

## Understanding the public attitude towards sharks for improving their conservation

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### ARTICLE INFO

#### Keywords:

Public opinion  
Public perception  
Shark conservation  
Attitude

### ABSTRACT

Sharks are among the oldest residents of the planet, they possess a unique value as top predators and constitute irreplaceable elements of marine ecosystems. Unfortunately, contemporary narratives widely presented in popular mainstream media have attached an utterly negative connotation to sharks, propagating an unsubstantiated and fabricated image of them as implacable and voracious predators. Recently a lot of attention is devoted to understanding the public perception towards sharks in order to promote their conservation given that a quarter of all shark species are facing extinction. This work assessed the current attitude of the public towards sharks on a global scale, utilizing modern technology through a single protocol that explored the importance of factors like culture, history, or educational level in shaping attitudes. We collected 13,800 questionnaires from 137 countries, with 25 countries presenting more than 100 answers each, representing in total 92% of the filled questionnaires. A generally positive attitude towards sharks emerged from our study, influenced significantly by several factors including knowledge and participation in marine conservation projects. Interestingly, shark

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attacks emerged as an important factor, with countries having high numbers of shark attacks exhibiting a highly positive attitude towards sharks, potentially because their citizens are more aware of the issue and the importance of sharks for the marine ecosystems. Guidelines for shifting public attitude towards sharks and consequently advancing shark conservation were also drawn.

## 1. Introduction

Sharks are among the oldest animals still surviving on the planet, showing high diversity and complex social structures [1] and representing irreplaceable elements of the integrity and the functionality of the marine communities [2,3]. Sharks' biological characteristics, slow growth, late maturity, and low fecundity make them extremely susceptible to overexploitation [4]. Globally, sharks are facing an unprecedented population decline, primarily due to intensification of fisheries [5], with about 100 million sharks being killed every year [6]. This is driven primarily by the demand for shark fins in Asia [7], while at the same time shark meat contributes significantly to the food security of several developing nations without being in most cases a targeted species [5].

Recently, several researchers put effort into understanding the attitudes of different factors involved, directly or indirectly, in shark protection and shark fisheries for advancing their conservation (e.g. [8–22]). Among other impacts, public opinion plays a significant role in shaping environmental policies [23] and is a key factor for achieving environmental “gains” [24]. Human attitudes towards wildlife, not only influence the coexistence between humans and animals [25] but is also an issue of high importance in terms of conservation [26]. Particularly when animal-human interactions result in conflicts, research on public attitudes is a prerequisite to developing effective strategies for the protection of wildlife species [27].

Sharks are considered one of the twenty most charismatic animals [28], however contemporary narratives still often attach them an utterly negative connotation, propagating an unsubstantiated and fabricated image of them as implacable and voracious predators [11,29]. This culture-driven negative image, which vilified sharks in the public, is currently one of the most significant issues for their conservation [11, 30]. Interestingly, this perception of sharks is gradually changing [31]. Surveys through questionnaires evidenced the rise of a positive shift, despite the fear still elicited by them (Australia: [8]; Brazil: [13]; Ecuador: [21]; Mozambique: [32]; UK: [10]; USA: [16]). This change in perception is also associated with a change in the use, from extractive to non-extractive, linked to the increase of interest in ecotourism and direct contact with these animals [31].

The present study aimed at assessing the current attitudes of the public towards sharks on a global scale, utilizing modern technology, with a survey that was administered online. The novelty of this work lies in the use of a single protocol that allows the exploration of how crossing social/demographic categories, and other drivers, like educational level and experiences, affect attitudes specifically for sharks. We further draw guidelines that will assist in future conservation efforts and primarily campaigning in different countries.

## 2. Material and methods

### 2.1. Survey design

A questionnaire-based survey was developed (Table A1), utilizing the attitudinal scale of Kellert [33] for assessing the attitudes of the respondents towards sharks. The questionnaire consisted of 4 parts facilitating the quantification of the results and the investigation of the relations between different factors and the attitudes.

The first part included questions on the demographic characteristics of the respondent and his/her educational level (Questions 1–6; Table A1). Analysing social features in an international survey like the

present one, heterogeneity between countries with a particular level of education, with various levels of literacy, or a particular social structure (e.g., Europe vs Asia) was likely to exist. The representativeness of the sample was expected to be very different according to the country. For reducing the above-mentioned uncertainty, the second part of the questionnaire (Questions 7–14; Table A1) was evaluated the connection of the respondents with the sea, the participation in different marine activities, and the main source of information that may provide knowledge on marine topics. The third part was designed to explore the attitudes of the respondent towards sharks (Table 1 and Question 13 in Table A1) using a Likert scale (1 = totally disagree; 5 = totally agree) for evaluating different statements. The last part was briefly assessing the knowledge of the respondents on sharks (Question 16; Table A1) with 5 closed formed statements and three possible answers (i.e. “I agree”; “I don't agree”; “I don't know”). The “I don't know” answer was included to reduce the possibility of selecting the right answer by chance, which is a known disadvantage of the closed-formed questionnaires [34].

The questionnaire was translated into 20 languages (i.e. Albanian, Arabic, Bengali, Chinese, Croatian, Dutch, English, French, German, Greek, Hebrew, Indonesian, Italian, Japanese, Mandarin, Portuguese, Russian, Slovenian, Spanish, Turkish), for overcoming linguistic barriers that would limit our potential sample. Although the selected languages cover most of the European, American, Middle Eastern, Eastern Asian, and Southeastern Asian countries, there is a lack of African languages. In most of these countries, English, French, Portuguese, Spanish, and/or Arabic are official languages and many residents speak more than one language. All the language versions of the questionnaire were uploaded in an online platform that allowed only one response by IP address limiting thus repetitive answers from the same IP address. The survey was disseminated through social media, almost exclusively through Facebook and Twitter, mass media, and through the national and local press of several countries- Only in a few cases (n = 50) via peer-to-peer interviews using tablets (Figure A). The distribution of the questionnaire took place during September 2016-March 2018.

### 2.2. Data analysis

The percentage contribution of the levels of each demographic

**Table 1**

The 13 statements used to assess the attitude of the public towards sharks, and the equivalent attitudinal scale based on Kellert [33].

