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MARIOS PAPAGEORGIOU, ELIZABETH G.T. BENGIL, ROBIN SNAPE, LOUIS HADJIOANNOU

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Increased knowledge affects public attitude and perception towards elasmobranchs and support for conservation

Marios PAPAGEORGIOU[1], Elizabeth G.T. BENGIL[2], Robin SNAPE[2, 3] and Louis HADJIOANNOU[1,4]

[1] Enalia Physis Environmental Research Centre, Nicosia, Cyprus
[2] SPOT – Society for Protection of Turtles, Nicosia, Cyprus
[3] Centre for Ecology and Conservation, University of Exeter, Penryn, UK
[4] Cyprus Marine and Maritime Institute, Larnaca, Cyprus

Corresponding author: Marios PAPAGEORGIOU; m.papageorgiou@enaliaphysis.org.cy

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Abstract

The tendency of world media to villainize of sharks has likely contributed to a disparity in the distribution of research and conservation resources among threatened marine megavertebrates, with elasmobranchs losing out. Increased public knowledge on elasmobranchs can shape public attitude and foster and gain support for elasmobranch conservation. Through an online survey, this study aimed to evaluate the drivers of public knowledge and examine linkages between awareness of elasmobranchs and attitude toward their conservation. To explore the relationships and effects between the different predicting variables and public elasmobranch knowledge and attitude indices, bi- and multi-variate analysis and a partial least squares path model were used. The results indicated that the average public elasmobranch knowledge of the Cypriot population was moderate and the average public attitude towards elasmobranchs was relatively low. Marine-related activities and marine-related education were highly correlated with increased public elasmobranch knowledge and were the strongest predictors of the partial least squares path model which explained a high degree of variation in elasmobranch knowledge. Public elasmobranch knowledge was highly correlated with public attitude towards elasmobranchs. The findings of this study highlighted the importance of ocean literacy and education and provide insights into the mechanisms for developing and designing successful advocacy actions for elasmobranch conservation.

Keywords: sharks and rays; public elasmobranch knowledge; public attitude; shark conservation.

Introduction

Elasmobranchs provide services to marine ecosystems that are of incommensurable value (Tavares *et al.,* 2019), but their populations have declined substantially over the last 50 years (Davidson *et al.,* 2016; Roff *et al.,* 2018), mainly due to overfishing (Stevens *et al.,* 2000) and increased market demand for shark products (Dent & Clarke, 2015). This decline may cause unpredictable cascade effects on marine trophic webs (Casini *et al.,* 2009; Ferretti *et al.,* 2010; Bornatowski *et al.,* 2014) and human activities that rely on sharks (Britten *et al.,* 2014). Eighty-eight chondrichthyan (sharks, rays, and chimaeras) species are found in the Mediterranean Sea (Serena *et al.,* 2020), of which, 53% of the species assessed by the International Union for Conservation of Nature (IUCN) are considered at risk of extinction (Dulvy *et al.,* 2016; Otero *et al.,* 2019), with an additional 18% classified as Data Deficient (Dulvy *et al.,* 2016).

It is fair to say that global media have negatively influenced people's perception of sharks by emphasizing the relatively few negative human-shark interactions and events (Muter *et al.,* 2013; McCagh *et al.,* 2015; Sabatier & Huveneers, 2018; Le Busque *et al.,* 2019; Shiffman *et al.* 2020). Examples include thriller films, such as 'Jaws' and 'The Shallows' as well as documentaries such as Discovery Channel's 'Shark Week' with titles including 'The Spawn of El Diablo', 'The Real Sharknado', and 'I Was Prey: Terrors of the Deep 2'. These types of shark representations only perpetuate the fear of sharks, trivializing their values in terms of, biodiversity, ecological importance, and their critical conservation status (O'Bryhim & Parsons, 2015). This is further exacerbated when media outlets disproportionately report on negative shark encounters, with very few news stories detailing positive encounters, for example through dive eco-tourism. These negative preconceived notions have resulted in a lack of public support for shark conservation actions compared to for example sea turtles and marine mammals (Friedrich *et al.,* 2014; Garla *et al.,* 2015).

In recent years, public perception of sharks has changed positively, with increased public concern for the conservation of sharks (Bargnesi *et al.,* 2020; Le Busque *et al.,* 2021; Giovos *et al.,* 2021). This shift of attitude may be linked to increased public knowledge about sharks (Friedrich *et al.,* 2014; O'Bryhim & Parsons, 2015), possibly through social media, documentaries, and ecotourism. Nature-related activities and experiences like fishing, diving, ocean education, and literacy can significantly positively change people's perception towards environmental conservation and lead to pro-environmental behaviours as described by Skubel *et al.,* 2019. Cebrián-Piqueras *et al.,* (2020) have shown that nature-related activities and education could play a crucial role in obtaining a deeper understanding of local natural environments. Positive public and stakeholder attitude towards sharks is important to guide decision-making, and conservation and management actions (Simpfendorfer *et al.*, 2011; Ward-Paige *et al.*, 2012), as communities tend to want to protect animals and environments that they are knowledgeable about (Giovos *et al.,* 2021).

It is essential to understand the drivers of public perception and attitude, as these will impact the understanding and support of conservation projects among public stakeholders (Kollumss & Agyeman, 2002). By managing these drivers, conservationists can ensure the successful implementation of environmental awareness campaigns (Mosler & Martens, 2008). Identification of specific knowledge gaps among different demographic groups will help to understand where knowledge deficits occur and identify where particular communities would benefit from further education (O'Bryhim & Parsons, 2015). Particularly relevant are those in coastal communities where the likelihood of shark interactions or activities reliant on sharks is more common (Garla *et al.,* 2015; Lucrezi *et al.,* 2019; Giovos *et al.,* 2021). If specific knowledge gaps lead to a lack of support for a conservation implementation, it would be crucial for conservationists to target their outreach efforts there. Therefore, understanding the factors that drive knowledge and perception towards sharks is essential for public awareness actions and engagement, in addition to developing strategies for elasmobranch conservation. This study aimed to 1) evaluate public knowledge and attitude regarding elasmobranchs, 2) understand the drivers of public knowledge and attitude towards elasmobranchs, and 3) explore the relationship between knowledge and attitude.

