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Source: Tropical Conservation Science, 14(1)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/19400829211023265

Research Article

Tropical Conservation Science
Volume 14: 1–11

DOI: 10.1177/19400829211023265
journals.sagepub.com/home/trc
SAGE

Ethnozoology Mediating Knowledge About Sea Turtles and Environmental Education Strategies in the North-Central Coast of Rio De Janeiro, Brazil

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Abstract

Natural environment has undergone rapid transformations, primarily attributed to human actions that threaten ecosystems' balance. Understanding the relationship between humans and nature is essential to generate effective strategies for sustainably using resources. In this study, we analyzed the environmental perception and knowledge about the biology of sea turtles through 120 informal interviews with visitors at beaches on the north-central coast of Rio de Janeiro state. Residents noticed garbage more often than tourists, as did women and younger individuals. The perception of initiatives necessary to increase the preservation of the beaches was higher for people with higher education. In general, there were no differences in biological knowledge about sea turtles between residents, tourists and people who work or study at the cities. The results point to the need for oceanic education strategies that can help raise environmental awareness through long-term conservation programs.

Keywords

flag animals, urban pollution, marine ecosystems, conservation, perceptions

Introduction

Rapid changes in the global environmental scenario have demonstrated the importance of linking local perceptions with strategies that can be used to minimize or contain landscape changes and threats to natural resources (Gill & Lantz, 2014; Silva & Topf, 2020). The proximity between human populations and natural environments promotes the development of intimate relationships with the available resources, generating and modifying the local ecological knowledge systems about these resources (Sieber et al., 2011). These knowledge systems can allow societies to develop strategies for the conservation of the resources used (Lykke, 2000), thus contributing to sustainable development (Martin, 1995; Silva & Topf, 2020).

Ethnozoology, a science that seeks to understand human interactions with animals, can optimize the implementation of strategic environmental actions to biodiversity conservation (Aguiar et al., 2011; Alves et al., 2008, 2014). In fact, knowledge related to the environment and it is ecological processes demonstrates the importance and functionality of animals for human populations, both from an ecological and socio-cultural perspective (Martin, 1995; Posey, 1987). Relevant ethnozoological studies have been carried having with different species of marine megafauna as model organisms, such as shark (O'Bryhim & Parsons, 2015) and

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Received 15 February 2021; Accepted 19 May 2021

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mammalians (Barney et al., 2005; Luksenberg & Parsons, 2013). These studies have shown that the increase in knowledge about wildlife promotes greater behavior and attitudes towards fauna conservation (Kraus, 1995; O'Bryhim & Parsons, 2015). Long-standing studies of environmental perception and conservation using flag animals such as sea turtles have shown promise for influencing attitudes towards wildlife, as seen in Costa Rica (Campbell, 2008; Campbell & Smith, 2006; Troëng & Rankin, 2005), Australia (Butt et al., 2016; Fuentes et al., 2011), United Kingdom (Botterell et al., 2020) and United States (Cella et al., 2016; Fuentes et al., 2016). These studies have shown that knowledge about wildlife can be related to the demographic profile (Cella et al., 2016; Kellert et al., 1996). The analysis between demographic characteristics and their influence on knowledge and environmental preservation measures can generate important data for ecosystem management and conservation programs. Gender was identified as one of the main factors that influence environmental perception (Kellert & Berry, 1987), in addition to characteristics such as age and level of education, and in general, people with greater opportunities for formal education were more interested in themes related to the environment, its threats and conservation strategies (Barney et al., 2005; Kellert, 1993; Kellert & Berry, 1987; Luksenberg & Parsons, 2013).

In Brazil, the TAMAR-ICMBio project, created in 1980, was fundamental for establishing turtles as model animals for the conservation of marine ecosystems and environmental awareness (Marcovaldi et al., 2011). Recent studies have sought to understand sea turtles' interaction with fishing, one of the main threats and cause of mortality in Brazil (Barboza et al., 2018; ; Zeineddine et al., 2018).