Attitude Statement	Attitudinal scale
S1 - Sharks are dangerous to humans	Negativistic
S2 - Sharks are beautiful	Aesthetic
S3 - Sharks can feel pain just like humans	Humanistic
S4 - It is necessary to adopt safety policies to prevent shark attacks	Negativistic
S5 - We should manage shark populations to sustain other fish stocks	Dominionistic
S6 - Sharks are important for the functioning of marine ecosystems	Ecologicistic
S7 - It is necessary to protect sharks as part of biodiversity for future generations	Ecologicistic
S8 - I wouldn't approach a shark in the wild because I am scared	Negativistic
S9 - I wouldn't like to go shark watching (from boats or underwater)	Naturalistic
S10 - I would like to learn more about the biology of sharks	Scientific
S11 - Sharks are important attractions in aquaria	Utilitarian
S12 - Fishing sharks for food is wrong	Moralistic
S13 - Hunting sharks to increase human safety is wrong	Moralistic

feature was estimated. Descriptive statistics (i.e., estimation of means, medians and standard deviations) were applied to the scores of the 13 statements (Question 15) assessing the attitudes of the respondents and the 5 statements (Question 16) assessing the knowledge of the respondents about sharks. For handling the 13 questions related to attitude of the respondents on sharks and for the five questions used to evaluate respondents' knowledge, a reliability analysis of the items/themes involved in each of them was conducted. Reliability analysis refers to the property of a measurement instrument that causes it to give similar results for similar inputs. Cronbach's alpha coefficients is a measure of reliability, which is defined as the proportion of variability in the responses to the survey that is the result of differences in the respondents.

Logistic regression models were used to identify the potential drivers of the dependent variables related to the respondent's attitudes. In this context, binary logistic regression was used to predict the probability of the respondent's knowledge about sharks (YES/NO) based on one or more independent variables (i.e., demographic features, the educational level, the connection of the respondents with the sea and the participation in different marine activities). Ordinary logistic regression was also used to predict the attitudes of the respondents towards sharks (Question 15; ordinal dependent variable, measured on a 5-point Likert item from "Strongly Disagree" to "Strongly Agree"), based on the above-mentioned independent variables. A cluster analysis was also used to identify the spatial heterogeneity of participants' responses to the 13 statements measuring the attitudes towards sharks. The cluster analysis was applied to a matrix comprising the mean of the scores for the five levels per statement, only including the countries with more than 100 participants (25 countries). The matrix was then transformed with the Ward method (complete linkage distance) and converted into a triangular matrix of similarities using the Euclidean coefficient [35]. The

non-parametric multivariate analysis of variance PERMANOVA test was used to determine the differences between the groups of countries identified from the multivariate analysis [36]. The non-parametric Likelihood-ratio  $\chi^2$ -test) were performed to determine the degree of dependence of demographic factors per cluster group. The scores obtained from each of the 13 statements measuring the attitudes of the participants towards sharks per group identified by the cluster analysis were then compared using the non-parametric test of Kruskal-Wallis (H:  $p < 0.05$ ). Whenever a significant difference was detected ( $p < 0.05$ ), the non-parametric post-hoc Tukey-test was used to identify the responsible factors [37]. For the knowledge section answers were numbered as: Correct answer = 3, Wrong answer = 1, Do not know = 2. All analyses were carried out using the statistical package IBM SPSS Statistics 25.0 (SPSS, 2017).

### 3. Results

In total 13,800 questionnaires were collected from 137 countries. The distribution of the answers among countries was uneven, with 25 countries presenting more than 100 answers and representing in total 92% of the filled questionnaires (Fig. 1).

#### 3.1. Demographic features

Table 2 shows the demographic composition of the sample and the interaction with the marine ecosystem and knowledge about the topic of the questionnaire. Sex-ratio of the respondents was slightly, but significantly, biased towards males (male proportion: 0.53, binomial test  $n = 13,749$ ,  $p < 0.001$ , 51 did not declare the sex). The majority of the respondents (83.7%) were from 18 to 50 years old, with the most represented age classes being 18–25 and 26–30 years (Table 2). Most

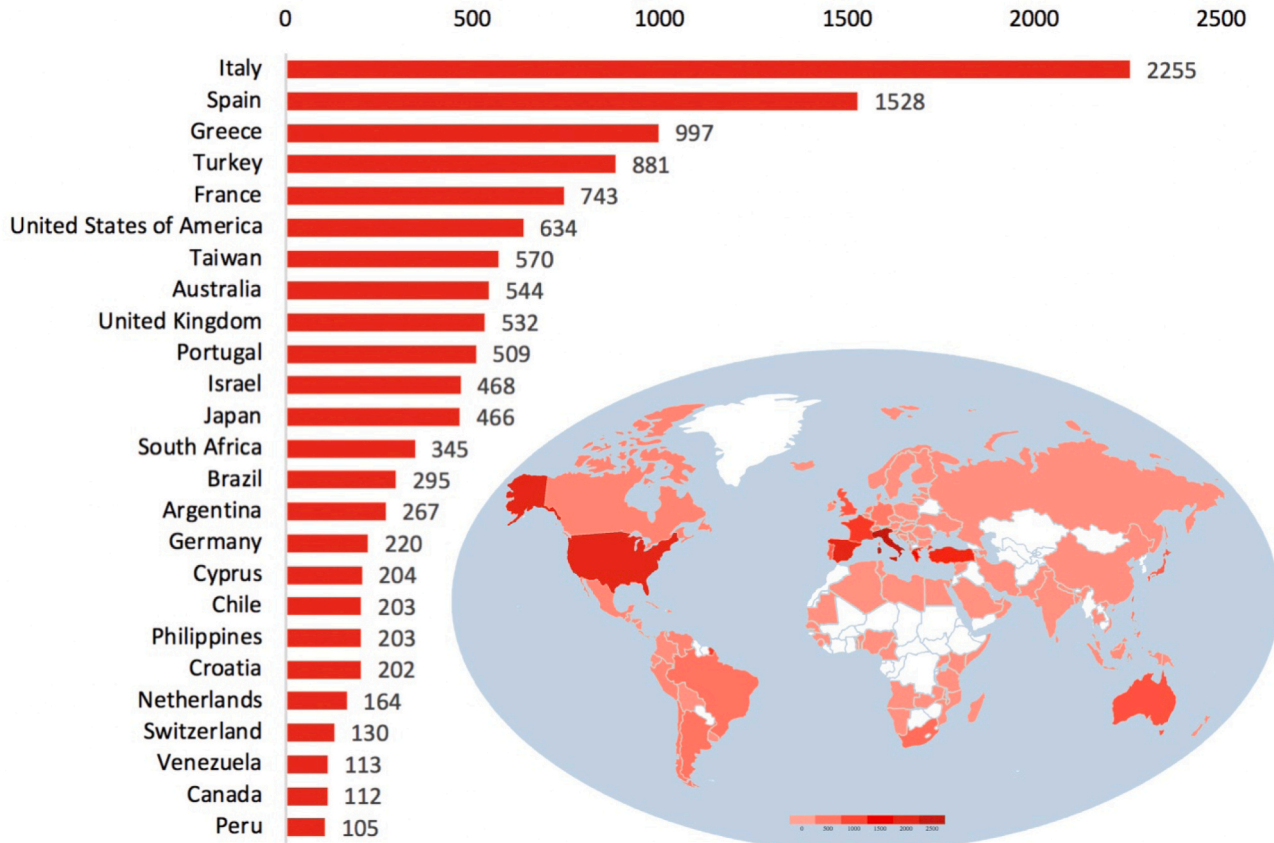


Fig. 1. Map of the distribution of the responses, colours represent the number per country; bars represent the number of responses for the top 25 countries. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