Materials and Methods

Survey design and data collection

A questionnaire was developed and conducted online through the platform 'SurveyMonkey' to gather information from Cypriot citizens regarding their knowledge on and attitude towards elasmobranchs. The questionnaire was piloted among ten people (an equal number of male and female participants, between 18 to 34 years old and holders of a university degree) prior to the official survey and adjusted as necessary and was divided into four sections with 31 questions in total (Fig.1). The first section was focused on participant demographics including questions on gender, age, nationality, and education. The second section was composed of 17 questions in three different thematic sub-sections regarding elasmobranch knowledge. The first thematic sub-section included nine general knowledge-related questions on elasmobranchs,

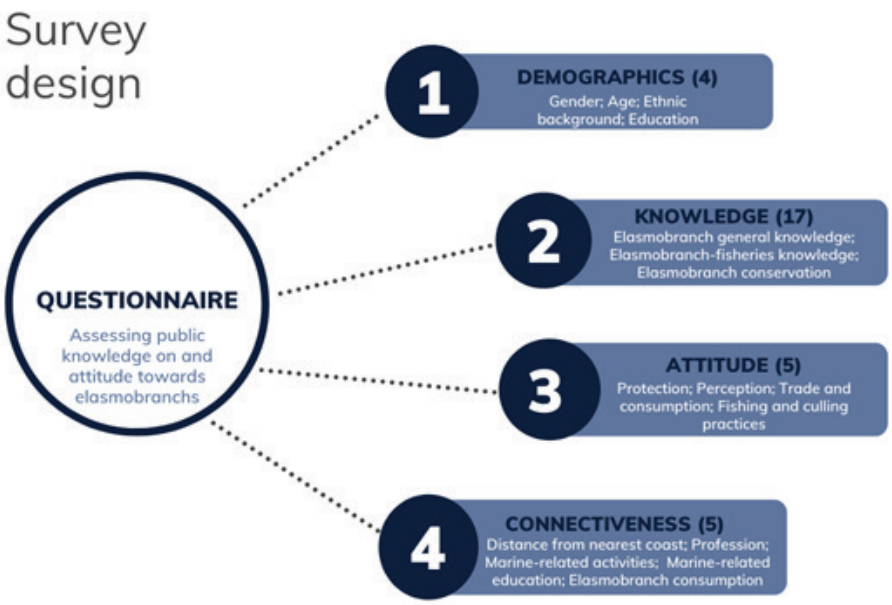

Fig. 1: Schematic diagram of the survey. The questionnaire was divided into four sections: 1) Demographics; 2) Elasmobranch knowledge; 3) Attitude towards elasmobranchs and; 3) Connectiveness to the marine environment. Each part was composed of different thematic contents. Numbers in brackets show the number of questions per part of the questionnaire.

the second thematic sub-section included five questions on elasmobranchs-fisheries knowledge and the third thematic sub-section included four questions on elasmobranch conservation. The third section included five questions regarding attitudes towards elasmobranch protection, perception, trade, and consumption, fishing, and culling practices. The fourth and final section was composed of five questions and aimed to gather information on participants' connectedness to the marine environment. A detailed explanation of variables description, methodology for value assignment, and variable type is shown in Supplementary Table 1.

The target population was defined as citizens of Cyprus and covered all different age groups with no age restrictions. Citizens of the two main ethnic communities of Cyprus were targeted (Turkish Cypriot participants residing in the north and Greek Cypriot citizens in the south of the island) with a local NGO based in each community tasked with disseminating the survey in their respective communities. The survey was disseminated on Facebook and posted on different groups and pages, and it was available for 20 days in November 2020. To boost the survey, 30.00 EUR were used on Facebook ads for a total of 10 days and helped reach 6,586 people mostly between the ages of 18 and 34. Additionally, participants who completed the survey were eligible to participate in a draw and win a prize that was worth 100 EUR. The survey was available in three languages, Greek, Turkish and English.

Table 1. Mean values of PEK index and PA index and Marine-related activities (MRA) and Marine-related education (MRE) with standard deviation (±SD) and results of comparisons between the independent and dependent variables. Mann-Whitney test used for comparisons between dependent variables and 'Gender', 'Ethnic background', 'Marine-related profession' and 'Elasmobranch consumption' variables. Kruskal-Wallis test used for comparisons between dependent variables and 'Age', 'Education' and 'Distance'. Significant comparisons ($p < 0.05$) are indicated in bold.

Variable	Category	Mean PEK index ±SD	Mean PA index ±SD	Mean MRA ±SD	Mean MRE ±SD
Gender	Male	5.3 ± 1.1	1.4 ± 0.3	2.1 ± 1.0	**2.7 ± 1.6**
	Female	5.0 ± 1.3	1.4 ± 0.3	1.9 ± 0.8	**2.3 ± 1.6**
Ethnic background	Greek Cypriot	5.1 ± 1.2	1.4 ± 0.3	2.0 ± 0.9	2.4 ± 1.5
	Turkish Cypriot	5.4 ± 1.1	1.5 ± 0.2	2.0 ± 1.0	2.8 ± 1.8
Age	<18	5.4 ± 0.8	1.5 ± 0.1	1.1 ± 0.7	1.1 ± 1.1
	18-24	4.5 ± 1.2	1.3 ± 0.3	1.9 ± 0.9	2.0 ± 1.4
	25-34	5.3 ± 1.3	1.4 ± 0.3	2.3 ± 1.0	2.7 ± 1.6
	35-44	5.4 ± 1.1	1.4 ± 0.1	2.1 ± 0.9	2.8 ± 1.6
	45-54	5.0 ± 1.0	1.5 ± 0.2	2.2 ± 1.0	3.2 ±1.8
	55-64	5.3 ± 1.0	1.4 ± 0.4	1.6 ± 1.0	2.5 ± 1.8
	>65	4.9 ± 0.9	1.3 ± 0.6	1.5 ± 1.0	1.3 ± 1.2
Education	Primary	3.8 ± 1.2	1.5 ± 0.2	1.0 ± 0.0	**0.5 ± 0.7**
	Lower secondary	4.8 ± 1.4	1.4 ± 0.4	1.4 ± 0.9	**1.2 ± 1.1**
	Higher secondary	5.3 ± 1.0	1.4 ± 0.3	1.8 ± 1.0	**2.0 ± 1.4**
	Other professional education	5.3 ± 0.8	1.4 ± 0.4	2.2 ± 1.1	**2.5 ± 1.9**
	Undergraduate	5.0 ± 1.2	1.4 ± 0.3	2.1 ± 0.9	**2.4 ± 1.4**
	Graduate	5.3 ± 1.2	1.4 ± 0.3	2.1 ± 0.9	**3.0 ± 1.7**
Distance	<5 km	5.2 ± 1.1	1.4 ± 0.3	2.0 ± 1.0	2.6 ± 1.6
	5-20 km	5.2 ± 1.2	1.4 ± 0.3	2.1 ± 1.1	2.4 ± 1.7
	20-35 km	5.2 ± 1.3	1.4 ± 0.3	1.9 ± 0.9	2.3 ± 1.8
	35-50 km	5.3 ± 1.2	1.4 ± 0.4	2.0 ± 0.8	2.8 ± 1.6
	>50 km	5.0 ± 1.1	1.4 ± 0.4	2.0 ± 1.0	2.3 ± 1.2
Marine-related profession	Yes	**5.4 ± 1.2**	1.4 ± 0.3	**2.2 ± 1.0**	**3.1 ± 1.7**
	No	**5.1 ± 1.1**	1.4 ± 0.3	**1.9 ± 0.9**	**2.2 ± 1.4**
Elasmobranch consumption	Yes	5.6 ± 1.4	1.3 ± 0.5	2.0 ± 1.1	3.0 ± 2.0
	No	5.1 ± 1.2	1.4 ± 0.3	2.0 ± 0.9	2.5 ± 1.6

