Ecol Res (2018) 33: 1125–1135
DOI 10.1007/s11284-018-1621-1

ORIGINAL ARTICLE

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Perceptions of nature conservation by future biologists attending private universities in São Paulo State, Brazil

Received: 23 November 2017 / Accepted: 10 May 2018 / Published online: 19 May 2018

Abstract As conservation agents, biologists play a central role in nature preservation as information-gatherers, promoters of environmental education, lobbyists, and members of societies. Consequently, it is important to understand what factors determine their attitudes towards conservation. We aimed to assess which taxa and recovery measures students from biology core courses consider priorities for conservation and to determine the value students associate with conservation compared to other topics. We asked students (n = 122) from two private universities in São Paulo State, Brazil to fill out an anonymous questionnaire. They highlighted rarity, vanishing habitats and endemism as important criteria in prioritizing species. Carnivores were identified as the most threatened mammals and habitat recovery was deemed to be the most efficient conservation action. Students valued healthcare, cultural heritage and science over conservation. Our results reveal a two-sided perspective of conservation among students from biology core courses; they possess knowledge of conservation issues but are greatly influenced by anthropocentric and utilitarian views of nature.

Keywords Brazil · Graduate students · Questionnaire · Attitudes · Core biological sciences

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11284-018-1621-1) contains supplementary material, which is available to authorized users.

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Introduction

Conservation biology emerged in the 1980s as a new discipline aimed at understanding and protecting biological diversity at all scales and all levels of biological organization (Meine 2010). To be successful, conservation biology requires a multifaceted approach involving fields as distinct as genetics, ecology, biogeography and an array of social sciences (Lindenmayer and Burgman 2005). Social/individual perspectives are a crucial element of the conservation puzzle and they are increasingly being addressed by conservation biologists.

The Society for Conservation Biology recognizes this significant role of the social dimension in conservation, stressing that education at all levels is an important way of informing the general public, managers, and environmental professionals about the principles of conservation biology and driving pro-conservation actions (Trombulak et al. 2004). Moreover, education improves knowledge accessibility and raises environmental consciousness, which together can change attitudes regarding conservation values (Jacobson 1990; Caro et al. 1994) and aid in the sustainable development of human communities. However, apart from a person's level of education, attitudes towards nature conservation are influenced by many other factors, such as social class (Van Liere and Dunlap 1980; Samdahl and Robertson 1989), economic status (Yilmaz et al. 2004), cultural background (Skogen 1999), area of residence (Berenguer et al. 2005), and school type and gender (Schultz 2001; Tuncer et al. 2005). Consequently, different societal groups can present distinct attitudes towards conservation, which need to be evaluated. For example, in China, teachers and students showed a more pro-conservation attitude towards the Protected Area of Jinyun Mountain than did farmers or businessmen (Liu et al. 2010), as they were more involved in touristic activities within the park, while farmers and businessmen were focused on economically profitable ones. In Greece, a similar pattern was detected among students who showed more pro-environmental

attitudes because they had easier access to information than did farmers and other primary or non-primary sector stakeholders (Kleftoyanni et al. 2011).

Biologists are central to nature conservation, acting as information gatherers (collection, analyses and discussion of ecological patterns and processes), promoters of environmental education (through outreach), lobbyists and as members of conservation societies. To ensure the success of nature conservation actions—from defining conservation plans, implementing and managing fieldwork, to disseminating information through outreach activities—it is important to understand what factors determine the attitudes towards conservation of students from biology core courses. According to Van Liere and Dunlap (1980), degrees of environmental concern can be directly associated with age, gender, social class and place of residence. As these factors may be geographically dependent (i.e., based on cultural, economic, religious, or educational variation between countries/regions; Chang 2010), it is crucial to understand regional patterns to facilitate successful implementation of large-scale conservation initiatives.

Mammals are considered a 'flagship' and charismatic taxon (Ceballos et al. 2005) and are often used as models in conservation planning. However, although most mammalian orders include threatened species, their relationships with humans vary greatly; some species are widely accepted as conservation priorities (e.g. Giant panda, *Ailuropoda melanoleuca*; Kontoleon and Swanson 2003), whereas others elicit antagonism due to competition with human activities (e.g. giant otter, *Pteronura brasiliensis*; Lima et al. 2014), fear (tigers, *Panthera tigris*; Kruuk 2002), or cultural/historical myths (e.g. bats; Prokop et al. 2009a). Moreover, the same species/groups can generate a wide range of perceptions, depending on the stakeholder or region (Linnell et al. 2013). Thus, regional evaluations of which mammalian groups are considered priorities for conservation is important to facilitate appropriate environmental education strategies, especially in biodiversity hotspots such as Brazil (Myers et al. 2000). Furthermore, such evaluations are more relevant when the target population will become responsible for generating ecological data, defining/implementing conservation action plans, and participating in outreach activities, i.e. biologists. Given the varied strategies that can be implemented to achieve sustainable conservation of threatened populations (e.g. habitat recovery, definition of protected areas) (Lindenmayer and Burgman 2005), it is important to understand how future biologists rank these strategies. This will help universities to determine if the information being transmitted to students regarding recovery measures are successfully perceived by them.

Several studies have addressed how the attitudes of students towards nature conservation are determined by socio-economic contexts, but most have focused on earlier stages of education (e.g. elementary and middle school). For example, the attitudes of young students are determined by different factors such as area context (urban vs rural) in Turkey (Yilmaz et al. 2004), parents' education level in Portugal (Rosalino and Rosalino 2012), or nature experiences in Greece (Paraskevopoulos et al. 1998). The importance of conservation among species also can vary, with charismatic species being preferred over species that instill fear (e.g. in Swiss primary schools; Schlegel and Rupf 2010). In the tropics, Bizerril (2004) found that sixth-grade students in the Brazilian Cerrado biome possessed little knowledge of Cerrado natural value; a pattern determined by their unfamiliarity with that natural system. In the Brazilian Pantanal, elementary school students from riverside schools presented a heterogeneous array of attitudes and knowledge towards felines, with bigger species being more feared (Porfírio et al. 2014). Even wider geographical approaches have been implemented, showing that elementary school students from rural Brazil are more prone to have a pro-conservation attitude than those from Europe (Portugal) and urban regions (Rosalino et al. 2017). However, to our knowledge, no study has yet focused on the conservation attitudes of Neotropical university students, especially those undertaking biology courses. Such studies have been conducted elsewhere, such as in Singapore where more pro-conservation attitudes were reflected by income level and biological knowledge among National University of Singapore students (Chua et al. 2008). Similarly, in California (USA), University of California students that already possessed conservation knowledge were more committed to conserving biodiversity (Caro et al. 2003).