**Table 2**  
Sample structure based on respondents' demographic, education and interaction with the marine environment.

	N	%		N	%
<b>Age (yr)</b>			<b>Sex</b>		
< 18	425	3.08	Males	7346	53.23
18–25	3368	24.41	Females	6403	46.40
26–30	2317	16.79	No declare	51	0.37
31–35	1877	13.60	<b>Profession</b>		
36–40	1642	11.90	Agriculturist	74	0.54
41–45	1284	9.31	Fisherman	110	0.80
46–50	1058	7.67	Freelance	871	6.31
51–55	767	5.56	Retired	354	2.57
56–60	542	3.93	School professor/ teacher	1037	7.51
> 60	519	3.76	Public servant	678	4.91
<b>Education level</b>			Student	3392	24.58
Primary	183	1.33	Private employee	2156	15.62
Secondary	678	4.91	Unemployed	589	4.27
High school	2716	19.69	Worker	1206	8.74
University	6137	44.48	Other	3333	24.15
Postgraduate studies	4083	29.59	<b>Knowledge on the survey topic</b>		
<b>Do you usually visit marine areas?</b>			Yes	6485	46.99
Once per year	2436	17.69	No	7315	53.01
More than once per year	9522	69.14	<b>Visit to aquaria</b>		
No	1814	13.17	Yes	11,855	86.57
<b>Participation in marine project</b>			No	1839	13.43
Yes	5534	40.17	<b>Practiced marine sport</b>		
No	8244	59.83	Snorkelling	6238	23.04
<b>If yes, when was the last time?</b>			SCUBA diving	4587	16.94
Less than half a year	2768	45.08	Freediving	2556	9.44
More than half a year	744	12.12	Spearfishing	1012	3.74
More than one year	2628	42.80	Surf	1574	5.81
<b>Do you eat shark meat?</b>			Windsurf	768	2.84
No	11,327	65.76	Sailing	2089	7.72
Once per year	3042	17.66	Canoeing	2382	8.80
More than once per year	2856	16.58	None	5867	21.67

respondents declared a university or postgraduate level. Almost a quarter of the respondents were students followed by private employers, workers, and school professors/teachers, whereas the remaining respondents declared other not-defined works. Most of the respondents were familiar with marine environments, declaring to visit marine areas more than once per year. For respondents practicing sports (58.5%), snorkelling and SCUBA diving were the most common ones. The majority of the respondents had visited an aquarium and more than 40% participated in projects for the marine ecosystem, with almost half of them within the last half a year. Likewise, most of the respondents do not eat shark meat. Almost half of the respondents declared to have specific knowledge on the topic of the questionnaire, mostly obtaining via documentaries and the internet (mean (SD) 4.46 (0.86) and 4.08 (1.09), respectively).

### 3.2. Perceptions towards sharks

Considering the questions regarding the knowledge on sharks, a range of the respondents from 33.2% to 44.4% answered correctly, while from 10.3% to 22.9% of them answered that they did not know (Fig. 2a). The number of right answers (maximum score = 3) was higher (Fig. 2b) in respondents who declared to have specific knowledge on the topic when compared to those declared to not have it (Knowledge:  $2.05 \pm 1.51$ ; No knowledge:  $1.84 \pm 1.37$ ,  $t = -8.61$ ,  $df = 13184$ ,  $p$ -value < 0.001), therefore the Knowledge answer (self-perceived knowledge) was used in the following analyses. Knowledge of the

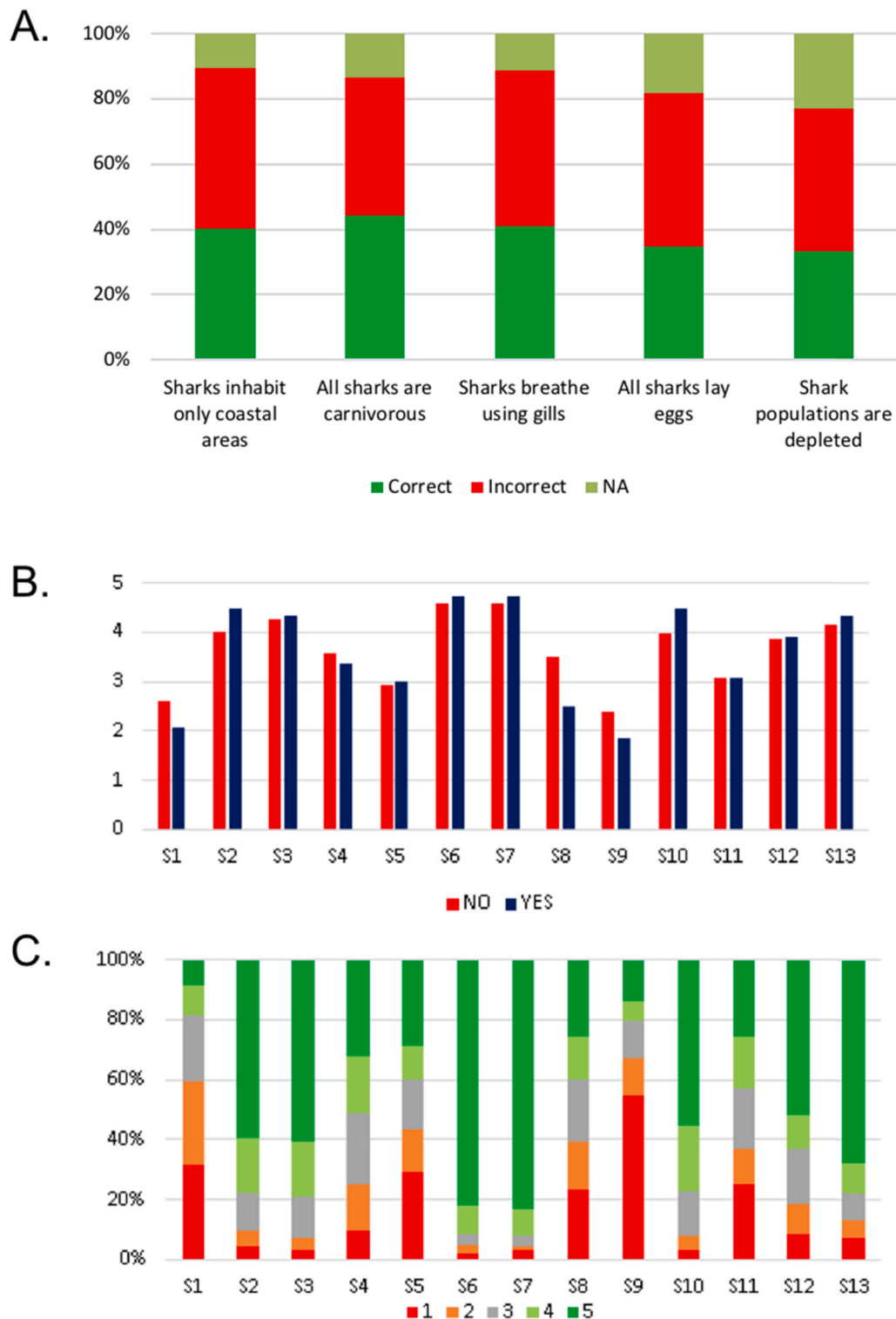
respondents about sharks was significantly affected by the source of information about this topic (PERMANOVA tests,  $p < 0.001$ ). In fact, documentaries were the main source of information (answers on levels 4 and 5) for the majority of the respondents (91.0%) that had knowledge about sharks, followed to a lesser extent by the internet, books, NGOs and TV programs (83.6%, 71.8%, 52.2% and 51.4%, respectively).