Survey measures and variables

Demographics

Demographic information including gender, ethnic background, age, and level of education were collected in the survey. Gender was divided into two categories, *male* and *female*. Ethnic background was divided into two categories, *Greek Cypriot* and *Turkish Cypriot*. Age was divided into seven categories (*less than 18, 18-24, 25-34, 35-44, 45-54, 55-64, more than 65 years*) and education into six categories (*Primary school, Secondary school, High school, Professional degree, Undergraduate degree, Graduate degree*).

Connectiveness to the marine environment

Information was gathered on the distance (km) participants live from the nearest coast, if their profession was related to the marine environment, if they consume sharks and rays, their activities in relation to the marine environment, and their education about the marine environment. The distance they live from the nearest coast was grouped into four categories (*less than 5 km, 5-20 km, 20-3 5 km, 35-50 km, more than 50 km*). Based on the participants' profession, a marine-related profession variable was created and divided into two categories, yes = related and no = unrelated, and then was transformed into a binary scale (1 = related; 0 = unrelated). Participants were asked to select a range of activities to express their connection to the marine environment such as *fishing, swimming/snorkelling, SCUBA diving, walking/ spending time by the sea, other (specify),* and *no connection*. Responses to these items were coded as single binary variables (1 = related activity; 0 = no activity, no connection) to measure connection to the marine environment. Binary results were then summed into a single number for each participant separately. Similarly, participants were asked to select from a range of activities to quantify their marine-related education such as *reading relevant books and articles, watching nature documentaries and videos, visits to aquariums, attendance at events concerning marine and other environmental issues, social media, other (specify)* and *no-related education*. Responses to these items were coded as single binary variables (1 = related activity; 0 = no activity, no education) to measure marine-related education. Binary results were then summed into a single number for each participant separately. Elasmobranch consumption factor was divided into two categories, yes = elasmobranch consumption and no = no consumption.

To evaluate participants' overall connectiveness to the marine environment, the marine connectiveness (MC) index was calculated based on the sum of their responses regarding the marine-related profession, marine-related activities, and marine-related education. The equation was expressed as follows:

$$\text{MC index} = \text{marine related profession} + \text{marine related activities}_{sum} + \text{marine related education}_{sum}$$

Public elasmobranch knowledge (PEK)

A set of 17 questions were used and coded into a binary scale (1 = Correct; 0 = Wrong). The first part (Score PEK1) regarding participants' general knowledge on elasmobranchs consisted of the following questions: *Did you know that the general name of sharks and rays is elasmobranchs? a) Yes, b) No; Sharks and rays are a type of fish? a) True, b) False; Sharks are long-bodied animals? a) True b) False; Rays are flat-bodied animals? a) True b)False; All sharks and rays are a potential threat to humans? a) True, b) False; Sharks have to come to the surface to breathe? a) True, b) False; Sharks and rays are an important part of marine ecosystems? a) True, b) False; Sharks and rays do not exist in Cyprus? a) True, b) False.* The second part (Score PEK2) regarding participants' knowledge on elasmobranchs and fisheries was composed of the following questions: *What do you consider to be the threats to sharks and rays? a) Commercial fishing, b) Habitat degradation, c) Climate change, d) Pollution, e) Don't know (+1 score for every correct answer); Sharks and rays are commercially fished in Cyprus? a) True, b) False; Sharks and rays are caught accidentally when fishing other species? a) True, b) False; Shark and ray meat is traded and consumed in Cyprus? a) True, b) False.* The third part (PEK3) aimed to evaluate participants' knowledge on elasmobranch conservation and consisted of the following questions: *Global sharks and ray populations are declining? a) True, b) False; Did you know that more than half of shark and ray species are threatened in the Mediterranean? a) Yes, b) No; Do you know any shark that is protected? a) Yes (Please name one), b) No; Did you know that most shark and ray species are prohibited to be traded in Cyprus? a) Yes, b) No; Are you aware of any shark and ray conservation projects or initiatives? a) Yes (Please name one), b) No.*

The total score of each PEK was calculated and then the scores were standardised by using a weighted mean as follows:

$$\text{PEK index} = (\text{PEK1}_{sum} \times 0.10) + (\text{PEK2}_{sum} \times 0.50) + (\text{PEK3}_{sum} \times 0.40)$$

The selection of score weights was chosen based on our perceived relative importance of each PEK section towards elasmobranchs' conservation.

Public attitude (PA) towards elasmobranchs

A set of 5 questions were asked and coded into a binary scale (1 = positive; 0 = negative). Positive means that the response is conducive to elasmobranch conservation. Q1: *Do you consider sharks and rays to be dangerous? a) Yes, b) No;* Q2*: Do you believe that sharks and rays should be protected? a) Yes, b) No;* Q3: *Do you believe*

that we should continue to fish sharks and rays? a) Yes, b) No; Q4: *Do you believe that we should continue to trade and consume shark and rays? a) Yes, b) No;* Q5: *Would you kill one of these species deliberately? a) Yes, b) No.*

The score of each question was calculated and then standardised by using weighted mean as follows:

$$\text{PA index}=(Q1\times0.10)+((Q2+Q3+Q4)\times0.30)+(Q5\times0.60)$$

The selection of score weights were chosen based on our perceived relative importance of each question towards elasmobranch conservation.