The objectives of our study were to: (1) understand how graduate students from biology core courses, from private universities, perceive nature conservation concepts and their applications; (2) assess what are their priorities in terms of which species/groups should be conserved and what recovery measures should be implemented; (3) evaluate how private universities' students attending biology core courses value nature conservation compared to other issues (e.g. cultural heritage, tourism, healthcare, ecosystem services, science, industry, intrinsic and social values), and what factors determine this value system (e.g. individual characteristics, socio-cultural or local contexts). We defined four working hypotheses for our third objective based on patterns detected elsewhere, i.e. that student pro-conservation values are determined by: (1) a student's individual characteristics (e.g. Rosalino et al. 2017); (2) parents' education level (e.g. Rosalino and Rosalino 2012); (3) nature-related experiences (e.g. Paraskevopoulos et al. 1998); or (4) individual values (cultural heritage, tourism, healthcare, ecosystem services, science, industry, intrinsic and social values) (e.g. Caro et al. 2003).

Methods

Study areas and the student population

We conducted our study in 2015, focusing on two private universities located in the countryside of São Paulo

State (Brazil): Universidade do Sagrado Coração (USC), and Fundação Regional Educacional de Avaré (FREA), the campuses of which are located in the municipalities of Bauru and Avaré, respectively (Fig. 1). They represent two of the principle private universities in São Paulo State hosting biology core courses and, therefore, are import actors in the formation of biologists. Regrettably, none of the public universities we contacted would participate in our survey, refusing to issue the legal permits necessary to interview their students. The student population from biology core courses is similar in both locations (USC = 88; FREA = 76 students), the majority of whom work during the day and attend classes in the evening. Consequently, students do not attend extra classes or practical courses related to biology or associated fields.

The biology core course curricula in both universities are similar and fulfill the minimum criteria required by the Brazilian Ministry of Education (Resolução CNE/CES 2009) for graduation in biology. Courses comprise at least three disciplines focused on ecology (population ecology, community ecology, and ecosystems ecology), but none of the university departments focus on nature conservation or conservation biology. Some universities offer optional conservation courses, but they are not mandatory for graduation core courses in biology in Brazil and neither of the universities we monitored do so.

We used a sampling survey approach (i.e. we gathered data from a representative group of the core biology graduate student population of both universities) and only those students that volunteered to participate were included in our study (Fowler 2014).

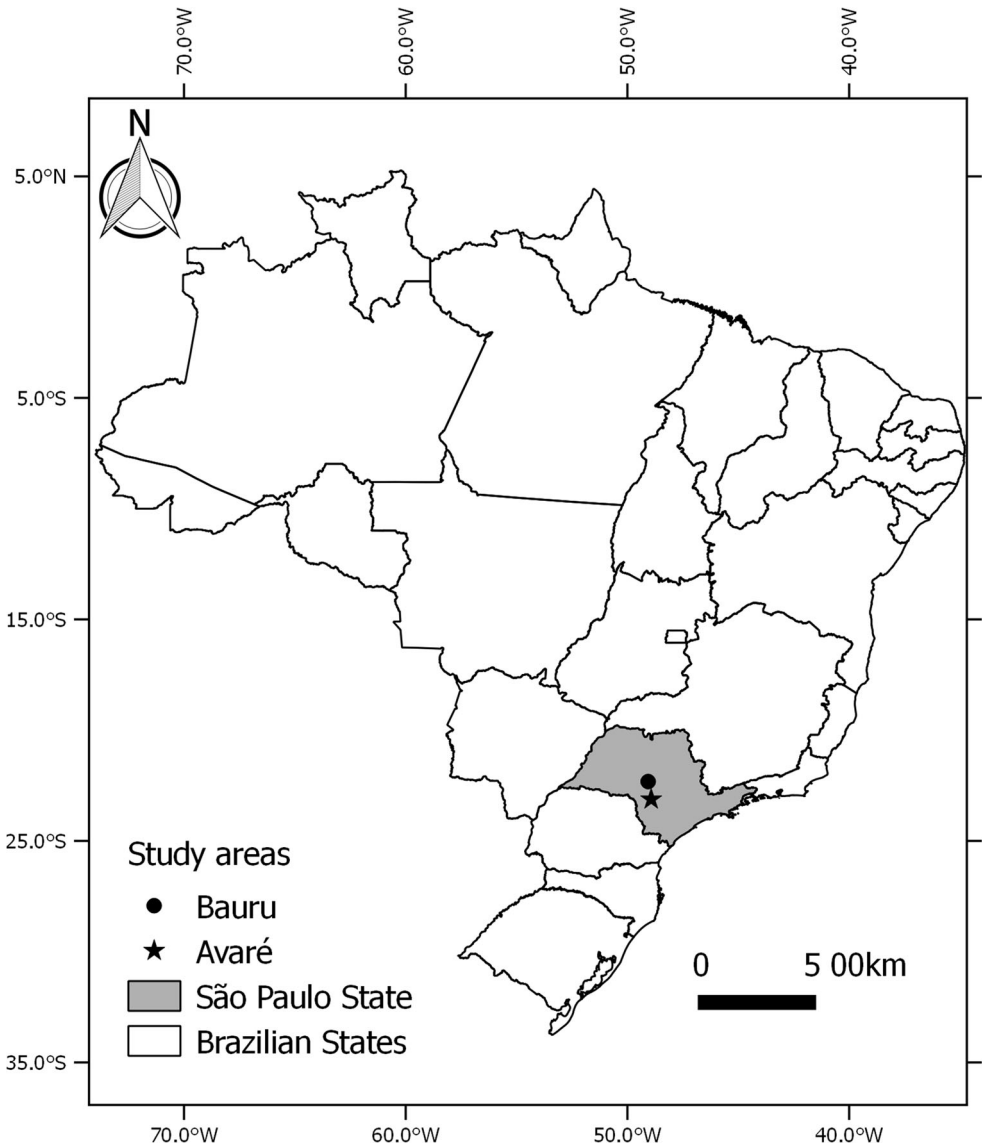

Fig. 1 Location of Bauru and Avaré Municipalities within São Paulo State, Brazil

Questionnaire protocol

Students were asked to anonymously fill out a questionnaire focused on nature conservation issues. The questionnaire was subdivided into six sections (see ESM 1), construction and analysis of which was based on the study by Rosalino and Rosalino (2012):

Section I Aimed at describing the student's perspectives regarding nature conservation in general and their importance in society and school curricula (elementary, colleges and high schools). Three questions were posed: (1) to ensure mankind's survival, nature conservation is…?; (2) citizens' participation in nature conservation actions is…?; (3) the inclusion of nature conservation issues in school (elementary, colleges and high schools) curricula is…? (questions P1–P3 in ESM 1). Students were asked to select among five possible answers based on the Likert scale [1 = not important; 2 = low importance; 3 = no opinion; 4 = important; 5 = highly important; Likert (1932)].

Section II Focused on evaluating the relative importance of different intrinsic individual values (cultural heritage, tourism, healthcare, ecosystem services, science, industry, intrinsic and social values) compared to nature conservation. Some questions were adapted from the study of Caro et al. (2003) and focused on the reasons why nature should be conserved (as described by Ehrenfeld's (1976) scale for measuring conservation values). For each question, students chose the Likert score (see above) that best described their feelings towards the issue. To account for random score selection, we considered two different statements for each tested value (questions P4–P19 in ESM 1).

Section III Students were asked to select four items from a list of eight criteria to identify priority species for conservation, grouped as having intrinsic (e.g., endemism, rarity, fragmented distribution, vanishing habitat) or instrumental values (edible, poisonous/venomous, harmless, aesthetic) (questions P23–P30 in ESM 1).