The internal reliability, measured by Cronbach's alpha coefficient, for the 13 questions related to attitude of the respondents on sharks was 0.450, indicating a moderate internal consistency, while for the five questions used to evaluate respondents' knowledge was 0.317, indicating a rather weak internal consistency. The knowledge of the respondents on sharks was significantly (PERMANOVA tests,  $p < 0.001$ ) affecting the attitudes of the respondent towards sharks. The vast majority of the respondents who declared to have knowledge about sharks (> 80%) agreed in high scores (mean values marked between 4.22 and 4.67 with a maximum value equal to 5) on "It is necessary to protect sharks as part of biodiversity for next generations", "Sharks are important for the functioning of the marine ecosystems", "I would like to learn more about the biology of sharks", "Sharks are beautiful", "Hunting sharks for human safety is wrong" and "Sharks can feel the pain just like humans". In contrast, low knowledge (mean values marked between 2.12 and 2.96) on the topic marked a higher agreement with the statements "Sharks are dangerous for humans", "Manage sharks' populations to sustain other fish stocks", "I wouldn't like to go shark watching (from boats or underwater)". Regarding the attitudes towards sharks, the highest degree of agreement was depicted for the statements S6, "Sharks are important for the functioning of the marine ecosystems", and S7, "It is necessary to protect sharks as part of biodiversity for next generation" (mean values 4.66 and 4.67, respectively), whereas the high degree of disagreement was depicted for the statements S1, "Sharks are dangerous for humans", and S9, "I wouldn't approach a shark in the wild cause I am scared" (mean values 2.17 and 2.13, respectively) (Fig. 2c).

### 3.3. Comparative and modelling approaches

The comparison of the demographic factors (i.e., age class, sex, educational level, visit marine areas and visit aquaria) with each of the attitudinal questions related showed that only one comparison out of the 65 (5 factors X 13 questions), exhibited no significant difference (PERMANOVA,  $p > 0.05$ ): the attitudes of the respondents to the statement "We should manage sharks' populations to sustain other fish stocks" did not differ by sex. In contrast, for all the remaining combinations of demographic factors with each of the questions related to respondents' attitudes showed significant differences (PERMANOVA,  $p < 0.001$ ). The top-10 combinations of the above-mentioned cases that exhibited most of the significant differences were those related to the positive answer of a visit to aquaria or marine areas and positive "agree" attitudes in the statements "Sharks are important for the functioning of the marine ecosystems", "It is necessary to protect sharks as part of biodiversity for next generations", "Sharks are beautiful", "We should manage sharks' populations to sustain other fish stocks" and "It is necessary to adopt safety policy against shark attacks". In contrast, those who have visited an aquarium disagreed in higher percentages on the statement "Sharks are dangerous for humans" (PERMANOVA,  $p < 0.05$ ) than those they have not visited (sum of level scores 1 and 2: 62.1% vs 43.7%, respectively). This was not true for those visiting or not a marine area (52.4% vs 61.8%, respectively).

A binary logistic regression was performed to evaluate if age, gender, educational level, visits to marine areas, participation in marine conservation projects, visits to aquaria and eating of shark meat affected the knowledge of the respondents about sharks. The model was statistically significant ( $\chi^2(20) = 2458.23$ ,  $p < 0.05$ ), explaining 16.5% of the initial variance (Table 3). Table 3 shows the levels of the demographic factors that were significantly added in the final model (Table 3; Wald test and sign values), as well as the contribution of these levels to the dependent one. For instance, the participation of the respondents belonging in age-



**Fig. 2.** (A) Percentage of correct, incorrect and no answers to the questions to evaluate respondents' knowledge, (B) mean score of the 13 statements separated for respondents who declared knowledge (YES) or absence of knowledge (NO) regarding the topic of the questionnaire, (C) percentage of scores for each statement to evaluate respondents' attitude (1: totally disagree; 2: disagree; 3: nor disagree or agree; 4: agree; 5: totally agree).

class 46–50 or males decreased the likelihood of knowledge (Knowledge; YES) by 0.25 times for both variables (Table 3; Exp(B) values). In contrast, the participation of the respondents to marine conservation projects increased the likelihood of knowledge by 5.4 times, and this is also true, but to a much lesser extent, for visiting aquaria (1.25 times) and visiting marine areas once per year (1.18 times) or more than once per year (1.36 times).

### 3.4. Spatial disaggregation

Three groups of countries were significantly (PERMANOVA test: pseudo F-ratio = 37.50;  $p < 0.05$ ) formed from the cluster analysis applied on the mean scores obtained from each of the 13 statements reported for those countries with more than 100 participants (Fig. 3), whereas two countries, Israel and Netherlands, were disaggregated

**Table 3**

Partial binary logistic regression coefficients for the seven independent variables applied to the knowledge of the responders about sharks. Exp(B) values indicated the contribution of the model variation to the dependent variable when controlling the other variables. Cox and Snell values indicated the values of pseudo  $R^2$  explaining the percentage contribution of the initial variation explained by the model.