Data analysis

The data were analysed in two phases. First, correlations and mean comparisons between the different parameters and PEK index and PA index were explored using nonparametric tests. Secondly, a partial least squares path model was conducted to test the hypothesised relationships between participants' characteristics and PEK, LA and elasmobranch consumption.

All the statistical analyses were performed with the R software (R Core Team, 2020) and the partial least square model with the SmartPLS software (Ringle *et al.,* 2015). Statistical significance at $a<0.01$ was used for all multiple comparisons statistical tests to account for the increasing probability of type I error multiple testing. Standard deviation is referred in the text as ±.

The data were explored using descriptive statistics. A Shapiro-Wilk's normality test, frequency density and q-q plots were used to test for normality prior to any other statistical analysis tests. A non-parametric Spearman rank correlations test was performed to explore the intensity of all possible associations between PEK index, PA index, MC index, marine-related activities, and marine-related education. A Mann-Whitney test was conducted to test for differences between PEK index, PA index, marine-related activities, and marine-related education with gender, marine-related profession, and elasmobranch consumption. A Kruskal-Wallis test followed by a post-hoc Dunn's test was conducted to explore relationships between PEK index, PA index, marine-related activities and marine-related education with age, education, and distance from the coast. Finally, a Pearson's chi-square test was conducted to explore the relationships between gender and level of education.

To test the hypothesised relationships between participants' characteristics, PEK, LA and elasmobranch consumption, the Partial Least Square Structural Equation Model (PLS-SEM), a non-parametric path regression modelling technique was performed. This prediction or exploratory modelling method allows estimating complex cause-effect relationships between latent and manifest (observed) variables. PLS-SEM is composed of two sub-models, the measurement, and the structural model. The measurement model assesses the relationships between latent variables and observed data while the structural model assesses the relationships between the latent variables themselves. The exogenous variables (latent variables and observed predictors) are independent variables not presumed to be caused by other latent variables in the model. The endogenous variables (observed variables) are variables assumed to be caused by at least one latent variable in the model (Hair *et al.,* 2014; Hair *et al.,* 2016). The PLS-SEM has been applied in social sciences such as in business, operations (Peng & Lai, 2012; Sarstedt *et al.,* 2014) and strategic management (Hair *et al.,* 2012), accounting (Nitzl, 2016; Nitzl & Chin, 2017) tourism (Rasoolimanesh *et al.,* 2017) medicine (Berglund *et al.,* 2013) and ecology (Brewer *et al.,* 2012; Peppler-Lisbach *et al.,* 2015; Cebrián-Piqueras *et al.,* 2020). The latent variables (marine-related activities + marine-related education = Engagement with marine environment; gender + age + level of education + marine-related profession = Socio-demographics; distance from the nearest coast = Coast-distance parameter) were applied to the model to test how highly they predicted elasmobranch knowledge (PEK). Then, the PEK was tested to predict its effect on participants' attitude towards elasmobranchs (PA index) and elasmobranch consumption. The goodness of fit was evaluated based on the average variance extracted (AVE) and composite reliability (CR). CR is a measurement test of convergent validity and varies from 0 to 1 (with 1 being perfect estimated reliability) and values equal to or greater than 0.70 indicate high reliability (Hair *et al.,* 2017). AVE is a test to measure both convergent and divergent validity and values greater than 0.50 indicate convergent validity and adequately of the model (Hair *et al.,* 2017). Bootstrapping is a resampling technique that creates a larger number of random subsamples from the original dataset and estimates models for each subsample. A bootstrapping test with 10,000 subsamples (following the methodology of Cebrián-Piqueras *et al.,* 2020) was conducted to evaluate the structural model path coefficients (generally, a test of more than 5,000 subsamples is recommended for the stability of estimates; Hair *et al.,* 2017).

Results

Demographics

A total of 364 people engaged with the survey and 261 completed the survey (response rate = 72%), all of which were residents of Cyprus and 177 were Greek Cypriots and 84 were Turkish Cypriots. Among the participants, 157 (60%) were male and 104 (40%) were female. The age of participants ranged from under 18 years old to older than 65 years old. The age group with the most participants was between the ages of 25 and 35 (30%, $n = 77$) and the least group was the 65 plus (2.3%, $n = 6$) (Fig. 2).

Ninety-eight respondents (37.5%) had an undergraduate degree, 97 (37.1%) had a post-graduate degree, 44 (16.9%) graduated from higher secondary school, 15 (5.7%) had completed a professional degree, 5 (1.9%) graduated from lower secondary school and 2 graduated from primary school (Fig. 3). No relationship was detect-

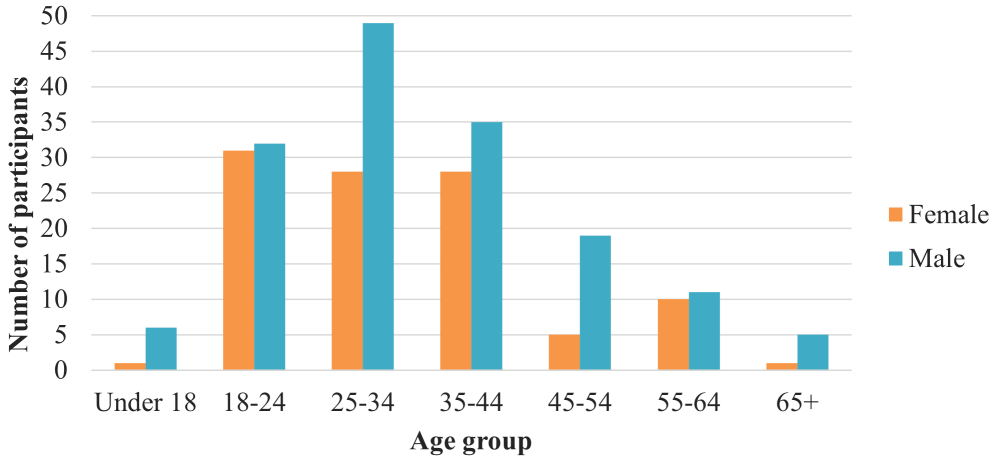

Fig. 2: Number of participants separated by age group and gender.