Section IV Students were asked to select three items from a list of seven that represent environmental management approaches used as recovery measures for the conservation of threatened priority species (questions P31–P37 in ESM 1).

Section V Students were asked to select four groups of mammals (from among carnivores, Artiodactyla, lagomorphs, rodents, Perissodactyla, bats, cetaceans and sirenians; although Artiodactyla and cetaceans are currently included in the same clade—Cetartiodactyla—we considered them separately) that in their opinion should be a priority for mammal conservation (questions P38–P45 in ESM 1).

Section VI To test the influence of socio-economic and individual characteristics on the pattern of student's answers, we asked questions regarding the student's individual characteristics and social/cultural background, namely sex, age, living area (rural, suburbs or city center), education level of both parents, frequency of visits to the countryside, protected areas, city parks or zoological parks (e.g. zoos, aquariums, etc.), and extent of reading exposure to conservation-related materials (ESM 1).

The questionnaire also included the following statements addressing simple concepts related to conservation and ecology that students classified according to the Likert scale: (1) nature conservation actions should be implemented only in protected areas; (2) protected areas should be regions focused on nature conservation where human presence and activities should be excluded; and (3) nature conservation should be implemented in all regions of a country without any regional bias (questions P20–P22 in ESM 1). We avoided the use of technical expressions to overcome/reduce possible bias associated with unfamiliar terms.

Researchers explained the study and questionnaire structure (but refrained from giving any personal opinions regarding the questions) before students completed the written questionnaire. Students undertaking biological courses answered the questionnaire during class and inside the classroom in the presence of the researchers to avoid students influencing each other's answers and/or interpretations of the questions. The questionnaires were completed within 45 min. A pilot test of the questionnaire was implemented prior to presenting it to the target population to evaluate and correct possible errors/misinterpretations and to validate how those issues were addressed. This pilot study was performed using a sample of 10 students from each university (students selected for the pilot and main study differed). This study was evaluated and approved by the Human Research Ethics Committee (CAAE no: 50976115.0.0000.5502).

Data analysis

We used proportion tests (Armitage 1966) to evaluate differences in the frequencies of the five categories of the Likert scale relating to students' perspectives regarding nature conservation (questions P1–P3 in ESM 1). We applied a Wilcox W test (Zar 2010) to compare the frequencies of each Likert scale category between male and female students. Differences in the frequencies of answers related to conservation-associated concepts (questions P20–P22), ecology conservation priorities (questions P23–P30), environmental management approaches (questions P31–P37), and priority mammalian groups (questions P38–P45) were also tested using proportion tests. We used a Bonferroni correction to adjust *P* values for multiple comparisons (Bland and Altman 1995).

To evaluate what factors might promote a pro-conservation attitude among students, we used a generalized linear mixed model (GLMM; Bolker et al. 2009), with a

log-link function (Poisson family), to assess the influence of: (1) students' individual characteristics [i.e. gender (male vs female), age, graduation year, place of residence (rural, city center, city suburbs)]; (2) parents' education (mother and father scholar group: first grade, second grade or university degree); (3) nature-related experiences [frequency of visits to the countryside/rural areas, to urban parks, to Protected Areas, to Zoological Parks (e.g. Zoos, Aquariums, etc.) and frequency of nature related book/magazines reading; six categories each, ranging from almost never (0) to every week (5)]; and (4) individual values (i.e. cultural heritage, tourism, healthcare, ecosystem services, science, industry, intrinsic and social values) [higher Likert scores reveal a negative attitude towards conservation]. We used student ID as a random factor in the GLMM to account for individual bias. We produced models according to our four predefined working hypotheses. Individual models were generated corresponding to a combination of all variables related to that hypothesis (see above). We selected the best models based on the Akaike Information Criterion corrected for small samples (AICc; Burnham and Anderson 2002). Best models were considered to be those with a ΔAICc < 2, i.e. whose difference between the model and the one with the lowest AICc is less than 2 (Burnham and Anderson 2002).

In a second analytical stage, we compared the best models of each hypothesis and selected the one that fulfilled the criteria for being considered best model (i.e. ΔAICc < 2). Finally, we also generated a full model (all variables) and a null model (no variables). We compared the AICc values of all these models (full, null, and best models of each hypothesis) and then selected the best models using the procedure described above. As more than one model fulfilled the selection criteria for best model, we applied a model averaging procedure (Burnham and Anderson 2002). We estimated the 95% confidence intervals (CI 95%) for the variables included in the best models, and only considered those whose intervals did not include 0 (so we could establish whether their influence was positive or negative). All analyses were performed in R software (R Core Team 2013), and the GLMMs were performed using the packages lme4 (Bates et al. 2015) and MuMIn (Barton 2016).

Results

One hundred and twenty-two students from biology core courses filled out the questionnaire (USC = 71; FREA = 51 students). The average age of the students was 22 years (range 18–33 years), with 75 females and 43 males (four students did not specify their gender). This sex-ratio (1.7 females/1 male) is lower than that estimated for both monitored universities as a whole (3 females/1 male) and reflects the gender bias among core biology graduates in Brazil (INEP 2016). Most students are in the first year of their biology core course (52%), with the number of students greatly decreasing in the last years of the course (14 and 10%, for third and fourth year, respectively, probably due to socioeconomic issues, as some students have informally stated). Most students live in suburban areas (60%), with 28% living in urban areas and 12% in rural areas.

Nature conservation in society and schools

Students considered that nature conservation was highly important to ensure the survival of mankind (question P1; $\chi^2 = 529.407$, $df = 4$, $P < 0.001$) and for it to be included in school curricula (question P3; $\chi^2 = 413.836$, $df = 4$, $P < 0.001$). It was also considered highly important for citizens to participate in nature conservation actions (question P2; $\chi^2 = 428.269$, $df = 4$, $P < 0.001$) (Fig. 2). There were no significant differences between genders for any of these three questions