Sea turtles are widely distributed worldwide, and five out of the seven species of current fauna occur in Brazil: the loggerhead turtle, *Caretta caretta* (Linnaeus, 1758), green turtle, *Chelonia mydas* (Linnaeus, 1758), leatherback, *Dermochelys coriacea* (Vandelli, 1761), hawksbill turtle, *Eretmochelys imbricata* (Linnaeus, 1766) and the olive turtle, *Lepidochelys olivacea* (Eschscholtz, 1829) (Macêdo et al., 2015; Pupo et al., 2006). All Brazilian sea turtle species are threatened and classified as vulnerable, endangered, or critically endangered (IUCN, 2020). The main threats are anthropogenic and result from fishing activities, habitat degradation, and improper disposal of solid residues (Alves et al., 2008, 2009; Alves & Rosa, 2006; Marcovaldi et al., 2010; Wallace et al., 2011).

In this study, we measured knowledge about sea turtle and environmental perception of tourists, residents, and people who study or work in beaches of Macaé and Rio das Ostras municipalities, Rio de Janeiro, Brazil. We tested the following hypotheses: age, gender, level of education, and the frequency of visiting the beaches influence both (i) knowledge about sea turtles and (ii) the environmental perception of respondents. Based on the analysis of the results generated, we developed strategies for environmental education practices to raise awareness and understand the importance of conserving coastal ecosystems.

Methods

Study Area

The study was conducted in the municipalities of Rio das Ostras (22°31′37 "S and 41°56′42″ W) and Macaé (22°22′15 "S and 41°47′13″ W) in the Northern region of Rio de Janeiro state, Brazil (Figure 1). The climate in the region is tropical, classified as Aw according to Köppen and Geiger (1930). The coast was originally covered by Atlantic Forest, currently characterized by strong urbanization and some fragments of "restinga" phytophysiognomy (Araújo, 1992). The average temperature is 22.9 °C and the average annual rainfall is 1126 mm with most of the rains concentrated during the summer (INMET, 2020).

Macaé and Rio das Ostras are neighboring municipalities with an estimated population of approximately 416.7 thousand inhabitants (IBGE, 2020). The economy was based on fishing and agriculture activities and, from 1980 decade with the establishment of an industry based on oil and gas exploration, cities became more economically attractive. The funds from royalties enabled an improvement in the conditions of infrastructure and access to goods and services, which impacted the tourist activities of the municipalities (Tribunal de Contas do Estado do Rio de Janeiro, 2016). Currently Macaé receives around 5,01,597 national and international tourists per year, while Rio das Ostras receives 3,53,001 tourists (Brazil, 2019). This economic development process was accompanied by an intense and disordered urbanization, which culminated in the favelization of a large part of the local population (Carvalho et al., 2013). The greater availability of jobs, combined with the establishment of public education institutions, attracted a contingent of residents without ties to the municipalities (people who study or work), while the local population (native residents) accessed this job offer in an unequal way, leaving a large portion with underemployment (Carvalho et al., 2013).

The ethnozoological analysis was carried out at the beaches "Boca da Barra," "Bosque," and "Costa Azul" in Rio das Ostras as well as at "Campista," "Cavaleiros," and "Pecado" in Macaé. Environmental education strategies and actions came from the Iurukuá project: Environmental Education and