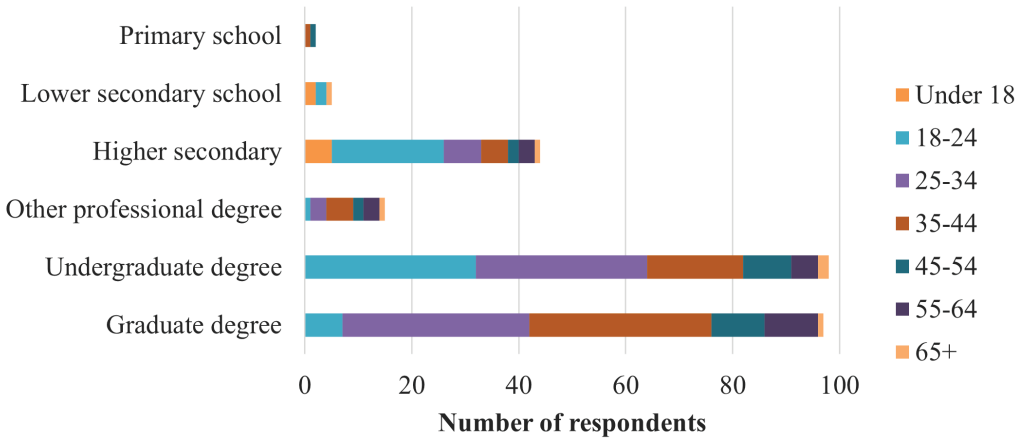

Fig. 3: Level education of participants separated by age groups.

ed between gender and level of education ($\chi^2 = 3.1281$, df = 5, $p = 0.68$). Detailed information on descriptive statistics is shown in Supplementary Table 3.

Public knowledge on and attitude towards elasmobranchs

The mean PEK index was 5.2 ± 1.2 and ranged between 1.2 to 7.7 and the mean PA index was 1.4 ± 0.3 and ranged between 0 to 1.6. Supplementary Table 3 shows the total number of the participants' responses to each question of the questionnaire regarding the elasmobranch knowledge and attitude.

Regarding the question of participants' knowledge on any sharks and rays conservation project or initiative, results showed that 29.1% of participants were aware of such project or initiative. Among the projects/initiatives reported by participants, only four were projects and initiatives (Cyprus Bycatch Project, CERECON, Shark Advocates International, Action Plan for Mediterranean Angel Sharks) while the rest of the responses were NGOs, charity organisations, and one governmental institution. The most-reported answers were the CERECON project (26.7%), followed by the Cyprus Bycatch Project (13.3%) and the NGO iSea (10%) while the rest of the responses were reported only one time (3.3%).

Connectiveness to marine environment

The distance that participants live from the nearest coast was considered as a factor for participants' connectedness to the marine environment. Among the participants, 92, 55, 38, 54 and 22 live at a distance from the nearest shore of less than 5 km, 5-20 km, 20-35 km, 35-50 km and more than 50 km, respectively.

Participants were also asked to state their profession. According to their answers, participants were grouped to 'Yes' ($n = 170$) if their profession was related in some way to the marine environment and to 'No' ($n = 91$) if their profession had no relevant connection to the marine environment. Examples of marine-related professions were: environmental consultant, natural life and landscape artists, bachelor or master students on marine sciences, project officers on environmental projects, business owners of sustainable and eco-friendly products concerning the marine environment, marine biology and ecology graduates, business owners of diving centres and water sports, academics and professionals in marine and maritime sci-

ences and professionals from the tourism industry.

The mean marine-related activities were 2.0 ± 1.0 and ranged between 0 to 5 and the mean marine-related education was 2.5 ± 1.6 and ranged between 0 to 7. The most common marine-related activities that the participants reported undertaking were walking and spending time by the sea and swimming and snorkelling (Fig. 4). Only 3% reported not taking any form of activity related to the marine environment. Watching nature documentaries and videos, social media and reading relevant books and articles were among the most common responses of the forms of education related to the marine environment. Among the respondents, only 11%, reported that they did not have any marine-related education (Fig. 5).

Comparisons and correlations between dependent and independent variables

The mean (±SD) PEK index, PA index, marine-related activities and marine-related education of the independent variables gender, ethnic background, age, education, distance, marine-related profession and elasmobranch consumption are shown in Table 1. Results from the Mann-Whitney test revealed that the PEK index (W = 7070.5, p = 0.07) and PA index (W = 7417.5, p = 0.2) were not significantly different between males and females. Marine-related education was significantly different between genders, with males having higher scores than females (W = 7024, p = 0.05) but not in marine-related activities (Table 1; W = 7139, p = 0.07).

Comparisons between ethnic backgrounds (Greek Cypriot and Turkish Cypriot) and PEK index (W = 6543.5, p = 0.18), PA index (W = 6743, p = 0.17), marine-related education (W = 6514.5, p = 0.10) and marine-related activities (W = 7476.5, p = 0.94) revealed no significant differences.

No significant differences were detected between PEK index (χ^2 = 46.6, df = 52, p = 0.7), PA index (χ^2 = 13.8, df = 9, p = 0.1), marine-related activities (χ^2 = 1.2, df = 5, p = 0.9) and marine-related education (χ^2 = 8.3, df = 7, p = 0.3) among ages.

PEK index (χ^2 = 49.9, df = 52, p = 0.6), PA index (χ^2 = 10.2, df = 9, p = 0.3) and marine-related activities (χ^2 = 1.3, df = 5, p = 0.9) were not significantly different with levels of education. However, marine-related education was significantly different among participants with different levels of education (χ^2 = 14.5, df = 7, p = 0.04). The post-hoc Dunn's test revealed that marine-related education was significantly different between Graduate and Higher secondary (p < 0.01), Graduate and Primary (p = 0.03), Graduate and Lower secondary (p = 0.02) and Graduate and Undergraduate (Table 2; p = 0.02).