Factors	B	S.E.	Wald	df	Sig.	Exp (B)
Age class 46–50	-0.285	0.115	6.162	1	0.013	0.752
Gender	-0.292	0.038	57.816	1	0.000	0.747
Secondary education	-0.268	0.103	6.693	1	0.010	0.765
High school	-0.127	0.058	4.827	1	0.028	0.881
Participation in marine conservation projects	1.684	0.040	1798.843	1	0.000	5.388
Visit in an aquarium	0.220	0.058	14.376	1	0.000	1.246
Once per year visit marine areas	0.163	0.070	5.441	1	0.020	1.177
More than a year visit marine areas	0.309	0.058	28.397	1	0.000	1.363
Avoid of eating shark meat	-0.440	0.082	28.923	1	0.000	0.644
Constant	-0.620	0.141	19.377	1	0.000	0.538
Cox & Snell R Square:						
16.5%						
Nagelkerke R Square:						
22.1%						

separately. Group A consisted of several different countries at distant locations from each other (Fig. 3), whereas Group B consisted of the countries in the edges of the Mediterranean Sea (Greece, Cyprus, Turkey) plus Portugal, Japan and Taiwan and Group C by South American countries (Brazil, Chile, Peru and Venezuela) plus the Philippines. Groups formed by the cluster analysis were significantly (PERMANOVA tests,  $p < 0.001$ ) different on the scores of the attitudes of the respondents towards sharks (Fig. 4).

All participants' demographic features (i.e., age, sex, education level, and occupation), education (i.e., knowledge on the topic) and interaction with the marine environment and sharks (i.e., visit marine areas, aquariums, participation to projects and consumption of shark meat) were significantly differed in relation to cluster groups (Table A2 in Appendix). With respect to mean scores obtained from each of the 13 statements reported, Group B marked significant (Kruskal-Wallis,  $p < 0.05$ ) highest values for S1, S8 and S9 while S4 and S5 (Kruskal-Wallis,  $p > 0.05$ ) with group C. In contrast, Group C showed highest values for S2, S3, S6, S7, S10, S12 and S13. In fact, for the attitudes S4 ("It is necessary to adopt safety policy against shark attacks") countries from groups B and C exhibited significantly higher percentages of respondents who totally agreed (level 5), whereas for the attitudes S5 ("We should manage sharks' populations to sustain other fish stocks") countries from the group A exhibited significantly higher percentages of participants who totally disagreed (level 1) (Fig. 4). For the attitudes S8 ("I wouldn't approach a shark in the wild cause I am scared") countries from group A exhibited significantly higher percentages of respondents who disagreed (level 1), whereas the inverse was true for the countries from group B (level 5). Likewise, for the attitudes S11 ("Sharks are important attractions in aquaria") countries from group A exhibited significantly higher percentages of participants who agreed (level 5), whereas the inverse was true for the countries from groups B and C (level 1).

Groups formed by the cluster analysis also differed on the scores of the knowledge of the respondents towards sharks (Fig. 5). In fact, for the questions S1 ("Sharks inhabit only coastal areas") and S4 ("All sharks lay eggs") countries from group C exhibited significantly higher percentages of respondents who totally agreed (level 1). In contrast, for the questions S3 ("Sharks breathe using gills") and S5 ("Shark populations are depleted") countries from group A exhibited significantly higher percentages of participants who totally agreed (Fig. 5). Countries from

group B were characterised by the highest percentages of the absence of knowledge (level 3: "I do not know") for all the five questions (Fig. 5).