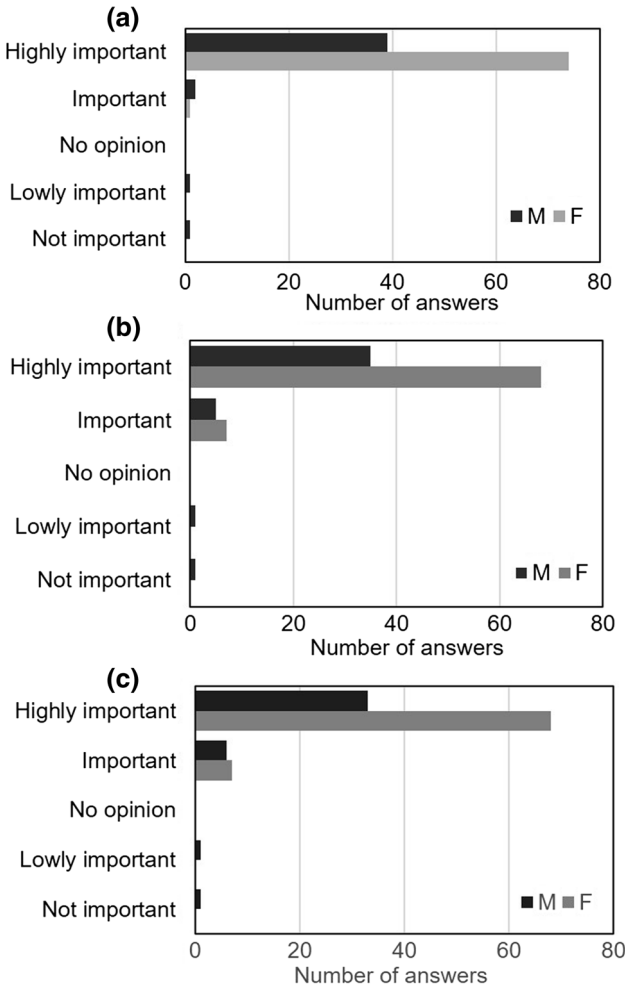

Fig. 2 Numbers of students [females (F) and males (M)] that selected one of the five possible answers to the following questions: P1—to ensure mankind's survival, nature conservation is…? (**a**); P2—citizens' participation in nature conservation actions is…? (**b**); and P3—the inclusion of nature conservation issues in school curricula (elementary, colleges and high schools) is…? (**c**)

(W_{P1} = 1742, P = 0.079; W_{P2} = 1697.5, P = 0.218; W_{P3} = 1701, P = 0.106; Fig. 2).

Priorities for nature conservation and management options

The criteria used by students to identify priority species for conservation was not uniform (χ^2 = 478.79, df = 7, P < 0.001; Bonferroni P value adjustment = 0.006; Fig. 3a). Two groups of criteria are apparent in Fig. 3; those less selected and corresponding to instrumental value (edible, poisonous/venomous, harmless, aesthetic), and those more selected and associated with species characteristics (e.g., endemism, rarity, fragmented distribution, vanishing habitat). Thus, our results show that students more significantly valued rarity, vanishing habitats and endemism criteria (without any difference between them; P > 0.006 for all comparison tests between these three criteria, which is higher than the Bonferroni correction threshold). The criterion "fragmented distribution" was selected less than these three criteria (χ^2 = 13.747, df = 1, P < 0.001), but more than the instrumental values "Poison/venomous" and "Edible" (χ^2 = 62.222, df = 1, P < 0.001). The least important criteria were "Aesthetic" and "Friendly", which were ranked significantly lower than the remaining two criteria from the instrumental group (χ^2 = 14.902, df = 1, P = 0.005). We can summarize these results as: Rarity = Vanishing habitat = Endemism > Fragmented distribution > Poison/venomous = Edible > Aesthetic = Friendly. We only detected a gender bias for the "Poisonous/venomous" criterion, with a higher proportion of males selecting it (χ^2 = 8.086, df = 1, P = 0.004).

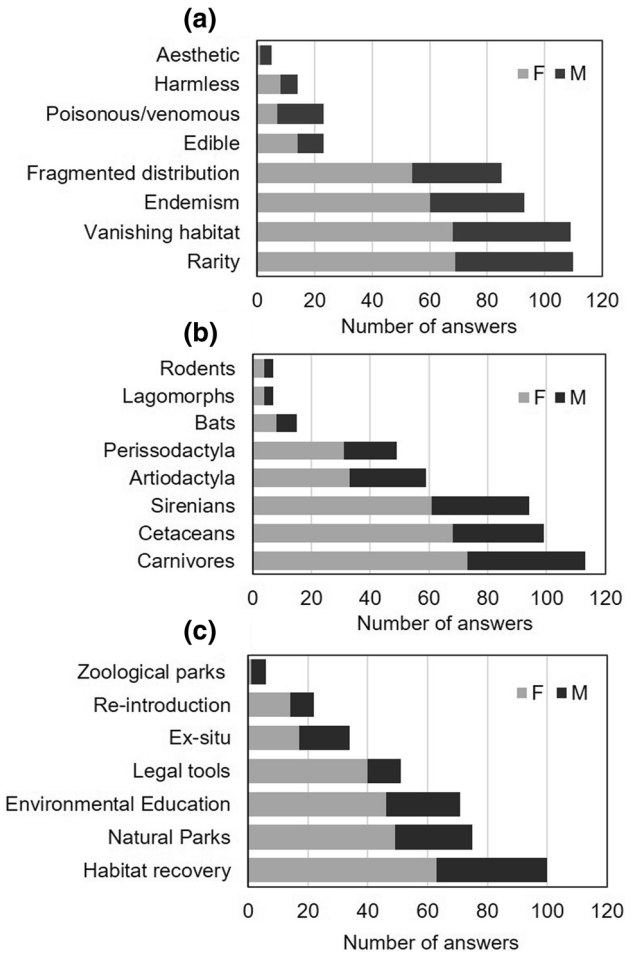

Fig. 3 Numbers of students [females (F) and males (M)] that selected different: **a** criteria to identify conservation priority species (endemism, rarity, fragmented distribution, vanishing habitat, edible, poisonous/venomous, harmless and aesthetic; questions P23–P30); **b** groups of mammals that should be a priority for mammal conservation (i.e. carnivores, Artiodactyla, lagomorphs, rodents, Perissodactyla, bats, cetaceans and sirenians; questions P38–P45); and **c** management conservation options (i.e. habitat recovery, natural parks, environmental education, legal tools, ex situ reproduction, re-introduction from natural populations, zoological parks; questions P31–P37 (ESM 1)

Carnivores were ranked as a significantly higher priority group for conservation (χ^2 1st vs 2nd/3rd rank = 10.228, df = 1, P = 0.001; Bonferroni P value adjustment = 0.008; Fig. 3b), followed by cetaceans and sirenians, which were equally selected by students (χ^2 = 0.270, df = 1, P = 0.603). Bats, rodents and lagomorphs were equally selected (χ^2 = 4.800, df = 2, P = 0.091), but were considered to be significantly less important (comparison between bats and the fourth lowest rank group, Perissodactyla: χ^2 = 26.835, df = 1, P < 0.001). There was no sex bias among selected groups (all P > 0.05).

Regarding management conservation options, students considered habitat recovery actions as significantly more important (χ^2 = 15.192, df = 1, P < 0.001; Bonferroni P value adjustment = 0.008; Fig. 3c), whereas creation of zoological parks was ranked lowest (χ^2 = 13.017, df = 1, P < 0.001, compared to the second lowest ranked criterion of "Re-Introduction"). There were no significant differences among the remaining management options (all P > 0.05, Fig. 3c). Again, there was no sex bias among responses (all P > 0.03; Bonferroni P value adjustment = 0.008).