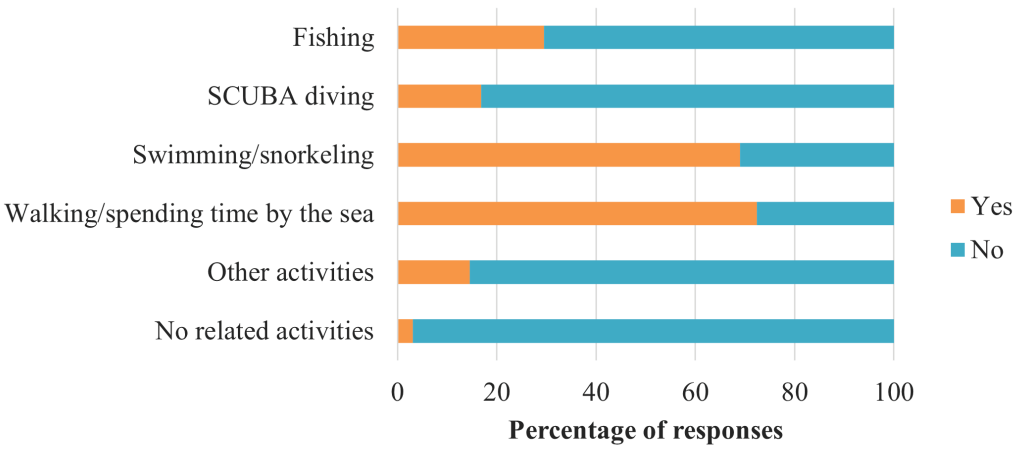

Fig. 4: Respondent's responses (Yes or No) in percentage of activities undertaken concerning the marine environment.

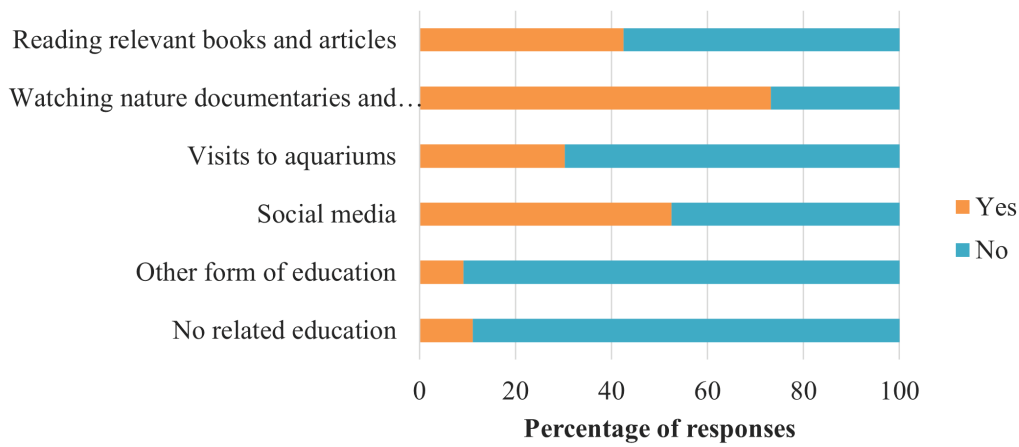

Fig. 5: Respondent's responses (Yes or No) in percentage of education undertaken concerning the marine environment.

Table 2. Spearman rank correlation coefficients (rho) between marine connectiveness variables and indices. Spearman's confidence level = 0.95. Significant correlations ($p < 0.01$) are indicated in bold.

Variable	Marine-related activities	Marine-related education	MC index	PEK index	PA index
Marine-related activities	1.00				
Marine-related education	**0.43**	1.00			
MC index	**0.71**	**0.91**	1.00		
PEK index	**0.27**	**0.40**	**0.98**	1.00	
PA index	**0.15**	**0.26**	**0.48**	**0.33**	1.00

No significant differences between PEK index (χ^2 = 49.9, df = 52, p = 0.6), PA index (χ^2 = 6.8, df = 9, p = 0.7), marine-related activities (χ^2 = 5.9, df = 5, p = 0.3) and marine-related education (χ^2 = 3.2, df = 7, p = 0.9), with participants' living distance from the nearest coast.

Significant difference was detected between PEK index (W = 6597.5, p = 0.05), marine-related activities (W = 6558.5, p = 0.03) and marine-related education (W = 5374.5, $p < 0.01$) and profession but no difference between PA index (W = 7261.5, p = 0.4) and profession.

Among the participants, 92% replied that they do not consume elasmobranchs. Among the participants who reported consuming elasmobranchs, 14 were Greek Cypriots (67%) and 7 (33%) Turkish Cypriots. It is worth mentioning here that elasmobranch consumption and trade is not prohibited within the Turkish Cypriot community. The Mann-Whitney test revealed no significant difference between PEK index (W = 1889, p = 0.06), PA index (W = 2622, p = 0.7), marine-related activities (W = 2613, p = 0.8) and marine-related education (W = 2230, p = 0.4) with elasmobranch consumption.

The Spearman's rank correlation test revealed that the variables 'marine-related activities', 'marine-related education', PEK index, PA index and MC index were all positively correlated with each other (Table 2).

PATH modelling

Among the variables, only 'Engagement with marine environment' had values greater than 0.5 and 0.7 of average variance extracted (AVE) and composite reliability (CR), respectively (Table 3). The total effects of the partial least square structural model between the variables are shown in Table 4 and the final model displaying the significant and non-significant pathways as well as the indicator variables is shown in Figure 6. The latent predictor 'Socio-demographics' and the observed predictor variable 'Coast-distance gradient' showed weak predictive power on the latent variable PEK index, whereas the latent predictor 'Engagement with the marine environment' showed very strong predictive power on PEK index. PEK index was a strong predictor on PA index and a weak predictor on 'Elasmobranch consumption'.

Discussion

Drivers of elasmobranch knowledge and effects on attitude

The results of this study support the concept that marine-related education and marine-related activities have the strongest effects on people's elasmobranch knowl-

Table 3. Results of partial least square structural model showing the Average Variance Extracted (AVE), Composite Reliability (CR) and R square (R^2) of latent variables and observed predictors.

Latent variables	AVE	CR	R^2
PEK index	0.293	0.554	0.178
PA index	0.250	0.250	0.064
Engagement with marine environment	0.730	0.844	
Socio-demographics	0.090	0.029	
Observed predictors	**AVE**	**CR**	**R^2**
Coast-distance gradient	0.232	0.007	
Elasmobranch consumption	1.000	1.000	0.002

Table 4. Results of partial least square structural model showing the total effects between the exogenous variables and latent and endogenous variables including sample mean values, Standard deviation (SD), T values and *p* values. Significant correlations indicated in bold.