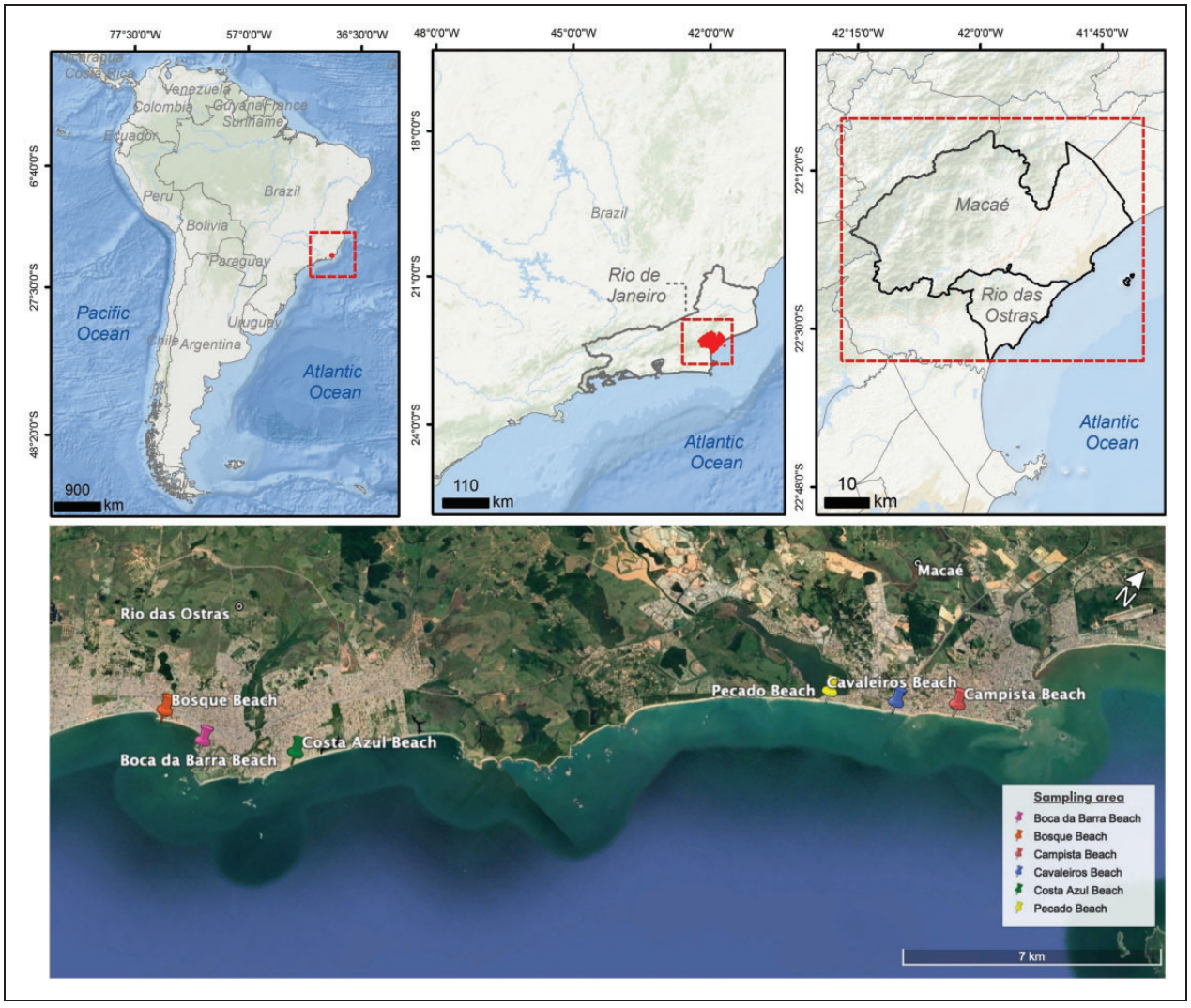

Figure 1. Map of the Study Area's Geographic Location Showing the Municipalities of Rio das Ostras and Macaé on the Coast of the State of Rio de Janeiro, Brazil. The colored markings indicate the beaches sampled on the southwestern portion of the Brazilian coast.

Conservation of Sea Turtles, which is currently registered as an extension project at the Federal University of Rio de Janeiro (UFRJ) and carried out mostly at the Biodiversity and Sustainability Institute, located in the municipality of Macaé.

Selection of Informants and Conducting Interviews

The selection of informants was carried out at random and based on people's presence and availability at the sampled beaches (Lavrakas, 2008). The research objectives were explained to participants, who then filled and signed the "Free and informed consent form" (ICF) as required by current legislation (Resolution No. 466 of December 12, 2012, of the National Health Council), in order to authorize the collection, use, and publication of data obtained in this work. The study was approved by the Research Ethics Council (Plataforma Brasil). We interviewed 120 individuals, 20 on each beach, both males and females who were at least 12 years old. Informal interviews (Newing, 2011) and semi-structured interviews (Albuquerque et al., 2014) were carried out between the years 2019 and 2020 to create a database with information on the interviewees' ethnozoological knowledge about sea turtles, issues involving the ways of occupying the marine environment and pollution. The interview comprised three sections with objective and open-ended questions that covered the socioeconomic profile, the knowledge about sea turtles, and the interviewees' environmental perception (online Appendices).

Data Analysis

For data analysis, scores were assigned considering the responses consistent with scientific knowledge that the

data could be treated quantitatively. Scores for questions about environmental perception were assigned depending on the number of categories that each question presented (Table 1). Scores for questions about knowledge were performed as follows: incorrect answers or "I do not know" were scored as zero, while satisfactory answers were scored as one (Table 1). To check if were significant differences in the level of environmental perception between tourists, residents, and people who study or work at the sampled beaches, we first tested the data's normality using the Shapiro-Wilk Test. As the data did not meet such an assumption, we tested for significant differences between the groups through the Kruskal-Wallis test. When significant differences (at 95% confidence level) were found, the Dunn test was carried out *a posteriori* to identify the groups between which significant differences were found. These same tests were used to investigate if there were significant differences in knowledge about sea turtles between the three groups of people.