Factors promoting a pro-conservation attitude

For each of our working hypotheses different models were identified as the best models (Table 1). For our hypothesis of "student's individual characteristics", eight models, including the null model, fulfilled the criterion for the best models (i.e. ΔAICc < 2, Table 1). For our "Parents' schooling" hypothesis, no model outranked the null model. For the "Nature-related experience" hypothesis, only two models could be considered best models. However, the best models of all of these hypotheses had a ΔAICc > 2 (i.e. did not fulfill the best model criterion) when compared to the best model generated using "Personal values" variables (with ΔAICc = 28.5 for the next best model, full model; Ta-

Table 1 Best models produced for each of our working hypotheses (i.e. ΔAICc < 2)

Model	*df*	LogLik	AICc	ΔAICc (hypothesis)	ΔAICc (total)
Full model	13	− 2436.1	4974.3		28.5
Null model	1	− 2585.4	5174.9		229.1
Student's individual characteristics					
Gender + age	4	− 2583.1	5174.3	0.0	228.5
Gender + age + place	6	− 2581.3	5174.6	0.3	228.8
Null model	2	− 2585.4	5174.9	0.6	229.1
Age	3	− 2584.6	5175.3	1.0	229.5
Gender	3	− 2584.7	5175.3	1.0	229.5
Age + place	5	− 2582.7	5175.5	1.2	229.7
Place	4	− 2583.8	5175.6	1.3	229.8
Grad_Y	7	− 2581.0	5176.1	1.8	230.3
Parents' schooling					
Null model[a]	2	− 2585.4	5174.9	229.1	229.1
Nature-related experience					
Freq_read	7	− 2576.7	5167.5	0.0	221.7
Freq_read + Freq_country	13	− 2571.5	5169.2	1.7	223.4
Personal values models					
Values	**8**	**− 2463.9**	**4945.8**	**0.0**	**0.0**

Models are ordered for each hypothesis according to their AICc scores. The overall best model is presented in bold
LogLik log-likelihood, *AICc* Akaike Information Criterion corrected for small samples, *ΔAICc* difference between the lowest AICc score of all generated models and the focus model's AICc score, *Place* place of residence (rural, city center, suburbs), *Grad_Y* graduation year, *Freq_read* frequency of reading nature-related book/magazines, *Freq_country* frequency of visits to the countryside, *Values* intrinsic individual values (cultural heritage, tourism, healthcare, ecosystem services, science, industry, intrinsic and social values)
[a]For this hypothesis the null model was considered the best model (i.e. lowest AICc, ΔAICc > 2 for all other models)

ble 1). Thus, our modeling procedure suggests that students prioritize "Healthcare", "Cultural Heritage" and "Science" over conservation (Table 2; positive coefficients indicate that students have a lower probability of being pro-conservation if the question is focused on one of these values). "Ecosystem services" were also highly valued (Table 2). None of the 95% confidence intervals for these variables spanned 0.

Discussion

Our results show that Brazilian undergraduate students of biological core sciences courses in private universities clearly recognize that nature conservation is an important issue that can influence human survival. Their responses highlight that citizen participation, individually or as a group of stakeholders, in conservation actions is important to guarantee successful conservation strategies. Furthermore, their responses also indicate that conservation issues are highly relevant in school curricula. Several authors have previously identified that citizens' participation in conservation efforts increases the likelihood of success (Pujadas and Castillo 2007; Sakurai et al. 2015; Comin and Gheler-Costa 2016), especially because distinct societal groups may have different conservations perspectives (Liu et al. 2010; Kleftoyanni et al. 2011). Furthermore, when the interests and knowledge of societal groups are incorporated into the planning and implementation of conservation activities, long-term success is more likely (Pretty and Smith 2004). However, participation of such groups could be more effective, constructive, and robust if conservation concepts and issues are debated in school environments (and curricula), as our surveyed students recognized. This is especially relevant when dealing with stakeholders

Table 2 GLMM best model variables' coefficients (β), standard error (SE), z value test scores, significance (P), and 95% confidence intervals (CI 95%)

Variable	β[a]	SE	Z value	*P*	CI 95%
Intercept	**0.562**	**0.055**	**10.2**	**< 0.001**	**0.454/0.670**
Value:Cult	**0.264**	**0.072**	**3.7**	**< 0.001**	**0.123/0.406**
Value:Sci	**0.0529**	**0.068**	**7.7**	**< 0.001**	**0.395/0.663**
Value:ES	**0.663**	**0.067**	**9.9**	**< 0.001**	**0.531/0.793**
Value:Ind	0.020	0.076	0.3	0.789	− 0.129/0.170
Value:Health	**0.372**	**0.070**	**5.3**	**< 0.001**	**0.234/0.510**
Value:Soc	0.003	0.077	0.1	0.971	− 0.147/0.153
Value:Tour	− 0.041	0.077	− 0.5	0.594	− 0.193/0.110

Statistically significant variables $P < 0.001$ are represented in bold
Cult cultural heritage, *Sci* science, *ES* ecosystem services, *Ind* industry, *Health* healthcare, *Soc* social values, *Tour* tourism
[a]Positive coefficients indicate that students have a lower probability of being pro-conservation if the question is focused on the mentioned value because higher values of the dependent variable indicate that students strongly agreed with the sentence that was formulated to evaluate the value being tested (see ESM 1)

whose activities overlap with conservation issues, such as biologists (Clark 2001).

Our surveyed students believe that rare species, endemic species, and those whose habitats are disappearing should be the principle targets of conservation efforts. They also recognize that species with fragmented distributions should not be ignored. These results are in accordance with other studies that have identified these factors as the main causes for classifying species as threatened (Villard and Metzger 2014; Meyer et al. 2015). Thus, by identifying as priority criteria the factors that are the major drivers of species declines (Lindenmayer and Burgman 2005), biology students seem to have already acquired relevant information prior to conservation issues being addressed in biology courses. This knowledge might be assimilated from different sources such as media (TV, newspapers, journal), books, or non-university classes (Blewitt 2010; Schelly et al. 2012) as it is not addressed in the monitored universities. Interestingly, we found that females are less prone to prioritize for conservation animals that are poisonous/venomous. Usually women show a more pro-conservationist attitude (e.g. Herzog 2007; Rosalino and Rosalino, 2012), but this behavior is highly complex and multidimensional. For many dimensions of Human-animals interactions there are no gender differences (e.g., desire to live with animals; Herzog 2007), or man seem more concerned (e.g. habitat conservation; Herzog 2007). However, several studies have detected that women are more fearful of specific taxa (e.g. reptiles; Ghimire et al. 2014) or dangerous and unpopular animals than men (Kaltenborn et al. 2006; Prokop et al. 2009b). This may be the underlying reason for the pattern we detected.

Students considered Carnivora (e.g. puma, *Puma concolor*), cetaceans (e.g. dolphins, whales) and sirenians (e.g. manatees, *Trichechus inunguis*) as being the most threatened mammals. These groups are considered highly threatened in the IUCN Red List of Threatened Species (IUCN 2017) or by the Brazilian list of endangered fauna (ICMBio 2016). The Carnivora have been a target species of numerous conservation projects, many of which involve outreach activities. They are also considered flagship and/or umbrella species, because they occupy the highest trophic level within the food chain (top predators) and perform important functions in ecosystems such as prey population control, seed dispersal, etc. (Noss et al. 1996; Duffy et al. 2007; Terborgh et al. 2001; Williams et al. 2004; Schipper et al. 2008). Moreover, mammalian carnivores are often the subjects of TV documentaries and news stories (Andersone and Ozolinš 2004; Clucas et al. 2008), promoting their popularity further. The same reasoning can be applied to cetaceans (Fortner 1985), and since some of these taxa are hosted in aquariums where environmental education programs are implemented (dolphins and killer whales) (Ballantyne et al. 2007), their ranking as conservation priorities is enhanced. The high ranking of sirenians might be a local effect due to the fact that Amazonian manatees (*Trichechus inunguis*) are an important and charismatic species that are subject to large-scale conservation programs in Brazil (Marsh et al. 2011).