Total Effects	Sample Mean	SD	T value	*p* value
Engagement with marine environment -> PA index	0.080	0.029	2.858	**0.004**
Engagement with marine environment -> Elasmobranch consumption	0.013	0.028	0.484	0.628
Engagement with marine environment -> PEK index	0.315	0.051	6.297	**0.000**
PEK index -> Attitude towards elasmobranch	0.214	0.068	3.122	**0.002**
PEK index -> Elasmobranch consumption	0.043	0.089	0.472	0.637
Socio-demographics -> PA index	0.056	0.043	1.112	0.266
Socio-demographics -> Elasmobranch consumption	0.010	0.024	0.325	0.745
Socio-demographics -> PEK index	0.217	0.149	1.255	0.209
Coast-distance parameter -> PA index	-0.010	0.033	0.607	0.544
Coast-distance parameter -> Elasmobranch consumption	-0.002	0.013	0.264	0.792
Coast-distance parameter -> PEK index	-0.037	0.128	0.619	0.536

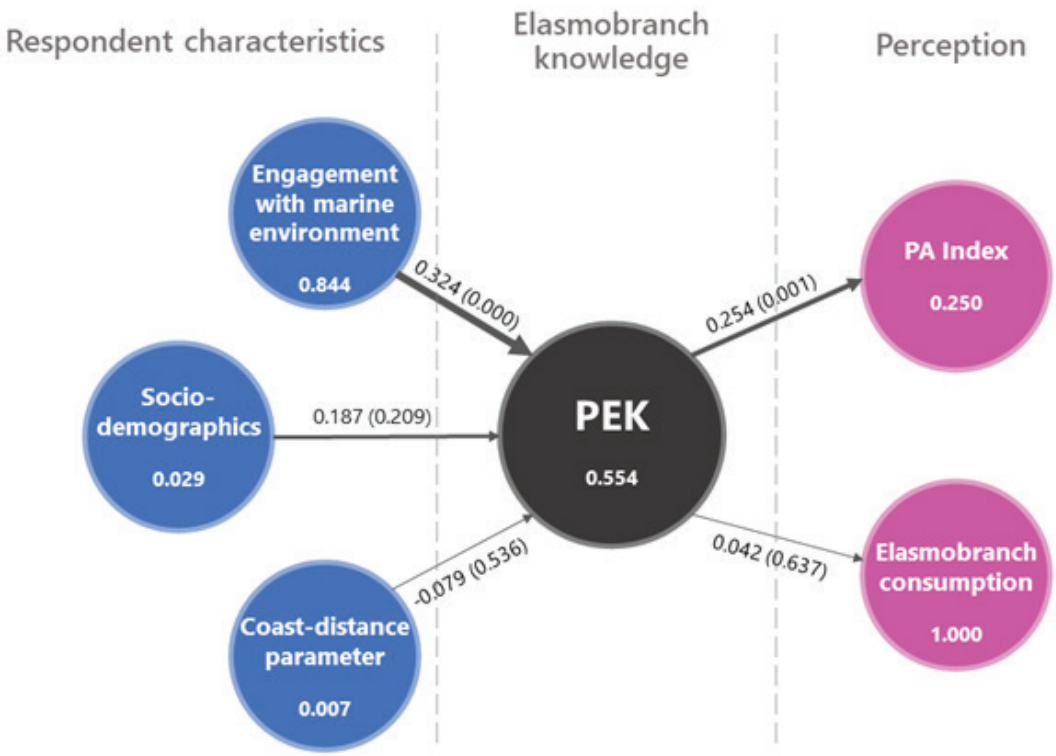

Fig. 6: PLS path model results showing relationships among study variables, including two latent variables (Engagement with marine environment; Socio-demographics) and one observed predictor (Coast-distance parameter) that influence the latent variable, PEK index, which then explain one latent variable (Attitude towards elasmobranchs) and one observe variable (Elasmobranch consumption). The Composite reliability values are displayed within the circles of the endogenous variables. Values on the highlighted paths linking the variables (use relative values) show Path Coefficients and *p* values (in brackets).

edge and on their attitude towards elasmobranchs. These findings support those of previous studies which have shown that a higher degree of nature-related activities and education predicted a higher level of public ecological knowledge (Cebrián-Piqueras *et al.,* 2020). The increasing PEK index was strongly positively correlated with PA index indicating the positive effect of knowledge on participant attitude towards the environment and wildlife, demonstrating a clear relationship between education and positive conservation outcomes for elasmobranchs. Like previous studies, increased knowledge on a species or certain taxa positively affects people's behaviour and at-

titude of becoming more supportive towards species conversation (Barney *et al.,* 2005; O'Bryhim and Parsons, 2015; Giovos *et al.,* 2021). However, results showed that PEK index does not affect the consumption of elasmobranchs. This may be because several elasmobranch species are legally sold and consumed in Cyprus like the *Dasyatis* spp., *Raja* spp., *Squalus blainville*, *Mustelus* sp., and *Prionace glauca*; indeed, in the Turkish Cypriot community, all species except *Carcharhinus plumbeus* and *Cetorhinus maximus* are open to trade and consumption as there is currently no legislative framework that protects these species. In the Greek Cypriot community, several elasmobranch species are prohibited to catch, retain on board, tranship, land and sell in the market following the recommendations by the GFCM (GFCM/36/2012/3) and ICCAT (ICCAT 09-07) and European regulations (EC 1185/2003; EU 2019/1241). However, there are unreported cases were prohibited to land elasmobranch species were gutted, filleted, and sold in the market as a different species. The issue of mislabelling has been reported elsewhere (Bornatowski *et al.,* 2013; Pazartzi *et al.,* 2019). Even though there are differences in the legislation for the protection of marine species between the two communities, there were no significant differences between PEK index, PA index and marine-related education and marine-related activities. This is a clear indicator that legislation and policy is not a major factor that could affect and shape people's knowledge and attitude towards biodiversity and conservation. The results also showed that gender, age and level of education do not affect elasmobranch-related knowledge and attitude which is contrary to some other studies (O'Bryhim & Parsons, 2015; Tsoi *et al.,* 2016; Lama *et al.,* 2018; Alfonso *et al.,* 2021).