Generalized Linear Models (GLM) were used to assess the influence of age, gender, education, and frequency of visiting the beaches (explanatory variables) on environmental perception estimates and knowledge about sea turtles (response variables, binomial family). All statistical tests were performed using Software R 3.5.3 (R Development Core Team, 2019) and BioEstat 5.3 (Ayres et al., 2007). See the "online Appendix" for all statistical tests conducted in this research, including descriptive statistics.

Environmental Education

After analyzing both interviewees 'knowledge about sea turtles' biology and interviewees environmental perception, didactic materials were developed didactic materials for application in ocean education. The materials were made using recycled materials and banners through the Canva application. The didactic models involved information about sea turtles morphology, life cycle, feeding strategies, reproduction, and the main anthropogenic threats to these species.

Results

The majority of the respondents identified themselves as belonging to the female gender (n = 70; 58.3%) and

Table 1. Subject of the Questions, Respective Categories and Scores and Results of the Interviews.

Subject	Question	Answer/category	Score	Number/ Percentage
Environmental perception	Frequency of dirt on the beach	Never	0	n = 12; 10%
		Few times	1	n = 72; 60%
		Mostly	2	n = 21; 17.5%
		Every time	3	n = 15; 12.5%
Environmental perception	Threat of extinction	Didn't know	0	n = 19; 15.8%
		Predation	1	n = 4; 3.3%
		Fishing	2	n = 7; 5.8%
		Pollution	2	n = 45; 37.5%
		Two or more factors	3	n = 45; 37.5%
Environmental perception	Beach choice	Easy access	0	n = 59; 49.1%
		Infrastructure	1	n = 36; 30%
		Preservation	2	n = 25; 20.8%
Environmental perception	Initiatives	Didn't know	0	n = 7; 5.8%
		Laws and enforcement	1	n = 9; 7.5%
		Environmental education and awareness	1	n = 49; 40.8%
		Pollution reduction	1	n = 34; 28.3%
		Projects	1	n = 4; 3.3%
		Two or more initiatives	2	n = 17; 14.1%
Knowledge about sea turtle	Difference between sea turtle and other Testudines	Didn't know or wrong answer	0	n = 63; 52.5%
		1 correct organism	1	n = 25; 20.8%
		2 corrects organisms	2	n = 20; 16.6%
		3 correct organisms	3	n = 12; 10%
Knowledge about sea turtle	Number of species in Brazil	Didn't know or wrong answer	0	n = 108; 90%
		Correct answer (=5)	1	n = 12; 10%
Knowledge about sea turtle	Number of eggs	Didn't know or wrong answer	0	n = 78; 65%
		Correct answer (>100)	1	n = 42; 35%
Knowledge about sea turtle	Number of surviving hatchlings	Didn't know or wrong answer	0	n = 59; 49.1%
		Correct answer (up to ten)	1	n = 61; 50.8%

presented higher education as a level of education (n = 61; 50.8%). The interviewees' age ranged between 13 and 69 years, with an average of 35 years (±14.8). Most respondents rarely visit the beaches where they were approached (n = 52; 43.3%), and the majority of them live in the sampled municipalities, Macaé and Rio das Ostras, for work and/or study (n = 63; 52.5%). Ease of access was the main factor influencing the beach choice (n = 59; 49.1%). Moreover, according to the interviewees, the beaches were rarely found dirty (n = 72; 60%) (Figure 2). However, there were significant differences between tourists, residents, and people who study/work in the sampling sites concerning the presence of garbage ($H = 9.6202$; $p = 0.0081$). Residents noticed garbage more frequently than tourists ($z = 2.6789$; $p < 0.05$;). There were also significant differences between different ages and genders concerning the presence of garbage. Likewise, women ($z = 2.180$; $p < 0.0312$) and younger individuals, between 19 and 30 years old, had higher perceptions about this topic ($z = -3.626$; $p < 0.05$; Figure 2).

