

Public awareness of the economic potential and threats to sharks of a tropical oceanic archipelago in the western South Atlantic



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ABSTRACT

Conservation actions for sharks are hampered partly by the negative beliefs and inaccurate knowledge about them among the general public. This paper investigated the knowledge and attitude of residents and tourists towards shark species of Fernando de Noronha Archipelago, a marine protected area, and one of the major ecotourism destinations in Brazil. Findings showed that residents had a lower knowledge of sharks and less positive attitudes towards sharks than tourists. Even though residents did not see sharks as threats to humans and they were aware of the role of the archipelago as a shark nursery, they did not completely understand the sharks' ecological and economic importance. This distinction between residents' and tourists' perceptions of sharks demands different strategies to assure engagement in management and conservation policies relating to both groups. Management actions focusing on providing enjoyable experiences with sharks to residents and enhancing their participation in tourist activities related to sharks are presented. They would require innovative cooperation between scientific, management and environmental institutions to build initiatives aimed at increasing the knowledge and improving attitudes of residents towards shark conservation and to homogenise conservation values held by the entire public on the archipelago.

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1. Introduction

Shark populations are declining worldwide due to a variety of human activities, including fishing, habitat destruction, pollution and climate change. Currently, the main threats to these animals are the incidental and directed fisheries, and the demand for their fins in the Asian market that results in the death of approximately 100 million sharks per year [1]. This decline is also exacerbated by the reproductive characteristics of most shark species, which are characterized by slow growth, late sexual maturity and having few offspring, when compared to bony fishes [2]; this results in a reduced population potential to resist or recover from the high mortality rates caused by commercial fishing. Indeed, 20% of the nearly 500 known shark species are currently included in one of the categories of risk of extinction in the Red List of the International Union for Conservation of Nature [3]. In the North Atlantic, for example, populations of pelagic species of sharks have declined

by 90–99% in the last 60 years [4].

From an ecological viewpoint, most sharks are opportunistic apex predators and, as such, they contribute to regulating the populations of species in lower trophic levels and to maintain the balance of marine ecosystems [5]. The massive removal of sharks has direct and indirect effects that may result in trophic cascades in the marine ecosystems, which affect other organisms, human communities and commercial activities [6,7]. The loss of sharks in aquatic ecosystems also has socioeconomic consequences. Sharks represent a source of protein and products such as leather, cartilage, oil and fins that are important for several communities in both developed and developing nations [8], as well as the high income generated by their exploitation as a tourist resource [9]. In this sense, the economic value of shark ecotourism was estimated at US \$78 million per year in the Caribbean and Bahamas [9] and at US \$40 million per year in the Indo Pacific [10].

Despite their ecological and economic importance, one of the main problems faced by conservation efforts for sharks is their negative image produced as a consequence of their occasional attacks on humans. Most of the general public has a negative view of sharks and considers them as human-eaters or vicious murderers, a stereotype that is often exacerbated by the media

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through melodramatic representations and reporting inaccurate knowledge about them [11,12]. These negative preconceived notions about sharks, often disseminated by the way they are erroneously portrayed by the media, can hamper public support for their conservation [13]. In fact, specialists now recognise that not only the production of scientific knowledge for management will be sufficient to promote shark conservation [14]. Positive public attitudes influence the general support to conservation actions for shark protection, such as supporting the end of finning and the fin trade. As members of the public are not uniform in its opinions and knowledge, their engagement in shark conservation may differ [5]. Thus, the success of shark conservation ultimately depends on the ability of researchers and educators to communicate the functional role of sharks in regulating marine ecosystems [14] and to promote a change in attitudes [15].

In this sense, many variables may affect public attitudes in relation to the environment (such as age, gender, income, ethnicity and participation in environmental activities). Formal and informal knowledge has been identified as the factor most likely to change attitudes and perceptions [16]. Evidence has shown that one's knowledge level can significantly predict one's personal attitude and behaviour about conservation [17].

Hence, the main goal of this paper was to investigate the differences in knowledge and attitude towards sharks between residents and tourists of a tropical oceanic archipelago, which is a marine-protected area and a major ecotourism destination in Brazil. The hypothesis under assumption is that both groups present different perceptions, with tourists more informed and more prone to shark management actions than residents.