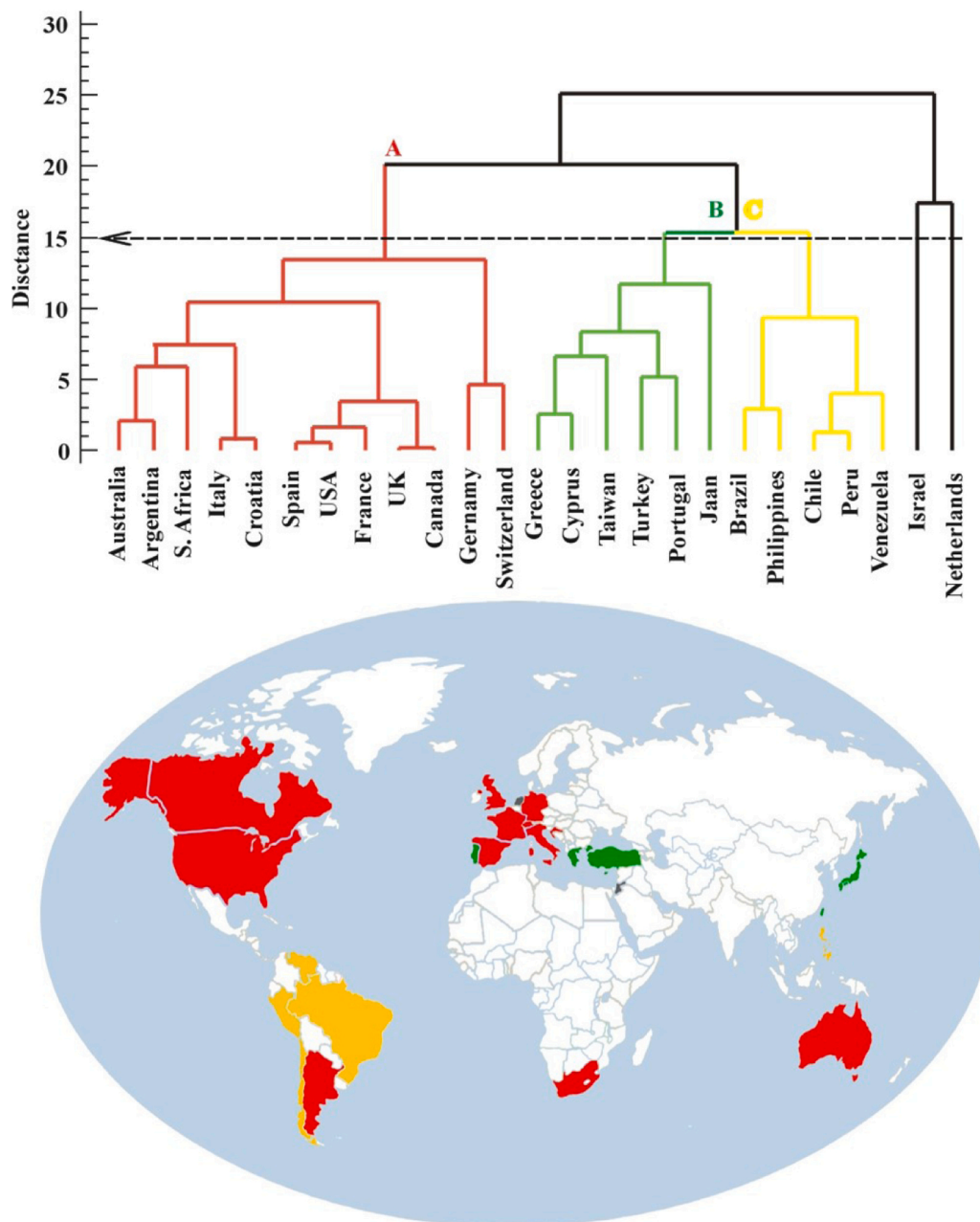
#### 4. Discussion

Our work represents the first global survey on the public attitudes about sharks and it is the most extended scientific study on attitudes of marine fauna to date, with more than 13,000 questionnaires from 137 out of almost 200 countries worldwide (46 countries do not have access to the ocean). Up to now, only one study was performed through an online questionnaire, aimed to compare conservation preferences between sharks and dolphins by presenting different information [38]. In addition to a different focus, the study showed a much smaller sample size ( $N = 168$ ) than the present study and data about nationality have not been collected. Questionnaires were collected with limited effort and budget, compared to conventional methods such as personal interviews, telephone surveys, or online paid survey platforms. Given that about 2.6 billion people use social media globally, such an approach is cost-effective for communicating studies to a large global audience, despite some limitations that must be considered for the interpretation of results, as is proven through the work of [39] on the largest global attitudes survey for cetaceans.

##### 4.1. Drawing globalized public attitudes on sharks

What most emerged from the results is the generally positive attitudes towards sharks. Respondents displayed positive aesthetic, humanistic, ecologicistic, naturalistic and scientific attitudes. In particular, a very strong agreement (more than 90% of the respondents) was linked to the ecologicistic statements ("Sharks are important for the functioning of the marine ecosystems" and "It is necessary to protect sharks as part of biodiversity for next generations"). This generally positive attitudes supported by other relevant studies (e.g., Australia: [8]; Brazil: [13]; Ecuador: [21]; South Africa: [32]; UK: [10]; USA: [16]) and highlight the shift in the public perception about these species [10,13,31]. On the other hand, some fear is still associated with these animals, as shown by the high agreement with the negativistic statements 4 and 8 ("It is necessary to adopt safety policy against shark attacks" and "I wouldn't approach a shark in the wild because I am scared") This is following recent studies conducted in Peru [40] and Ecuador [21] and have been investigated in beach users in areas with shark attacks [9,22,32,41,42].

Our work finds a strong positive relationship between knowledge and attitudes especially for the ecologicistic, scientific and moralistic statements while feeling of danger was more pronounced in people with no specific knowledge on sharks. Although knowledge does not promote positive moods in all cases, nonetheless its importance in shaping people attitudes has been also found in various environmental studies [43–45], and in those focused on shark attacks (Australia: [46]; Brazil: [13]; Peru: [40]; South Africa: [32]). It is important to mention that knowledge can be acquired by an array of sources including formal, informal and non-formal education. In our work, the participants in marine conservation projects and the visitors to aquaria showed a highly positive attitudes towards sharks. Marine conservation projects promote experiential knowledge; hence they positively affect environmental knowledge and attitudes among the participants [47]. It is important however to note that voluntary participation in nature conservation projects and aquaria visits is strongly linked to the existing attitudes towards the environment [10,48]. Participants in conservation projects and aquaria visitors are more likely to have already developed pro-environmental attitudes and relevant knowledge, since they already express interest in the marine environment and its species [49,50]. Thus, the increased positive attitudes towards sharks showed by aquaria visitors is explained by the fact that people visit an aquarium due to their prior interest and existing attitudes. Nonetheless, people participating to marine conservation projects and visiting aquaria may also be likely to be more willing to learn more about marine organisms and their



**Fig. 3.** Cluster analysis (Euclidean distances with complete linkage) on a matrix comprising the sum of the scores for the 5 levels consisted each of the 13 statements for the countries with more than 100 participants (25 countries). Group A is represented in red, B in green and C in yellow. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

conservation, and therefore these contexts may take advantage of positive attitudes to deliver appropriate conservation messages.

Documentaries were the primary source of information about sharks, followed by the web, books and NGOs. The easy access to the information through online videos or texts has been also proven to be a powerful tool for the conservation of formerly misunderstood species, like cetaceans [31,51]. Sharks for centuries were depicted as monsters of the sea [52]. This representation continued until recently, in movies and books (see the book *Jaws* and the consequent movie) with severe impacts on their populations worldwide [11]. However, over the last 20 years, documentaries and TV programs presenting scientific facts about sharks have increased [31]. Only in 2010, up to 30 million people watched Discovery Channel’s *Shark Week* [53] with this number potentially increasing in upcoming years. The documentary “*Sharkwater*”, a landmark in shark conservation, influenced several other modern

documentaries and increased the pressure of the public towards shark conservation issues, predominantly against finning. Our results underline the importance of documentaries in the shifting attitudes of the modern world towards sharks.

The majority of the respondents answered that they are not eating shark meat (65.76%). We believe that this is an extremely high percentage and potentially unrealistic. It is proven, indeed, that people in several countries eat shark meat without being aware that it is a common substitute for fish meat (Global: [54]; EU: [55]; Brasil: [56]; Peru: [40]) while it is also possible that people from Asia do not consider the shark fin soup as shark meat. In contrast, in several countries, people consume shark products that are labeled as such, but they are not aware that they are sharks. The accidental or erroneous mislabelling of shark meat is a known issue in shark conservation [57] and fisheries in general [58]. Moreover, China and other Asian countries where shark



Fig. 4. Parallel bars with the percentage contribution of responses in the 13 questions per cluster groups related to attitude, percentages indicate the cumulative % of the 1, 2, 3, 4, 5, level scores.