General knowledge about various factors that threaten sea turtles, such as pollution, fishing, and predation has been detected and there were no significant differences between tourists, residents, and people who study/work in the sampling sites in the perception of these threaten ($H = 4.3358$; $p = 0.1144$). Although beach preservation condition is an indicator of environmental perception, we did not find significant differences between tourists, residents, and workers/students perceptions of the beaches preservation condition ($H = 5.2424$; $p = 0.0727$). No socioeconomic factors showed influence in perception of factors that threaten sea turtles and factors that influence beach choice (see online Appendix).

For many respondents, environmental awareness is the main factor to reduce such threats (n = 49; 40.8%). However, there were no significant differences in the perception of initiatives to reduce beach pollution between tourists, residents, and people who study/work in the sampled areas ($H = 0.8787$; $p = 0.6445$;). The perception of initiatives necessary to increase the preservation of the beaches, on the other hand, was higher for people with higher education ($z = 2.006$; $p < 0.05$; Figure 2).

Only 10% (n = 12) of the interviewees knew how to differentiate sea turtles from other organisms of the order Testudines (tortoises and turtles) and pointed out aspects of morphology and habitat differences as main arguments (Figure 2). There were no significant differences in the knowledge of Testudines between

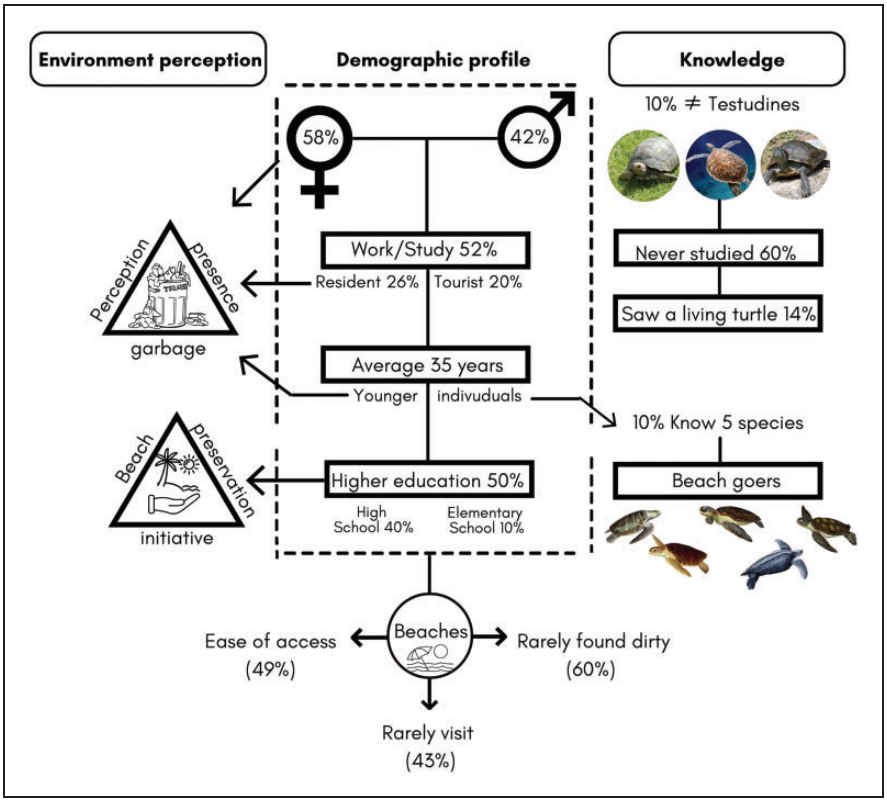

Figure 2. Flowchart With the Demographic Profile of the Interviewees, Showing the Proportions of Gender, the Relationship of the Interviewees With the Area of Study, Age and Level of Education. The left the significant relationships with the variables of environmental perception and the right with the knowledge about sea turtles. Below is the interviewees' relationship with the beaches visited.

tourists, residents, and people who study/work at the site ($H = 5.5383$; $p = 0.0627$). Furthermore, no socioeconomic factors had a significant influence on the issue addressed (see online Appendix). The majority of respondents ($n = 73$; 60.8%) said they had not studied sea turtles previously, while 14.1% ($n = 17$) have seen a sea turtle specimen on any of the sampled beaches.

Among the interviewees, 10% knew the number of sea turtle species occurring along the Brazilian coast (Figure 2). There were no significant knowledge differences between tourists, residents, and people who study/work at the beaches ($H = 1.0247$; $p = 0.5991$). On the other hand, younger people ($z = -2.616$; $p < 0.05$) and those who visit beaches more frequently ($z = 1.941$; $p = 0.05$) made significantly more correct responses in that topic.