However, it remains crucial to develop environmental education programs aimed at other less charismatic taxa, such as rodents that are often considered pests but may nonetheless be threatened species (Fox-Parrish and Jurin 2008). According to Wilson (2007), a gene-culture hypothesis can explain the origin of biophilia (a natural tendency to pay attention to living things), as well as human relationships towards bats, rats, snakes, scorpions, spiders, etc. These species are sometimes associated with myths (e.g. vampires), which can negatively influence attitudes towards them (Prokop et al. 2009a). Some bats are associated with diseases (e.g. rabies; Mayen 2003), which can make people averse to them. Why lagomorphs are considered of lower importance is not clear from our analyses and should be investigated further.

Habitat recovery, which is one of the main conservation management actions being implement worldwide (Lindenmayer and Burgman 2005), was considered the most important by our surveyed students. This outcome once more seem to indicate that students have already acquired sound ecological knowledge and that this knowledge was gained prior to attending university, most likely through media, pre-university courses or environmental education activity. This latter activity can play an important role in shaping students' attitudes towards nature conservation (Trewhella et al. 2005), with our surveyed students ranking "Environmental Information" third among the most important management conservation options.

Regarding the importance of nature conservation values versus other individual and socio-economic values (ecosystem services, medicine, culture, science, society, industry, tourism, or species intrinsic value), our results demonstrate a somewhat anthropocentric bias. Most students revealed that they would favor activities related to medicine/healthcare, cultural heritage and science over those linked to nature conservation. Students also highly valued ecosystem services. All these value systems can be directly linked to human survival (provisioning services—e.g. food; regulatory services—e.g. climate; support services—e.g., species habitats; cultural services—e.g. recreation) (Wallace 2007). According to Grün (2007), among the main reasons hindering nature conservation is the fact that we live according to an anthropocentric ethic, perhaps explaining the selection of medicine/healthcare over conservation. Even the high value attributed to science relative to nature conservation fits this perspective, i.e. the overall objective of science is to generate knowledge useful to humans (for resource production, to understand how nature functions or solely as an intellectual challenge), although it is influenced by cultural, societal, and other drivers (Lederman 2007). For all the questions regarding individual values and conservation, the rate of neutral replies (i.e. "Neither agree nor disagree") was

low (overall percentage: 11%; mean per question: 11; SE: 2.4). Other studies showed that a neutral position regarding some conservation issues by specific social groups can be relevant, indicating a detachment from nature [e.g. 30% of Swedish hunters showed a neutral attitude towards wolf importance as a species—Ericsson and Heberlein (2003); 24% of local people revealed that they did had no opinion regarding Tanzania Protected areas—Newmark et al. (1993)]. However, the low percentage of neutral answers detected in our study may indicate a higher involvement of biology graduate students in conservation questions,

Although we believe this is the first study to assess how future biologists perceive nature conservation, we acknowledge that our small sample size and the sample composition may bias our results and interpretations. We sampled 122 students from private universities in São Paulo state and our results should be interpreted accordingly, especially since São Paulo exhibits socio-economic specificities even within Brazil (it is the Brazilian state responsible for most of Brazilian Gross Domestic Product; SEADE 2018). Furthermore, cultural and religious values may also influence people's attitudes towards nature (e.g. Lindemann-Matthies et al. 2014), but we did not evaluate such factors due to the need to acquire specific permits to collect data on religion. However, these parameters should be assessed in future studies. Finally, the variation in numbers of students from different academic years may have influenced our results. However, since the topic of conservation biology is not addressed in any year of their biology courses, we do not think this fact significantly influenced students' responses. Moreover, this variation is correlated with student age (older students attend later years; significant correlation Spearman $\rho = 0.60$, $P < 0.001$), which we explicitly factored into our analysis.

Our study demonstrates a two-faceted perspective for how students from biology core courses relate to nature conservation. First, the student responses seem to indicate that they have already acquired knowledge that allows them to properly identity: (1) which species characteristics warrant a high priority conservation status; and (2) which management conservation options are most widely used and appropriate. However, the students also revealed limited knowledge regarding which mammalian species are more threatened (probably under the influence of species' ''popularity'' in media or environmental education projects) and evidenced an anthropocentric or even utilitarian perspective of nature. Therefore, it is crucial to include conservation topics in biology courses' curricula. Doing so might motivate students to challenge their values and views of nature conservation based on available ecological knowledge. We believe our findings could prove important to university and environmental education managers in São Paulo and might serve as a guideline for future studies to be developed in the Neotropics.

Acknowledgements We would like to thank Universidade do Sagrado Coração and Fundação Regional Educacional de Avaré for authorizing this research, and the students for answering the questionnaires. This work was supported by CAPES under a BMS Grant; University of Aveiro (Department of Biology), CESAM and FCT/MEC through national funds, and by co-funding from FEDER within the PT2020 Partnership Agreement and Compete 2020 under project (number UID/AMB/50017).

References

Andersone Ž, Ozolinš J (2004) Public perception of large carnivores in Latvia. Ursus 15:181–187. https://doi.org/10.2192/1537-6176(2004)015<0181:ppolci>2.0.co;2

Armitage P (1966) The Chi square test for heterogeneity of proportions, after adjustment for stratification. J R Stat Soc B 28:150–163

Ballantyne R, Packer J, Hughes K, Dierking L (2007) Conservation learning in wildlife tourism settings: lessons from research in zoos and aquariums. Environ Educ Res 13:367–383. https://doi.org/10.1080/13504620701430604

Barton K (2016) MuMIn: multi-model inference. R package ver. 1.15. 6. https://cran.r-project.org/web/packages/MuMIn/MuMIn.pdf. Accessed 26 Jun 2016

Bates D, Mächler M, Bolker B, Walker S (2015) Fitting linear mixed-effects models using lme4. J Stat Softw 67:1–48. https://doi.org/10.18637/jss.v067.i01

Berenguer J, Corraliza JA, Martín R (2005) Rural-urban differences in environmental concern, attitudes, and actions. Eur J Psychol Assess 21:128–138. https://doi.org/10.1027/1015-5759.21.2.128

Bizerril MXA (2004) Children's perceptions of Brazilian Cerrado landscapes and biodiversity. J Environ Educ 35:47–58. https://doi.org/10.3200/JOEE.35.4.47-58

Bland JM, Altman DG (1995) Multiple significance tests: the Bonferroni method. BMJ 310:170. https://doi.org/10.1136/bmj.310.6973.170

Blewitt J (2010) Media, ecology and conservation: using the media to protect the World's wildlife and ecosystems. Green Books, Totnes

