Santos, EM, Medeiros, PM, Alves, RRN, Albuquerque, UP (2015). **Ethnozoology in Brazil: analysis of the methodological risks in published studies**. Brazilian Journal of Biology 75 (4): 184-191.

Lundberg, P., Vainio, A., Macmillan, D.C., Smith, R.J., Veríssimo, D. and Arponen, A. 2019. **The Effect of Knowledge, Species Aesthetic Appeal, Familiarity and Conservation Need on Willingness to Donate.** Animal Conservation 22(5):432–443.

Maciusik B, Lenda M, Skórka P (2010) **Corridors, local food resources, and climatic conditions affect the utilization of the urban environment by the Black-headed Gull *Larus ridibundus* in winter.** Ecological Research 25:263–272.

Maguire, G.S., Miller, K.K., Weston, M.A. and Young, K. 2011. **Being Beside the Seaside: Beach Use and Preferences Among Coastal Residents of South-Eastern Australia.** Ocean and Coastal Management 54:781–788.

Martino D (2008) **Gender and Urban Perceptions of Nature and Protected Areas in Bañados del Este Biosphere Reserve**. Environmental Management (2008) 41:654–662.

Medeiros, P.M. De, Almeida, A.L.S. De, Lucena, R.F.P. De, Souto, F.J.B.A. and Paulino, U. 2014. **Use Of Visual Stimuli in Ethnobiological Research.** In Methods and Techniques in Ethnobiology and Ethnoecology P.480.

De Mendiburu, F. 2020. **Agricolae: Statistical Procedures for Agricultural Research.** R Package Version 1.3-2.

Miralles, A., Raymond, M. and Lecointre, G. 2019. **Empathy And Compassion Toward Other Species Decrease with Evolutionary Divergence Time.** Scientific Reports 9(1):19555.

Mulder, M.B., Schacht, R., Caro, T., Schacht, J. and Caro, B. 2009. **Knowledge And Attitudes of Children of The Rupununi: Implications for Conservation in Guyana.** Biological Conservation 142(4):879–887.

Otto S, Pensini P (2017) **Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour.** Global Environmental Change 47:88–94.

Pereira, L.F. and Barreto, S. 2009. **Recovery with social participation - the experience of Lagos São João consortium, RJ, Brazil**. OP Conf. Series: Earth and Environmental Science 6:402007.

Preston, S.D., Liao, J.D., Toombs, T.P., Romero-Canyas, R., Speiser, J. and Seifert, C.M. 2021. **A Case Study of a Conservation Flagship Species: The Monarch Butterfly.** Biodiversity Conservation 30(7):2057–2077.

R Core Team. 2019. **R: A Language and Environment for Statistical Computing.**

Shokri MR, Gladstone W, Jelbart J (2007) **The effectiveness of seahorses and pipefish (Pisces: Syngnathidae) as a flagship group to evaluate the conservation value of estuarine seagrass beds**. Aquatic Conservation: Marine and Freshwater Ecosystems 656:636–656.

Simberloff, D. 1998. **Flagships, Umbrellas, And Keystones: Is Single-Species Management Passé in The Landscape Era?** Biological Conservation 83(3):247–257.

Smith RJ, Veríssimo D, Macmillan DC (2010) **Marketing and conservation: How to lose friends and influence people**. In: Leader-Williams N, Adams W., Smith R. (eds) Trade-Offs in conservation: Deciding what to save. Hoboken, Nova Jersey, pp. 215–232.

Tavares, D.C. and Siciliano, S. 2013. **An Inventory of Wetland Non-Passerine Birds Along a Southeastern Brazilian Coastal Area.** Journal Threatened Taxa 5(11):4586–4597.

Veríssimo, D., Fraser, I., Groombridge, J., Bristol, R. and Macmillan, D.C. 2009. **Birds As Tourism Flagship Species: A Case Study of Tropical Islands.** Animal Conservation 12(6):549–558.

Veríssimo, D., Macmillan, D.C. and Smith, R.J. 2011. **Toward A Systematic Approach for Identifying Conservation Flagships.** Conservation Letters 4(1):1–8.

Veríssimo D, Vaughan G, Ridout M, Waterman C, MacMillan D, Smith RJ (2017) **Increased conservation marketing effort has major fundraising benefits for even the least popular species**. Biological Conservation 211:95–101.

Vincent ACJ, Foster SJ, Koldewey HJ (2011) **Conservation and management of seahorses and other Syngnathidae**. Journal of Fish Biology 78:1681–1724.

Wosnick N, Leite RD, Giareta EP, Nunes AROP, Nunes JLS, Charvet P, Monteiro-Filho ELA (2021) **Evaluating conservation status and governmen-**

tal efforts towards regional flagship species in Brazil. Journal of Environmental Management 291:112732.

Wu Y, Xie L, Huang SL, Li P, Yuan Z, Liu W (2018) **Using social media to strengthen public awareness of wildlife conservation**. Ocean and Coastal Management 153:76–83.

Yang YCE, Passarelli S, Lovell RJ, Ringler C (2018) **Gendered perspectives of ecosystem services: A systematic review**. Ecosystem Services 31:58–67.

Yasué M, Nellas A, Vincent ACJ (2012) **Seahorses helped drive creation of marine protected areas, so what did these protected areas do for the seahorses?** Environmental Conservation 39:183–193.

Zhang X, Vincent ACJ (2019) **Conservation prioritization for seahorses (Hippocampus spp.) at broad spatial scales considering socioeconomic costs**. Biological Conservation 235:79–88.

Received: 01 June 2024
Accepted: 29 July 2024
Published: 21 November 2024

Editor: Rômulo Alves