2. Methods

2.1. Study area

Fernando de Noronha Archipelago (hereafter referred to as Noronha) is an isolated group of volcanic islands with a total area of 26 km², located 345 km off the north-eastern coast of Brazil. About 60% of the main island of the archipelago and the insular shelf within the 50 m depth isobaths constitute a Marine Protected Area (MPA) established in 1988. This MPA is designed as a National Marine Park, a Brazilian category of conservation unit, which allows scientific research, environmental education and ecotourism activities. The remaining 40% of the archipelago's main island and insular shelf is an Environmental Protection Area, a conservation unit designed for sustainable use of natural resources. It consists of public and private lands, and is the area where the human population of Noronha is allowed to reside [18]. The population of Noronha consists of approximately 2800 permanent and 900 temporary residents, totalling 3700 residents. Ecotourism is the main economic activity of Noronha, which receives about 60,000 people annually, most of them coming from south-eastern Brazil [18,19, Administration of Noronha (ADEFN), unpublished]. Diving is one of the main attractions, with approximately 24,000 divers visiting Noronha annually [Brazilian Environmental Agency (ICMbio), unpublished].

2.2. Sharks in Noronha

There are at least 20 shark species known to exist in Noronha [20,21]. The three most common shark species of Noronha, namely the Caribbean reef (*Carcharhinus perezi*), nurse (*Ginglymostoma cirratum*) and lemon sharks (*Negaprion brevirostris*), use the insular shelf as a nursery and mating area where their juveniles are resident [22–24].

Local diving business operators believe that a local fishery

operating from 1992 to 1997 targeting sharks outside the protected areas of Noronha depleted populations of *C. perezi* and *N. brevirostris*. At least 498 *C. perezi* were caught in the last 18 months of this fishery, representing 60% of the total shark catch during that period (Noronha Pesca Oceânica, unpublished). This fishery became unprofitable in relation to marine ecotourism opportunities before being closed in 1997 (Veras, L., owner of Noronha Pesca Oceânica, personal communication).

2.3. Data sampling

Data on knowledge and attitude were collected by interviews with residents and tourists visiting Noronha. The questionnaire was composed of open-ended questions that collected information on gender, age, educational level, time of residence in Noronha (for local inhabitants) and place of origin (for visitors). Additionally, 10 questions assessed specific knowledge of sharks and six other questions assessed attitudes towards shark species. Both inhabitants and visitors were randomly approached, but, before any interview, the purpose of the study was given and those who agreed to participate were interviewed. All interviews were conducted between February and July 2011 and in January 2012.

Information sampled by the 10 questions was used to create an index to measure the degree of knowledge of sharks. Eight questions (Table 1) were described by binary values (0–1). Correct answers were scored as one while incorrect or unanswered questions were scored as zero. Two questions had scores ranging from one to four (regarding to shark species occurring in Noronha and on the role of sharks in the environment; Fig. 1). If the interviewee quoted just one shark species from Noronha and one role of sharks in the environment, the question was scored as a one. When two species and roles were quoted, the question was scored as a two. The same process defined when interviewees reached scores three and four. The value for the index of knowledge ranged from zero up to 16, which is the maximum value for all answers summed, assuming only correct answers.

Information sampled by the six questions on attitude was used to calculate an index of attitude. Four questions were described by binary values (Table 1). The two remaining questions (actions to protect sharks and people that should be in charge of this task, see Fig. 1) received scores ranging from zero to four, which were defined according to the number of actions and people/institutions quoted by interviewees. In case of just one action and one person/institution being quoted, the question was scored as a one. If two actions and people/institution were quoted, the question was scored as two and so on, until reaching the scores of three and four. The values of these questions were summed to create an index of attitude ranging from zero to 12. Higher values represented more favourable attitudes towards sharks.

2.4. Statistical analyses

For binary coded questions, G-test (Yates) analyses were performed to compare the proportions of binary answers (Yes=1; No=0) among residents and visitors. Questions that were not answered or were answered by "I do not know" were excluded from the analyses, due to their low frequency of occurrence. For non-binary coded questions, G-tests (Yates) were also used to compare the proportions of each category of answers among residents and visitors. The U-test was used to compare age, educational level, index of knowledge and index of attitude between residents and visitors. Spearman correlations were performed to determine whether there was an association between these variables. All analyses were performed with the software Statistica[®] and significance levels were set at 5%.