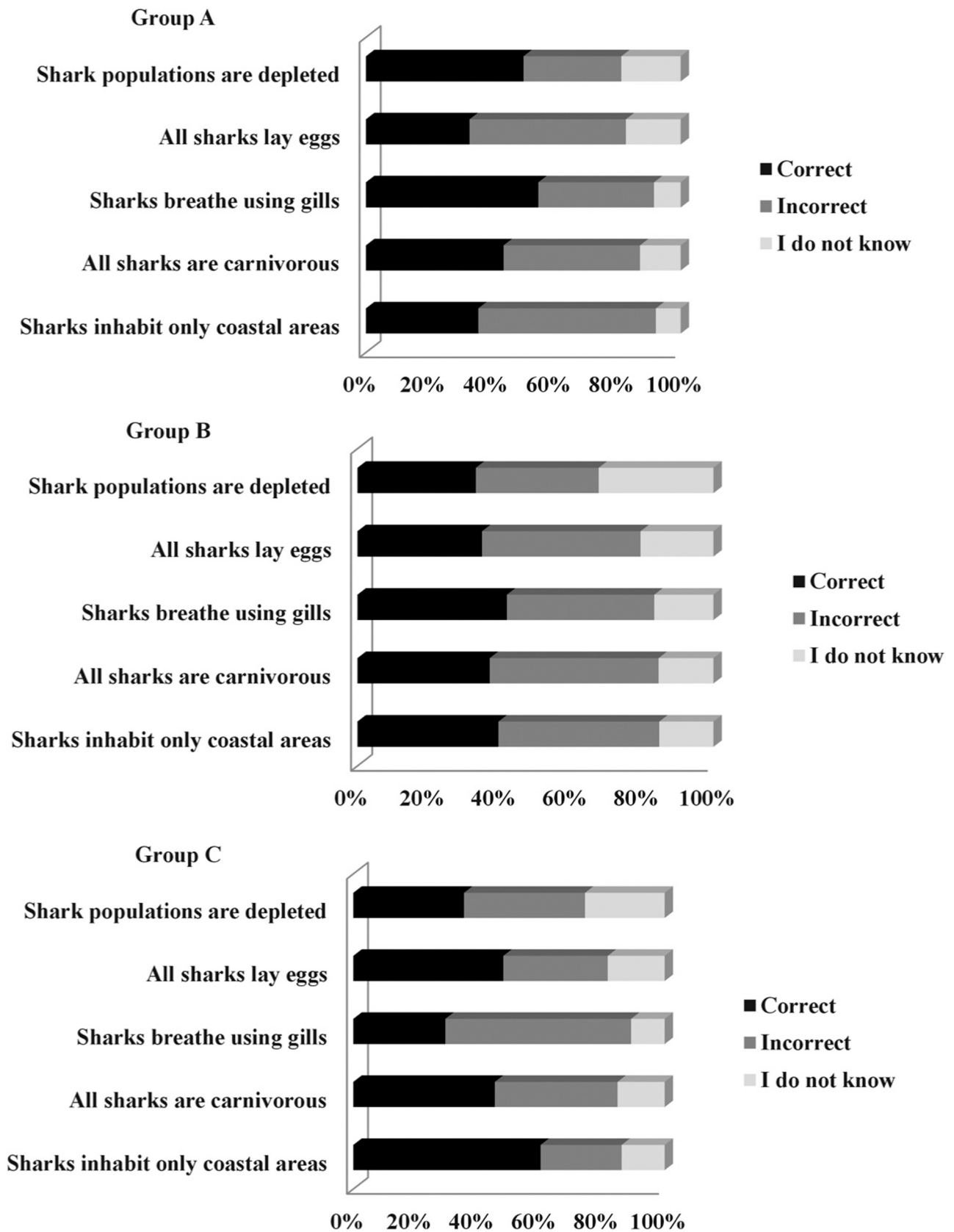


Fig. 5. Percentage of correct, incorrect and I don't know responses to the five questions used to evaluate respondents' knowledge.

consumption is relevant [7] are poorly represented in this study. This result should be considered as a relevant issue for shark conservation. Indeed, it poses the problem of the knowledge of which species the consumer eats and therefore push towards the need of an appropriate education to raise consumer awareness. On the other hand, in terms of attitudes, the fact that people believe that they do not consume shark meat might indicate a positive attitudes and respect for them.

The cluster analysis revealed a partial association between attitudes and history. The influence of historical culture in modern attitudes has been well described in cetaceans [39] and in general, is a factor that affects the attitudes of different communities towards animals [59]. Indeed, one cluster includes mainly countries belonging to the so-called western world and another included all, but one (Argentina) South American countries. On the contrary, some distant and quite different countries are included in these groups, while the third cluster is composed of the Latin American countries plus the Philippines (very related to Latin America). However, we believe that in the case of sharks, culture and history do not fully explain attitudes. Indeed, the first cluster includes some countries in which shark attacks are more likely to occur (Australia, South Africa, USA), while the attitudes of the respondents were not characterized by fear and perception of danger. Analysing our findings under this scope, we believe that shark attacks seem like a possible factor influencing the cluster's formation. USA, Australia, South Africa, France, including Reunion islands, all belong to cluster A, exhibited highly positive attitudes towards sharks and yet are among the countries with the most shark attacks [60]. We believe residents of countries with shark attacks are possibly more aware of the issue and the importance of sharks for the marine ecosystems due to the possible long debate that takes place after every incident. During the past decades, several projects promoted coexistence and awareness towards sharks in these areas and this is a topic commonly and more deeply discussed in these countries in respect to other ones. Therefore, residents progressively shift their attitudes and learned how to coexist and appreciate these animals [61], while in some cases sharks are becoming an important economic source e.g. South Africa. Similar findings were also presented in a local study in Galapagos islands [21] in which "..., residents were less fearful of sharks than were visitors, perhaps because residents live in closer proximity to abundant populations of sharks, leading to more experiences and a better understanding of sharks...". Other factors may have influenced the clustering. Countries of cluster A are also characterized by high incomes, a factor that may have influenced their positive attitudes by providing easier access to education tools.