Bolker BM, Brooks ME, Clark CJ, Geange SW, Poulsen JR, Stevens MHH, White J-SS (2009) Generalized linear mixed models: a practical guide for ecology and evolution. Trends Ecol Evol 24:127–135. https://doi.org/10.1016/j.tree.2008.10.008

Burnham KP, Anderson DR (2002) Model selection and multimodel inference: a practical information-theoretic approach. Springer, New York

Caro TM, Pelkey N, Grigione M (1994) Effects of conservation biology education on attitudes toward nature. Conserv Biol 8:846–852. https://doi.org/10.1046/j.1523-1739.1994.08030846.x

Caro T, Mulder MB, Moore M (2003) Effects of conservation education on reasons to conserve biological diversity. Biol Conserv 114:143–152. https://doi.org/10.1016/s0006-3207(02)00423-8

Ceballos G, Ehrlich PR, Soberón J, Salazar I, Fay JP (2005) Global mammal conservation: what must we manage? Science 309:603–607. https://doi.org/10.1126/science.1114015

Chang B (2010) The power of geographical boundaries: cultural, political, and economic border effects in a unitary nation. Master of Arts, Iowa State University, Ames

Chua S, Giam X, Yeo CK, Tan HTW (2008) Attitudes towards biological conservation of one class of National University of Singapore undergraduate students. Nat Singap 1:9–20

Clark TW (2001) Developing policy-oriented curricula for conservation biology: professional and leadership education in the public interest. Conserv Biol 15:31–39. https://doi.org/10.1111/j.1523-1739.2001.99007.x

Clucas B, Mchugh K, Caro T (2008) Flagship species on covers of US conservation and nature magazines. Biodivers Conserv 17:1517–1528. https://doi.org/10.1007/s10531-008-9361-0

Comin FH, Gheler-Costa C (2016) The role of family farms in environmental conservation in agricultural landscapes. In: Gheler-Costa C, Lyra-Jorge MC, Verdade LM (eds) Biodiversity in agricultural landscapes of southeastern Brazil. De Gruyter Open, Berlin, pp 14–27

Duffy JE, Cardinale BJ, France KE, Mcintyre PB, Thébault E, Loreau M (2007) The functional role of biodiversity in ecosystems: incorporating trophic complexity. Ecol Lett 10:522–538. https://doi.org/10.1111/j.1461-0248.2007.01037.x

Ehrenfeld DW (1976) The conservation of non-resources: conservation cannot rely solely on economic and ecological justifications. There is a more reliable criterion of the value of species and communities. Am Sci 64:648–656

Ericsson G, Heberlein T (2003) Attitudes of hunters, locals and the general public in Sweden now that the wolves are back. Biol Conserv 111:149–159. https://doi.org/10.1016/s0006-3207(02)00258-6

Fortner RW (1985) Relative effectiveness of classroom and documentary film presentations on marine mammals. J Res Sci Teach 22:115–126. https://doi.org/10.1002/tea.3660220203

Fowler FJ (2014) Survey research methods. SAGE Publications, Thousand Oaks

Fox-Parrish L, Jurin RR (2008) Students' perceptions of a highly controversial yet keystone species, the black-tailed prairie dog: a case study. J Environ Educ 39:3–14. https://doi.org/10.3200/joee.39.4.3-14

Ghimire HR, Phuyal S, Shah KB (2014) Protected species outside the protected areas: people's attitude, threats and conservation of the Yellow Monitor (*Varanus flavescens*) in the Far-western Lowlands of Nepal. J Nat Conserv 22:497–503. https://doi.org/10.1016/j.jnc.2014.08.003

Grün M (2007) A pesquisa em ética na educação ambiental. Pesq Educ Ambient 2:185–206

Herzog HA (2007) Gender differences in human-animal interactions: a review. Anthrozoos 20:7–21. https://doi.org/10.2752/089279307780216687

ICMBio (2016) Sumário executivo Livro Vermelho da Fauna Brasileira Ameaçada de Extinção. Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Brasília

INEP-Instituto Nacional de Estudos e Pesquisas, Educacionais Anísio Teixeira (2016) http://portal.inep.gov.br/

IUCN (2017) The IUCN red list of threatened species. Version 2017-2. http://www.iucnredlist.org

Jacobson SK (1990) Graduate education in conservation biology. Conserv Biol 4:431–440. https://doi.org/10.1111/j.1523-1739.1990.tb00318.x

Kaltenborn BRP, Bjerke T, Nyahongo J (2006) Living with problem animals—self-reported fear of potentially dangerous species in the Serengeti region, Tanzania. Hum Dimens Wildl 11:397–409. https://doi.org/10.1080/10871200600984323

Kleftoyanni V, Abakoumkin G, Vokou D (2011) Environmental perceptions of students, farmers and other economically active members of the local population near the protected area of Axios, Loudias, Aliakmonas estuaries in Greece. Glob Nest J 13:288–299

Kontoleon A, Swanson T (2003) The willingness to pay for property rights for the giant panda: can a charismatic species be an instrument for nature conservation? Land Econ 79:483–499. https://doi.org/10.2307/3147295

Kruuk H (2002) Hunter and hunted: relationships between carnivores and people. Cambridge University Press, Cambridge

Lederman NG (2007) Nature of science: past, present, and future. In: Abell SK, Lederman NG (eds) Handbook of research on science education. Lawrence Erlbaum, Hillsdale, pp 831–880

Likert R (1932) A technique for the measurement of attitudes. Arch Psychol 140:1–55

Lima DDS, Marmontel M, Bernard E (2014) Conflicts between humans and giant otters (*Pteronura brasiliensis*) in Amanã Reserve, Brazilian Amazonia. Ambiente Sociedade 17:127–142. https://doi.org/10.1590/s1414-753x2014000200009

Lindemann-Matthies P, Keller D, Li X, Schmid B (2014) Attitudes toward forest diversity and forest ecosystem services—a cross-cultural comparison between China and Switzerland. J Plant Ecol 7:1–9. https://doi.org/10.1093/jpe/rtt015

Lindenmayer D, Burgman M (2005) Practical conservation biology. CSIRO Publishing, Collingwood

Linnell J, Salvatori V, Lescureux N, Von Arx M, Majić Skrbinŝ A (2013) From conflict to coexistence? Results from a stakeholder workshop on large carnivores in Brussels, 25, January, 2013. http://www1.nina.no/lcie_new/pdf/634994154761943079_Task%205%20Workshop_report_FINAL_DEF.pdf

Liu J, Ouyang Z, Miao H (2010) Environmental attitudes of stakeholders and their perceptions regarding protected area-community conflicts: a case study in China. J Environ Manag 91:2254–2262. https://doi.org/10.1016/j.jenvman.2010.06.007

Marsh H, O'Shea TJ, Reynolds JE III (2011) Ecology and conservation of the Sirenia: dugongs and manatees. Cambridge University Press, Cambridge

Mayen F (2003) Haematophagous bats in Brazil, their role in rabies transmission, impact on public health, livestock industry and alternatives to an indiscriminate reduction of bat population. J Vet Med B 50:469–472. https://doi.org/10.1046/j.1439-0450.2003.00713.x