Table 1
Proportion of “Yes” answers to questions on knowledge (K) and attitude (A) of residents and tourists towards sharks between 2011 and 2012 in Noronha.

| Questions on knowledge (K) and attitude (A) toward sharks | Resident | Tourist | G test (p value) |
|--|----------|---------|------------------|
| 1. Do you think it is important to protect sharks in Noronha? (A) | 100.0 | 99.6 | 0.06 (0.81) |
| 2. Do you think sharks loss could have harmful effects to the marine environment? (K) | 89.9 | 94.4 | 2.39 (0.12) |
| 3. Do you believe that somehow is possible to earn money, exploiting sharks? (A) | 88.2 | 93.9 | 3.73 (0.05) |
| 4. Do you think that fishing other species could harm sharks population? (K) | 52.9 | 87.6 | 63.61 (< 0.001) |
| 5. Would you agree with the prohibition of shark fishing in Noronha? (A) | 75.9 | 87.6 | 9.33 (< 0.01) |
| 6. Do you think that some species of sharks may be currently endangered? (K) | 69.1 | 84.9 | 14.17 (< 0.001) |
| 7. Do you think human presence and activities may influence shark behaviour? (K) | 60.3 | 76.2 | 11.72 (< 0.001) |
| 8. Have you heard about shark finning and the shark fin trade? (K) | 86.0 | 75.8 | 6.52 (< 0.05) |
| 9. Are you aware that Noronha is a birth and mating area to sharks? (K) | 82.0 | 53.4 | 39.55 (< 0.001) |
| 10. Do you know Noronha is the best site in Brazil to observe sharks during dives? (K) | 59.6 | 32.5 | 31.4 (< 0.001) |
| 11. Which shark activity could make more revenue: fishery or diving? ^a (A) | 30.5 | 29.4 | 0.02 (0.88) |
| 12. Do you think shark attack against humans depend on human behaviour/activity? (K) | 9.7 | 14.6 | 1.98 (0.16) |

^a Value refers to the proportion of interviewees choosing fisheries.