#### 4.2. Data limitations

Surveys collecting self-reported information suffer from social desirability norms; bias refers to the tendency of research subjects to choose responses they believe are more socially desirable or acceptable rather than choosing responses that are reflective of their true thoughts or feelings [62]. Like any other survey that the most motivated people (with a stronger negative or positive attitudes toward the shark) answered, potentially exaggerating their responses towards positive or negative attitudes. Another main weakness of the study is related to the use of online questionnaires and is the bias in the sample structure. In fact, respondents are mostly highly educated and at a young age. The high educational level of survey respondents is a common bias not only limited to online questionnaire but also in studies performed using face-to-face surveys (Brazil: [13]; Ecuador: [40]; South Africa: [32]; UK: [10]; USA: [16]). Discrepancies due to different levels of internet access in different regions are also likely to occur. These are particularly true, in deprived and rural areas with limited internet access. The lack of truly global coverage in the data collection and the difficulty to generalize the findings at a global scale is also a potential drawback. In our sample, despite the high number of participating countries, 25 were cumulatively contributing 92% of the filled questionnaires, partly a reflection of

the geographic locations of the participating researchers. Therefore, we tried to build a team of researchers that works on all continents and in different regions. However, almost half of the African countries did not participate in the survey (we must also mention that several are landlocked), a fact related to the level of internet access of the residents. The same was also true regarding Asian countries, with only Taiwan and Japan being among the first 25 countries in responses. Additional uncertainty in results' interpretation is related to the absence of information on the ethnicity of respondents and the way that the questions have been understood by many different cultures. The attitudinal scale used in the present study has been widely used in the western world by environmental psychology and they might be less informative when applied to communities with completely different views of the world. For that reason, the questionnaire included issues related to the knowledge of sharks in order to check whether participants were aware of basic information about sharks. Despite these weaknesses, this study provides some clear indication about public attitudes towards sharks and more importantly how different factors might affect them.

#### 4.3. Drawing recommendations for advancing shark conservation

Given that sharks are in deep need of better and more effective conservation [7], these globalized surveys help scientists and policy makers to understand gaps of knowledge and misconceptions, guide future efforts [63] regarding raising awareness, shifting public attitudes and creating a social echo that increases the uptake of management and conservation strategies [8,64]. General positive attitudes towards sharks emerged from our survey. Indeed, a strong agreement towards the role of sharks in ecosystems and the need to protect these species for next generations emerged. These two points highlight that the general public has the attitudes to push administrations to strength and adopt conservation strategies for these species. Nonetheless, positive attitudes are not universal, therefore some actions on the general public may be developed to improve attitudes and to make people more active respect to conservation.

##### 4.3.1. Advancing knowledge

The role of knowledge in shaping attitudes was highlighted in the current work. In addition, differences between countries in knowledge were emerged. Based on the survey results, hereby we provide general guidelines for three different types of education (formal, non-formal, informal).

- School did not emerge as an important source of knowledge. To fill this gap and considering that in some countries access to documentaries (the main source of knowledge) can be limited, educational tools for the incorporation of shark conservation in formal education curricula should be developed.
- Considering the willingness of the respondents to learn more about sharks, shark conservationists should invest in experiential non-formal educational projects that increase the knowledge and awareness of the general public towards sharks. In such a way they will increase social license and boost public awareness and future campaigning. We further suggest, fishers and key policy makers (e.g., Ministries, MPA Boby managers, RFMOs) to be involved in such activities for progressively shifting also their attitudes.
- Documentaries emerged as important means of information for the public. Shark conservationists must invest in productions that will increase the knowledge of the public about sharks and uplift their image. Priority must be given to the countries of Cluster B and C

##### 4.3.2. Improving the image of sharks

- Fear towards sharks is still present, and in the survey this emerged especially for countries in cluster B. Professionals working on shark management should work closely with journalists and professionals

of mass and social media for ensuring that accurate information reaches the general public, avoiding the dissemination of new misconceptions [11]. Even today most of the media are emphasising the risks that sharks pose to humans presenting them as greedy predators [29]. Uplifting the image of sharks is urgent and priority must be given in countries of cluster B, as well as in the major shark fishing nations.

- Campaigns on shark awareness and mass media coverage of sharks must refrain from words with a negative quotation to sharks, like “monsters”, “monstrous”, “beast” etc., and create a positive aura around them.

#### 4.4. Conclusions

Humans tend to protect and conserve what they know and respect. In the past, sharks were always considered monsters of the sea while more recently documentaries and conservation efforts seem to have shifted this perception, however there is a lot of work still to be done. Our survey is the most extended work in assessing the attitudes of the public towards sharks. We identified countries where shifting perception is more urgent than others while that documented the importance of knowledge in shaping attitudes. Education through formal and informal experiential means are excellent strategies for shark conservation professionals, while a close collaboration with mass and social media professionals is required for securing the dissemination of accurate information and expunging negative connotation of sharks in the public attitudes.

#### Funding

This work has been partially funded by the Oceans Past Platform (COST Action IS1403) and the Department of Animal Production, Fisheries & Aquaculture of the University of Patras, Greece and the Biology Department of the University of Padova, Italy as part of IG Ph.D. thesis.

#### CRediT authorship contribution statement

**Carlotta Mazzoldi and Ioannis Giovos:** Conceptualization, Methodology, Data curation, Writing – original draft. **Ioannis Giovos, Carlotta Mazzoldi and Dimitrios K. Moutopoulos:** Questionnaire dissemination: all authors, Data analysis, Visualization. **Carlotta Mazzoldi and Dimitrios K. Moutopoulos:** Supervision. **Carlotta Mazzoldi:** Funding acquisition. **Cristina Brito, Dimitrios K. Moutopoulos, Carlotta Mazzoldi:** Writing – review & editing. **Ruth Thurstan** and all authors.

#### Acknowledgments

We would like to warmly thank all participants that anonymously contributed to the realisation of this research. Several people, institutes and organizations helped in questionnaire distribution and we wish to thank them all. Inma Ferrer Mateu, Satoko Koda, Verena Riedl, Viktoria Lazareva, Georgina Wiersma and Salman Habibur Rahman provided translations. Besides several people, the following organizations provided great support in dissemination: GRIS (Italian group of researchers studying sharks, rays and chimaeras), SIBM (Italian Society for Marine Biology), Ocean Past Platform, Florence Wallemacq from FAO, Centro Studi Squali, Conservation International, Hong Kong Shark Foundation, the Dutch Shark Society, International Ocean Institute - Southern Africa, ELMO - South African Elasmobranch Monitoring, Legambiente Italy, Costa Endutainment (Aquarium of Genova, Italy), Bloomassociation, Orca Foundation, Eco New Zealand, OceanCare, European Elasmobranch Association, Tethys Research Institute, South African Network for Coastal and Oceanic Research, Marine Wildlife Watch of the Philippines, Anabel Colmenero, Tiburones en Galicia, Instituto Español

de Oceanografía (IEO), Planeta Profundo, Condros, Tiburones y Rayas del Perú, SBEEL - Sociedade Brasileira para o Estudo de Elasmobrânquios, Mexico Azul, SOMEPEC, Rede de monitoramento participativo de tubarões e raias, Associação Tubarões da Costa – RN, VERBALLENAS.COM, Fundación CRAM, Plàncton, Divulgació i Serveis Marins.

#### Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2021.104811.

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