No socioeconomic factors had a significant influence on the knowledge of the number of eggs (see online Appendix) and also there were no differences in knowledge regarding the number of eggs ($H = 0.9680$; $p = 0.6163$) between tourists, residents, workers/students at the sampling site. For 46.6% ($n = 56$) of people, sea turtles approach the continent only for nesting, while 35% ($n = 42$) stated that the turtles lay on average more than 100 eggs per nest.

There were no differences in knowledge regarding the number of hatchlings between tourists, residents, and people who study/work at the surveyed sites ($H = 0.9693$; $p = 0.6159$) and no socioeconomic factors had a significant influence on the answers about this subject (see online Appendix).

Considering the insufficient knowledge about sea turtles and environmental perception according to the interviewees, supplementary didactic material was developed for use in environmental education practices (Figure 3A-E). The material will be used in itinerant workshops that will be held on the beaches in the region. The educational material consists of an illustrative didactic banner model showing the life cycle of sea turtles, the main threats to these animals, as well as ways to contribute to the conservation of sea turtles and coastal ecosystems (Figure 3A). The materials made up include models of turtles, eggs (Figure 3B), hatchlings (Figure 3C), shells and bone elements (Figure 3D), solid residues found in the digestive tract of stranded turtles (Figure 3E).

Discussion

The demographic profile of populations in coastal areas can protect knowledge and environmental perception, being associated with decision-making for the conservation of marine ecosystems (Campbell, 2008; Cella et al., 2016; Botterell et al., 2020). The Brazilian coast is the area where the highest demographic densities are concentrated (Rocha et al., 2007), which amplifies the anthropic pressures related to the exploitation of resources and threatens beaches with urbanization and the incorrect disposal of waste (Dias-Filho et al., 2011). Solid waste is primarily responsible for visual pollution in coastal environments and negatively affects tourism, human health, and the conservation of the associated biota that depends on the marine environment to complete its life cycle (Dias-Filho et al., 2011). In this study, women, younger individuals, and residents were the groups with the highest perception of garbage at the beaches.

Ethnozoological studies with sea turtles are usually carried out in traditional communities that present fishing activities for subsistence and, in most cases, are dominated by male individuals (Aires et al., 2015; Alves & Rosa, 2006; Pinto et al., 2016; Zeineddine et al., 2018). However, beaches are considered democratic environments for leisure and recreation, with high variability in terms of gender and socioeconomic factors of their visitors (Wolch & Zhang, 2004), which may explain the balanced distribution of the genders sampled in the present study.

Although there are studies that address the differences between men's and women's interactions with animals (Alves et al., 2014; Cella et al., 2016; Farias et al., 2007; Kellert & Berry, 1987), there is no discussion about the predisposition of the female gender in the perception of the presence of garbage. Among the youngest, there may be a greater influence of social media concerning solid waste and its threats to the environment (Correia et al., 2016). According to Souza et al. (2019), tourists do not know about the conservation conditions of the beaches they visit and tend to have a positive view regarding the cleanliness of the area. Furthermore, tourists favorably assess those places that offer a better entertainment infrastructure. This fact is also evidenced herein since the natural preservation level was the last factor considered for the choice of the visited beach.

The influence of gender, age and education level are commonly associated with knowledge about sea turtles when applied to the general public (Cella et al., 2016; Kellert, 1993; Kellert & Berry, 1987). However, in a study carried out in the United States, it was demonstrated that residents close to places where long-term wildlife conservation practices are developed generally had a positive impact on knowledge and environmental perception (Cella et al., 2016). On the Caribbean coast, conservation efforts over many years have resulted in increases in nesting populations of green turtles, olive ridleys (Plotkin et al., 2012) and leatherback turtles (Tiwari et al., 2013). Despite the importance of these conservation programs, there are still many conflicts between marine turtle conservation initiatives and traditional communities, which have different uses and purposes for these animals, including food and shell trade (Barrios-Garrido, 2018; Barrios-Garrido et al., 2017; Erlandson & Rick, 2010). In the Caribbean region, a

Figure 3. Educational Material Developed as a Strategy for an Environmental Education Workshop on Beaches. A: Banner illustrating the life cycle of turtles and covering aspects of their biology such as oviposition (1), hatching of eggs in the sand; (2) hatchling and problems arising from urbanization, such as lighting on beaches, garbage, vehicles and sewage; (3) natural enemies such as crabs and birds; and (4) threats in the aquatic phase such as vessels, solid waste such as plastics, fishing nets and oil spill. B and C: Schematic model with characteristics of the turtle species that occur along the Brazilian coast. D: Use of morphological materials such as bone skeleton. E: Samples of solid waste taken from the stomach of sea turtles stranded on beaches.

study involved different countries and compiled data that demonstrated these strong conflicts between sea turtle conservation initiatives and communities, which reinforces the importance in solutions that can mediate mutual cooperation in development of some alternative management methods (Barrios-Garrido et al., 2019).