Meine C (2010) Conservation biology: past and present. In: Sodhi NS, Ehrlich PR (eds) Conservation biology for all. Oxford University Press, Oxford, pp 7–26

Meyer S, Robertson BC, Chilvers BL, Krkošek M (2015) Population dynamics reveal conservation priorities of the threatened New Zealand sea lion *Phocarctos hookeri*. Mar Biol 162:1587–1596. https://doi.org/10.1007/s00227-015-2695-8

Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403:853–858. https://doi.org/10.1038/35002501

Newmark WD, Leonard NL, Sariko HI, Gamassa D-GM (1993) Conservation attitudes of local people living adjacent to five protected areas in Tanzania. Biol Conserv 63:177–183. https://doi.org/10.1016/0006-3207(93)90507-w

Noss RF, Quigley HB, Hornocker MG, Merrill T, Paquet PC (1996) Conservation biology and carnivore conservation in the Rocky Mountains. Conserv Biol 10:949–963. https://doi.org/10.1046/j.1523-1739.1996.10040949.x

Paraskevopoulos S, Padeliadu S, Zafiropoulos K (1998) Environmental knowledge of elementary school students in Greece. J Environ Educ 29:55–60. https://doi.org/10.1080/00958969809599119

Porfírio G, Sarmento P, Fonseca C (2014) Schoolchildren's knowledge and perceptions of jaguars, pumas, and smaller cats around a mosaic of protected areas in the Western Brazilian Pantanal. Appl Environ Educ Commun 13:241–249. https://doi.org/10.1080/1533015X.2014.978047

Pretty J, Smith D (2004) Social capital in biodiversity conservation and management. Conserv Biol 18:631–638. https://doi.org/10.1111/j.1523-1739.2004.00126.x

Prokop P, Fančovičová J, Kubiatko M (2009a) Vampires are still alive: Slovakian students' attitudes toward bats. Anthrozoös 22:19–30

Prokop P, Özel M, Uşak M (2009b) Cross-cultural comparison of student attitudes toward snakes. Soc Anim 17:224–240. https://doi.org/10.1163/156853009X445398

Pujadas A, Castillo A (2007) Social participation in conservation efforts: a case study of a biosphere reserve on private lands in Mexico. Soc Nat Resour 20:57–72. https://doi.org/10.1080/08941920600981371

R Core Team (2013) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna

Resolução CNE/CES (2009) Resolução CNE/CES no 4, de 6 de abril. Diário Oficial da União no 66-07/04/2009 (terça-feira), Seção 1, Pág. 27

Rosalino LM, Rosalino C (2012) Nature conservation from a Junior High School perspective. J Nat Conserv 20:153–161. https://doi.org/10.1016/j.jnc.2012.01.001

Rosalino LM, Gheler-Costa C, Santos G, Gonçalves MT, Fonseca C, Leal AI (2017) Conservation priorities for elementary school students: neotropical and European perspectives. Biodivers Conserv 26:2675–2697. https://doi.org/10.1007/s10531-017-1380-2

Sakurai R, Kobori H, Nakamura M, Kikuchi T (2015) Factors influencing public participation in conservation activities in urban areas: a case study in Yokohama, Japan. Biol Conserv 184:424–430. https://doi.org/10.1016/j.biocon.2015.02.012

Samdahl DM, Robertson R (1989) Social determinants of environmental concern specification and test of the model. Environ Behav 21:57–81. https://doi.org/10.1177/0013916589211004

Schelly C, Cross JE, Franzen W, Hall P, Reeve S (2012) How to go green: creating a conservation culture in a public high school through education, modeling, and communication. J Environ Educ 43:143–161. https://doi.org/10.1080/00958964.2011.631611

Schipper J, Chanson JS, Chiozza F, Cox NA, Hoffmann M, Katariya V, Lamoreux J, Rodrigues AS, Stuart SN, Temple HJ (2008) The status of the World's land and marine mammals: diversity, threat, and knowledge. Science 322:225–230. https://doi.org/10.1126/science.1165115

Schlegel J, Rupf R (2010) Attitudes towards potential animal flagship species in nature conservation: a survey among students of different educational institutions. J Nat Conserv 18:278–290. https://doi.org/10.1016/j.jnc.2009.12.002

Schultz PW (2001) The structure of environmental concern: concern for self, other people, and the biosphere. J Environ Psychol 21:327–339. https://doi.org/10.1006/jevp.2001.0227

SEADE-Fundação Sistema Estadual de Análise de Dados (2018) Produto interno bruto do estado de São Paulo (PIB). http://www.seade.gov.br

Skogen K (1999) Another look at culture and nature: how culture patterns influence environmental orientation among Norwegian youth. Acta Sociol 42:223–239. https://doi.org/10.1177/000169939904200303

Terborgh J, Lopez L, Nunez P, Rao M, Shahabuddin G, Orihuela G, Riveros M, Ascanio R, Adler GH, Lambert TD (2001) Ecological meltdown in predator-free forest fragments. Science 294:1923–1926. https://doi.org/10.1126/science.1064397

Trewhella W, Rodriguez-Clark K, Corp N, Entwistle A, Garrett S, Granek E, Lengel K, Raboude M, Reason P, Sewall B (2005) Environmental education as a component of multidisciplinary conservation programs: lessons from conservation initiatives for critically endangered fruit bats in the Western Indian Ocean. Conserv Biol 19:75–85. https://doi.org/10.1111/j.1523-1739.2005.00548.x

Trombulak SC, Omland KS, Robinson JA, Lusk JJ, Fleischner TL, Brown G, Domroese M (2004) Principles of conservation biology: recommended guidelines for conservation literacy from the Education Committee of the Society for Conservation Biology. Conserv Biol 118:1180–1190. https://doi.org/10.1111/j.1523-1739.2004.01851.x

Tuncer G, Ertepinar H, Tekkaya C, Sungur S (2005) Environmental attitudes of young people in Turkey: effects of school type and gender. Environ Educ Res 11:215–233

Van Liere KD, Dunlap RE (1980) The social bases of environmental concern: a review of hypotheses, explanations and empirical evidence. Publ Opin Q 44:181–197. https://doi.org/10.1086/268583

Villard MA, Metzger JP (2014) Beyond the fragmentation debate: a conceptual model to predict when habitat configuration really matters. J Appl Ecol 51:309–318. https://doi.org/10.1111/1365-2664.12190

Wallace KJ (2007) Classification of ecosystem services: problems and solutions. Biol Conserv 139:235–246. https://doi.org/10.1016/j.biocon.2007.07.015

Williams JH, Phillips TD, Jolly PE, Stiles JK, Jolly CM, Aggarwal D (2004) Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions. Am J Clin Nutr 80:1106–1122

Wilson EO (2007) Biophilia and the conservation ethic. In: Penn D, Mysterud I (eds) Evolutionary perspectives on environmental problems. Transaction Publishers, New Brunswick, pp 249–257

Yilmaz O, Boone WJ, Andersen HO (2004) Views of elementary and middle school Turkish students toward environmental issues. Int J Sci Educ 26:1527–1546. https://doi.org/10.1080/0950069042000177280

Zar JH (2010) Biostatistical analysis. Pearson Prentice Hall, Upper Saddle River