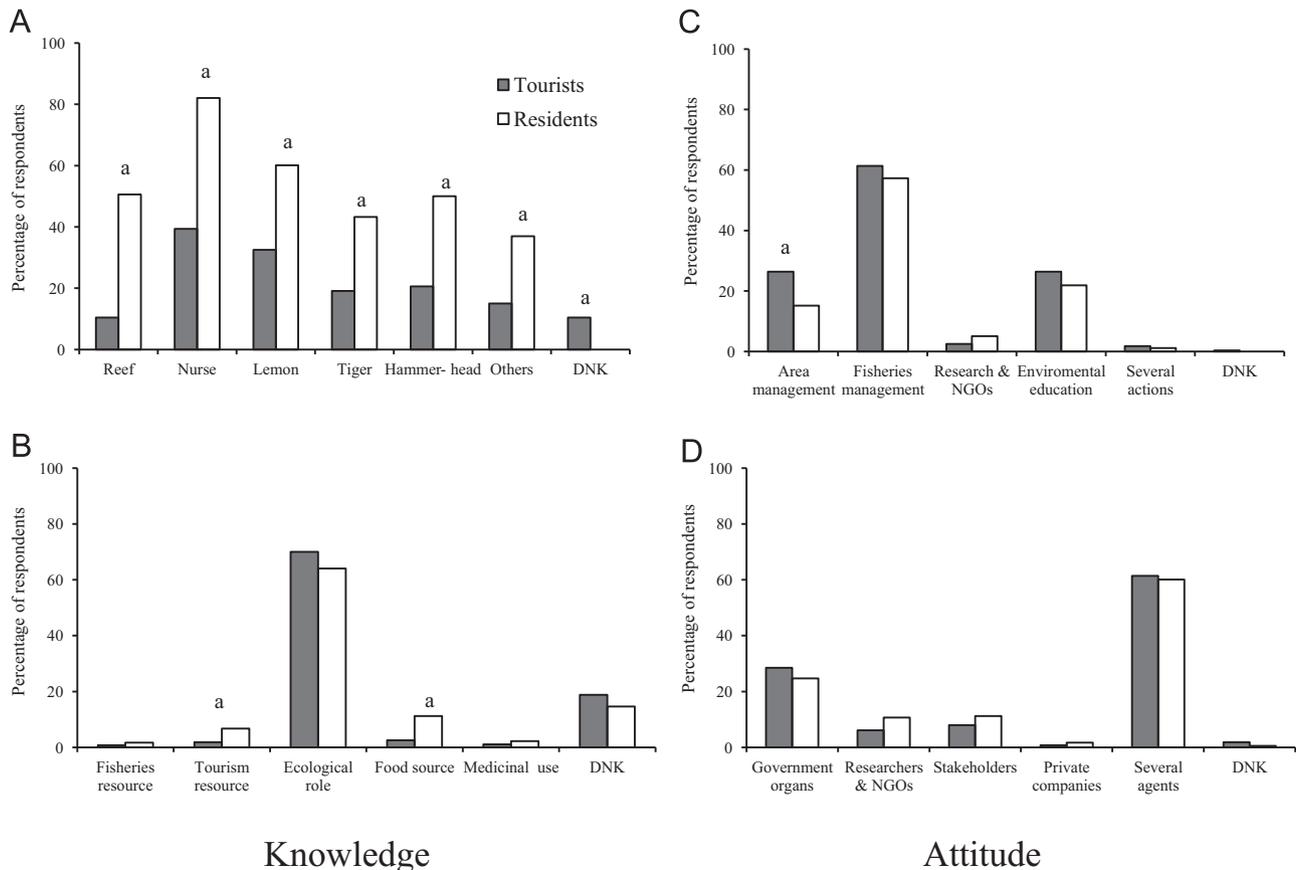


Fig. 1. Knowledge (A, B) and attitude (C, D) of residents and tourists towards sharks in Noronha between 2011 and 2012. (a: significant statistical difference between tourists and residents at $p=0.05$; DNK-Do not know).

3. Results

3.1. Characteristics of residents and tourists

The final sample of residents consisted of 178 respondents, ranging between 15 and 65 years old, with an average age of 33.6 years. Respondents have lived in Noronha from 1 to 65 years and had mainly finished secondary school (40%) or obtained a university degree (20%).

A total of 277 tourists were interviewed, ranging between 12 and 82 years in age, with an average of 36 years. Their main qualifications were university degree (70%) and secondary school (17%). Most interviewees were Brazilians (97%) who came mainly from the southern and south-eastern regions (66%). Approximately 23% of visitors came from the north-eastern region and 11% came from other regions.

3.2. Knowledge and attitude Indexes

The mean index of knowledge – IK (7.55 ± 1.91) and index of attitude – IA (7.56 ± 1.90) of tourists were significantly higher than the IK (7.13 ± 2.00) and IA (7.16 ± 1.95) of residents ($U=21,872.5$, $p < 0.05$ for IK; and $U=21,867.5$, $p < 0.05$ for IA).

Two to five species of sharks (out of 14 most commonly occurring in Noronha) were known by most of the interviewees. The nurse shark was the species most quoted by residents and tourists (Fig. 1A), and both groups indicated that the main role played by sharks in the environment is ecological (Fig. 1B).

Most of the actions reported by residents and tourists to protect sharks were positive and mainly related to fisheries management, environmental education and management of the areas occupied by sharks (Fig. 1C). Both groups also agreed that several agents and/or institutions should be in charge of the protection of shark species (Fig. 1D).

The majority of residents and tourists agreed with the importance of protecting sharks in the archipelago. A large proportion of residents and tourists believed in negative effects to the marine environment if sharks disappeared, and that it might be possible to generate revenue by exploiting sharks (Table 1; Questions 1, 2 and 3). However, more tourists than residents were aware of the effects of other species' fisheries upon shark populations, and would agree with banning shark fishing in the archipelago. Similarly, tourists were more aware of the current endangered status of some shark species than residents (Table 1; Questions 4, 5 and 6). Few interviewees of both groups identified shark fisheries as an activity likely to generate higher revenue than shark watching, and few believed that shark attacks occur without being induced by human behaviour or interference (Table 1; Questions 11 and 12).

Educational level was only correlated with IA for all groups, and was slightly higher among residents. The IA and IK were correlated with each other, and this correlation was stronger among tourists. For all interviewees, age was not correlated with IK ($r=0.004$, $p=0.93$) or IA ($r=0.03$, $p=0.47$) (Table 2).