Marine-related education and marine-related activities were the strongest predictors of a participant's knowledge and attitude towards elasmobranchs. The study underlined the importance of documentaries, social media and other forms of visual and extra-curricular education as well as the participation in marine-related activities on shaping people's attitude towards elasmobranchs (e.g. Giovos *et al.,* 2021). Marine-related education was significantly different between sexes and educational ranks. Males and respondents with a superior degree (professional, undergraduate, graduate degree) had a higher value of marine-related education. This could be explained due to the differences among the sample size, as male participants (60%) were higher than females and that 80.3% of participants held a superior degree. The most-reported marine-related activities by participants were walking and spending time by the sea, swimming and snorkelling, and fishing. These activities are among the most common summer activities undertaken by locals and as well as tourists in Cyprus (Charalambous & Violaris, 2021). Considering the strong impact of marine-related education and activities on people's knowledge on a specific subject and hence, on their attitude, as well as the different forms of activities and education for obtaining this knowledge, it is therefore suggested that awareness campaigns of a marine-related subject/issue should be focused and developed around these means. For example, a combination between a marine-related activity and media to educate the public such as a short awareness video posted on social media and/or displayed at common public beaches during the summer could have a high awareness impact.

The distance that people live from natural environments like mountains, forests, rural and coastal areas could have significant effects on people's local ecological knowledge (Cebrián-Piqueras *et al.,* 2020). Our results revealed that the distance that people live to a coastal area did not affect their knowledge on elasmobranchs. However, it is important to mention that in Cyprus the farthest resident lives within an hour's car journey away from the nearest coast. It is therefore expected that this factor could affect people's PEK who live in countries with large distances to natural environments.

A marine-related profession was also considered as a potential factor to affect PEK. The results showed people with a marine-related profession had significantly higher PEK on elasmobranchs than those without. This is a particularly important factor when evaluating PEK. Examples have shown that people with a related profession tend to have high local ecological knowledge and therefore more likely to participate in conservation activities and management of natural resources (Gadgil *et al.,* 2002).

Opportunities for elasmobranch conservation and citizen science projects

Among the four projects and initiatives reported by participants were the CERECON and the Cyprus Bycatch Projects which are both local Cyprus-based projects and aim towards the conservation of marine vulnerable species including elasmobranchs. These two projects as well as their activities and findings have been extensively communicated through social media platforms and have gained over 12,000 followers since 2019. In Cyprus, there were 990,000 Facebook users in 2020, which accounted for 80% of the entire population of the country (NapoleonCat, 2020). The use of social media networks has significantly increased over the years around the world. In 2020, over 3.6 billion people were using social media and 6.05 billion people were using smartphones worldwide (Statista Research Department, 2021). The number of social media users is projected to increase to 4.41 billion by 2025. Considering the above information, social media networks and smartphones can offer massive opportunities for spreading knowledge and awareness on a topic/issue (Newman *et al.,* 2012) as well as to engage more people in citizen science (CS) projects (Bargnesi *et al.,* 2020). Changes in the attitude of people towards elasmobranchs could also have a beneficial effect on engaging more citizens in CS projects. It is also expected that CS projects would be more effective when educational efforts and awareness campaigns accompany them (Bargnesi *et al.,* 2020). CS publications have rapidly increased since 2014, however very few of these publications dealt with shark research (Bargnesi *et al.,* 2020).

Future research direction for assessing public elasmobranch knowledge

Attitudes and perceptions toward species conservation can be acquired through early social or cultural experiences. According to Bandura's social learning theory, learning can be a cognitive process that creates a learning attitude through early social or cultural experiences. (Bandoura, 1986). For example, in France, there is a higher consumption of snails and frogs compared to other countries around the world (Bartkowicz, 2020). These species form part of the common French diet that has been passed down through generations, forming part of the French culture. Thus, the specific attitudes that are held towards marine life in the Cypriot population, could be learned behaviours taught from family backgrounds. For example, citizens who grew up in a family of fishers may be more likely to consume fish, compared to one who has no fisheries background. A person who learns to consume this kind of food from the early years of life is more likely to continue this behaviour as an adult. Likewise, activities, hobbies and education undertaken by peers and family could significantly affect the habits of an individual. Nature-related activities like hiking, SCUBA diving, snorkelling and recreational fishing, and visits to aquariums and natural history museums are forms of entertainment. If the majority in a group of people engage in such activities, it is likely that the rest of the group may conform and follow, known as social conformity (Asch, 1956). In other words, peers and social conformity could also be a potential factor that explains marine-related attitudes from the Cypriot population. It is thus suggested that the above demographics, fisheries-related family background and peers, are potential demographic factors to be investigated in further research on the subject as they haven't been addressed in the current study nor in other shark-public knowledge related studies.

A clear caveat of our survey was its bias toward the social media community that follow the two partner marine conservation NGOs. Systematically engaging all demographics in a representative way would have been preferable, but required additional research to understand the composition of the population, to ensure representative coverage of all the various citizen groups. Here we used a novel method to acquire information that would be of relevance to conservation, at relatively little financial outlay. Participants, therefore, are expected to have a greater-than-average interest in the marine environment, nature, conservation and may represent demographics with greater access to educational resources. The study therefore could have excluded important demographics, such as marginalised rural communities, where fishing is an important source of food and where trade in and consumption of elasmobranchs may be more significant. The two NGOs participating in the study could investigate and address these biases in their social media following, by targeting their paid outreach to such demographic groups, or through in-person questionnaires with target demographic groups. Whilst this action could improve the robustness and sample size of similar studies, conservation outcomes of raising awareness in those excluded demographics (rather than preaching to the converted) could be particularly high.

Implications on elasmobranch conservation

The findings of the current study show the strong effect of marine-related education and marine-related activities on ecological knowledge and citizen's attitude towards elasmobranchs. The study also provided insights into the different forms of marine-related education and activities undertaken by the participants of this study, such as watching documentaries, reading books/articles, information from social media posts and activities like fishing, diving, and spending time by the sea, which will be useful in informing and developing advocacy actions towards elasmobranch conservation. It is also very likely that citizens who encompass these characteristics and values will support conservation actions and come into conflict over inappropriate behaviours towards elasmobranchs and bad media portrayals. Such efforts could be best targeted at specific stakeholder groups/demographics that are actively interacting with elasmobranchs (commercial and amateur fishers, fisheries workers, fishing communities, etc.).

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Supplementary Data

The following supplementary information is available online for the article:

Table 1: Overview of variables; **Table 2:** Dataset; **Table 3:** Descriptive statistics; **Table 4:** Normality test for PEK index and PA index; **Table 5**: Output from Spearman's correlation calculation; **Table 6:** Comparison of parameters with PEK index and PA index; **Table 7:** Results of PLS-SEM.