In Brazil, since the early 1980s, the TAMAR project established a long-term program for the conservation of sea turtles through measures that involve local communities and beach users (Silva et al., 2016). The results of the actions reveal that since the creation of TAMAR, constant increases in the number of nests have been observed and more than 15 million pups have reached the sea (Silva et al., 2016), with the success of the program attributed to efficient communication and integration among researchers, fishermen, residents and tourists.

Pollution by solid residues is the main threat to sea turtles pointed out by the interviewees, as in other studies that also report the incorrect disposal of garbage as one of the leading causes of strandings and deaths of these animals on the Brazilian coast and in other regions

of the world, together with fishing (Marcovaldi et al., 2011). Thus, the appropriate destination of garbage, with selective waste collection and recycling, is a crucial action that could mitigate the anthropogenic impacts on marine ecosystems (Correia et al., 2016). However, in municipalities of Rio das Ostras and Macaé, there are no comprehensive and effective policy for selective collection and recycling. The greatest perception of initiatives that are necessary to increase the preservation of beaches came from the group with the highest level of education, as also reported in other studies that addressed preventive or prophylaxis actions (Moura et al., 2010).

The dataset of research conducted within traditional communities is predominantly dominated by people with elementary education (Torres et al., 2009; Zeineddine et al., 2018). In this study, we did not find that higher educational status is associated with a better knowledge about the biology of sea turtles. This result indicate that the approach and the teaching/learning relationship may have an effect on the construction of environmental knowledge throughout the schooling of Brazilians. Thus, the greater knowledge about the number of hatchlings that reach the reproductive phase observed among people with lower educational status may be associated with the school grade/age at which people are exposed to environmental and science themes.

Knowledge about the number of sea turtle species occurring in Brazil and possible characteristics that differentiate them is considered technical and specific for experts or scholars. Indeed, interviewees that fit into this category were rare, a pattern also observed at beaches in Paraíba (Aires et al., 2015), Pernambuco (Santos et al., 2019), and São Paulo states where only 8% of handmade fishers were able to differentiate turtle species, but in this case, they had biology training (Zeineddine et al., 2018). The five sea turtle species that occur along the Brazilian coast have already been recorded at the beaches sampled in this study. The green turtle (*Chelonia mydas*) are the most common in the area and, during their juvenile stage, feed on algae banks present in rocky shores (Almeida et al., 2011; Awabdi et al., 2013; Guimarães et al., 2018; Reis et al., 2017; Tagliolatto et al., 2020). Among the 14% of respondents who have already seen alive turtle on the beaches in the present study, the majority were regular beachgoers. Such answers enhance the need for raising education and environmental awareness in the region, given that most of the interviewees were unaware of green turtles' biology even with a high incidence of this species at the surveyed beaches.

Implications for Conservation

In this study, we analyzed the relationship of visitors to beaches on the north-central coast of the state of Rio de Janeiro with environmental perception and knowledge about the biology of sea turtles. Regarding environmental perception, we observed that residents perceive garbage more frequently than tourists, as do women and younger individuals. The level of preservation of the visited beach and the perception about initiatives to reduce the pollution of the beaches did not significantly differ between tourists, residents, and people who study/work in the sampled areas. The perception of initiatives necessary to increase the preservation of the beaches, on the other hand, was higher for people with higher educational status. However, there were no differences in knowledge between tourists, residents, and people who study/work at the surveyed sites. The results indicated to the need to expand ocean education, which can be developed through environmental awareness strategies aimed at the conservation of marine ecosystems.

Acknowledgements

The authors are grateful to Danielle Rodrigues Awabdi, who kindly provided stomach contents for sea turtles for use in ocean education workshops at the Iurukuá Project of the Federal University of Rio de Janeiro. The authors thank the 120 interviewees who contributed to this study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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Supplemental material

Supplemental material for this article is available online.

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