4. Discussion

Findings indicated that residents and tourists had different characteristics in educational level and knowledge regarding to sharks. In general, residents from Noronha had less knowledge of sharks and less positive attitudes towards sharks than tourists. This distinction between residents and temporary public leads to different strategies to assure engagement in management and conservation policies among both groups and to contribute to a better management planning for shark species there.

Table 2

Pearson coefficient value and p value for correlation among educational level (EL) and the index of knowledge (IndexKnow) and the index of attitude (IndexAttitude) toward sharks in Noronha for only tourists, only residents and all interviewees (tourist and residents together). Bolded values indicate values statistically significant. p -Value is presented in parenthesis.

| Variables correlated | Tourists | Residents | All interviewees |
|------------------------|---|---|---|
| EL × IndexKnow | $r=0.02$ (0.74) | $r=-0.04$ (0.56) | $r=0.04$ (0.34) |
| EL × IndexAttit | $r=0.12$ (< 0.05) | $r=0.22$ (< 0.01) | $r=0.18$ (< 0.001) |
| IndexKnow × IndexAttit | $r=0.43$ (< 0.001) | $r=0.29$ (< 0.001) | $r=0.40$ (< 0.001) |

Under the current stated opinions and attitudes, tourists are most likely to engage and cooperate with actions aimed at shark conservation. Despite representing a large proportion of the public in the archipelago, they most likely are visiting Noronha because they already are interested in nature and sympathetic to conservation. Residents, as the permanent public, could be the drivers in influencing pro-conservation values in the archipelago and creating an environment of positive behaviour towards shark conservation. However, the lower levels of understanding and attitude towards shark conservation among residents may result in a disregard for governance actions or non-engagement in individuals changing their behaviour to safeguard local shark populations.

The perceptions of conservation issues [25] and the public engagement in conservation and pro-environmental behaviour may be influenced by external factors such as infrastructure, policies and culture, and by internal variables such as values, attitudes and knowledge [17]. The contrasting perspective of sharks among tourists and residents in Noronha seems to be attributed to internal factors like knowledge but also to external values, given that culturally for residents, sharks always represented competitors to the local fishery or just large apex predators. For example, conservation concerns towards sharks and ecotourism opportunities led to a spontaneous shark fishery ceasing around 1997 but shark diving or shark watching initiatives did not arise as an economic activity. Protective measures allied with economic incentives are expected to support economically dynamic diving and ecotourism industries and avoid depletion, as observed with the most charismatic shark species under protection, such as the whale, basking and white sharks [9]. However, recent environmental awareness in Noronha did not necessarily introduce this picture. Then, local people may be less aware not only of the potential of Noronha for shark watching as shown by the results, but also of the economic benefits from shark protection. Once local shark species are not necessarily charismatic for most residents they have limited appeal mainly for local residents that do not enjoy their existence. Under residents' views, except for divers and snorkelling guides, sharks do not seem to inspire wonder or fear. As a result, even though residents do not see sharks as human threats and they are aware of the role of the archipelago as a shark nursery, they do not fully understand sharks' ecological and economic importance. Therefore, a chance exists that residents may feel they get few benefits from sharks.

In general, low levels of knowledge about sharks are expected and have been previously observed [11,12,17]. With respect to Noronha, field observations made clear that most respondents (including both groups) simply just knew about shark predatory behaviour.

The residents' greater sense of the role of Noronha as a shark nursery and mating area and as the Brazilian best site for underwater observation of sharks is likely due to (i) the ongoing educational campaigns since 2006 and (ii) the weekly shark lectures

offered at the local visitors' centre. However, the low level of knowledge about the complexity of trophic relations among residents and their fear of having local fisheries constrained by shark conservation measures may hamper their understanding or cause them to assume the effects of other species' exploitation by the fishery over shark populations.

Noronha is near the city of Recife, where shark incidents with humans have been recorded since 1992 and partially credited with environmental disturbances that changed sharks' behaviour [31]. Indeed, most interviewees of both groups believe that unprovoked shark attacks to humans are rare. Among residents, this view likely exists since sharks are part of the local fauna and historically there are no records of shark attacks on humans in Noronha. Also, tourists are usually informed by tourism guides that shark attacks do not happen in Noronha due to its pristine condition compared to Recife. Those shark incidents are also discussed in the weekly lectures and occasionally in the national media, likely influencing the general views on this issue.

Even though residents trusted that human presence does not interfere with shark behaviour, few studies may have shown the contrary [28,29] even in Noronha [22,23]. Increasing local sightings of sharks in shallow waters, markedly juvenile lemon sharks *N. brevirostris* in sites of intense human activity underline this view [22,24]. Certainly these outcomes reflect good results regarding the conservation status of the archipelago but also can help build the image of unthreatened shark populations there.

Previous studies [16,17,26] have demonstrated that knowledge seems to play a major role in shaping attitude. Moreover, information on attitude and knowledge captures individual pro-environmental values. These values may define commitment to conservation and how prone to a change of behaviour each respondent is [27], while behavioural change may determine the public support for policy change and environmental policies [15].

The general situation found in Noronha regarding sharks indicated that a higher level of education does not imply better knowledge, but, conversely, is correlated to attitude, mainly for tourists. As individuals may require more than knowledge of an issue to catalyse a behavioural response [17], this may indicate that until now education did not add to residents' knowledge of ecological or ecosystem issues on sharks, but allowed them access to general information on tourism and pro-environmental and pro-conservation attitudes. This whole scenario has consequences and may be a driver for management actions in the archipelago.

4.1. Management implications

Since public support and engagement can be an important driver of environmental policies [5], the different views among tourists and residents of Noronha could shape management actions towards sharks. The actions have to influence not only tourists but should be tailored to improve awareness among residents to involve them in conservation issues and improve their attitudes and behaviour regarding sharks.

However, to achieve these goals, innovative cooperation involving scientific, management and environmental institutions has to be built and initiatives should focus on providing enjoyable and fascinating experiences with sharks to residents not involved in diving and tourism activities and enhance their participation in tourist activities related to sharks. Such broad cooperation would sound fair for respondents, since both groups stated that several social agents are needed to achieve shark conservation. For residents, this view is remarkable, since single institutions hold conservation projects specifically for dolphins and turtle protection in Noronha.

Accordingly, partnership among managers, local environmental agencies, the archipelago administration, private companies and

institutions, local schools and scuba dive operators could be used to provide shark-watching opportunities for residents of all ages as a conservation approach. This institutional arrangement could allow the use of part of the Environmental Preservation Tax (currently approximately US \$17 per day) paid by each tourist per day visiting the archipelago to support the following initiatives:

1. Shark-watching experiences could be offered for adult residents guided by local scuba diving operators and snorkelling guides. This would provide them with the enjoyment of the marine environment and sharks, which are frequently enjoyed only by tourists. Local trekking and snorkelling guides registered by the Brazilian Environmental Agency (ICMBIO) to operate dives and tours with tourists already include aerial and underwater shark observation in three or four sites in Noronha. They could be permitted to develop the same activity with residents on specific occasions.
2. Shark-watching activities could be included as part of schooling activities for children and teenagers. For teenagers, local scuba dive operators and snorkelling guides could perform the activities and those could be complemented or followed by lectures discussing interactions among sharks and the whole ecosystem. They could also use at least three easily reachable sightseeing areas on the top of cliffs where sharks can be observed at high tides. Likewise, boat trips for shark searching could be offered to children as part of their school education. Following some arrangements, these boat trips could be made using a glass bottom vessel, which belongs to the owner of the only shark thematic shop in the archipelago. These schooling activities are expected to increase the residents' awareness of sharks and their knowledge of ecological and trophic interactions.
3. Train residents as local scuba divers and snorkelling guides to strengthen their participation in tourism and engage them in conservation and environmentally driven attitudes. Such an opportunity could be offered annually to a certain number of residents interested in scuba diving. This activity could be funded by part of the Environmental Preservation Tax.

Under tourists' and residents' points of view, these strategies together would create a suitable use for the Environmental Preservation Tax, generating an important ecological and social benefit. Further, since personal experience is considered an important factor to influence environmental attitudes and motivation for personal engagement and conservation behaviour [30], all these strategies together may increase knowledge and attitude of residents in shark conservation issues, homogenising conservation values through the entire public present in the archipelago.

5. Conclusion

Beyond indicating a socio-ecological use for the Environmental Preservation Tax, the main contribution here relies on suggesting that in tourist areas, mainly in developing countries, conservation assessments considering the entire public may not capture the true attitudes and knowledge. Consequently, individual values may differ between visitors and residents, demanding different strategies from managers to better respond to conservation issues among the whole public.

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