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Common and threatened animal identification and conservation preferences among 6 to 12 year-old students

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Biodiversity loss is one of the biggest environmental issues in the world today and the biodiversity literacy of citizens can be key to counteracting this. Considering that children can be change agents and actively take part in decision-making from early years, we have assessed the native fauna identification skills of Primary School students (aged 6 to 12 years-old; n=1975) from northern Spain along with their conservation preferences regarding common and threatened species. We have observed that, despite students' species literacy increasing with the education level, it remains overall very low. Besides, the conservation preferences of children are not exclusively guided by conservation priorities and, although are partially explained by species identification accuracy, other factors also seem to skew these preferences. These findings point out the need to properly address knowledge of local fauna from the early school years and the urgent need to provide children with the appropriate training regarding the characteristics to be taken into account when selecting species for protection and ensure their conservation.

Keywords: biodiversity education, native fauna, species identification, species conservation, primary school

Introduction

Together with climate change, biodiversity loss is one of the most pressing issues of the Anthropocene (Johnson et al., 2017). It is estimated that up to one million animal and plant species are threatened with extinction, many within decades (IPBES, 2019), and we are facing a sixth mass extinction (Barnosky et al., 2011). We have already exceeded the planetary boundary of biosphere integrity (formerly called "biodiversity loss"), at least at the "genetic diversity" level (Rockström et al., 2009; Steffen et al., 2015). The direct drivers of global biodiversity loss in descending impact order are land/sea use changes, direct exploitation of natural resources, pollution, climate change, and invasive alien species (Jaureguiberry et al., 2022). Among indirect causes that underlie and shape

those direct drivers, scientists include sociocultural ones, such as values, norms, beliefs or education (Pörtner et al., 2021). Only if these indirect drivers (root causes of biodiversity loss) are transformed would current species decline be reversed (Díaz et al., 2019). Therefore, education can be either the trigger of biodiversity loss as an indirect driver, or a weapon to battle against its threats, since improving environmental education and learning about biodiversity can increase people's awareness about biodiversity issues, which is crucial for building broad-based support in society for conservation.

Biodiversity literacy can be considered as a subcategory of scientific literacy and environmental literacy (Schneiderhan-Opel & Bogner, 2020), and refers to knowing and understanding the concept of biodiversity as well as adopting appropriate behavior to contribute to biodiversity preservation (Moss et al., 2015). One of the simplest and most assessed biodiversity literacy scales among citizens is species literacy, which can be evaluated through people's species identification skills (Hooykaas et al., 2019). Latest research works employing this proxy suggest that citizens from westernized countries have little knowledge about local fauna (e.g., Almeida et al., 2018; Gerl et al., 2021), which can be attributable to their disconnection from nature (Soga et al., 2016). That would explain why public awareness of native species decreases the bigger or the more urbanized their hometown is (Barrutia et al., 2022; Díez et al., 2018; Enzensberger et al., 2022).

This is worrisome, since it has been suggested that a greater species literacy could be linked to higher pro-environmental attitudes, including pro-conservationists (Cornelisse & Sagasta, 2018; Kubiatko et al., 2021; Oražem et al., 2021; Papageorgiou et al., 2022). Likewise, attitudes towards conservation shape individuals' preferences for specific actions, policies, and resource allocations. As saving species usually requires human mediation, and public preference should influence conservation in democratic

contexts (Czech et al., 1998; Smith, 2011), it is imperative to identify which factors shape citizens' preferences to protect animals. That is, citizens' choices dictate where funds are allocated, which species and their habitats receive protection, and the overall success of conservation plans (Martín-López et al., 2007, 2009; Norton, 1986). In fact, when conservation planning ignores how local people perceive a species, it may lead to unsuccessful conservation interventions because of a lack of public support or an unexpected public opposition (Kaltenborn et al., 2006). Furthermore, children's' opinions should also be taken into account as they can be natural change agents and actively take part in decision-making processes from early years (e.g., Chawla & Cushing, 2007; Roe, 2007).

Recent studies suggest that children's reasons for protecting a species can vary greatly, and several aspects come into play, such as species' aesthetic characteristics, their profitability, their salience in media or their cultural heritage (Hopper et al., 2019; Panisi et al., 2022; Rosalino et al., 2017; Shapiro et al., 2016). Conservation preferences may also vary between genders (Prokop & Randler, 2018), females manifesting stronger preferences for cute animals whereas male score higher in preferences for less attractive, unpopular animals. Also, it has been observed that the socioeconomic status (sometimes linked to public/private schooling) and rurality may influence people's conservation attitudes because of fear of economic losses (e.g., Oliveira, 2015).

Thereby, considering that children will have to face individual as well as political decision-making processes about biodiversity issues both at present and in the future, it is key to assess their conservation preferences, and the factors shaping them, in order to design proper educational interventions in the field of biodiversity education. Moreover, attitudes and behavior toward the environment start developing at the early age of seven, increase until the age of ten, and afterwards level off and decrease (Otto et al., 2019).

Hence, promoting positive attitudes during childhood is more feasible than during adulthood, when attitudes and behavior are consolidated. Interestingly, a similar trend has been observed for species identification skills, which are powerful during childhood and tend to reach a peak or even decrease during puberty (Huxham et al., 2006; Randler, 2008).

In previous works in the same region (Basque Autonomous Country), we identified that 11 to 14 year-old teenagers were not aware of local species (Barrutia et al., 2022; Díez et al., 2018; Pedrera et al., 2023), especially the students living in urbanized areas, and we coined the phenomenon as "Native Species Awareness Disparity" (NSAD) (Barrutia et al., 2022). In the current study, we aim to delve deeper into the onset (age) and the factors that can influence this phenomenon by studying younger children because, as mentioned before, their interests, identification skills and conducts are still modifiable and can determine adulthood behavior (Evans et al., 2018; Hahn, 2021; Otto et al., 2019). As the NSAD previously diagnosed in teenagers was particularly prevalent for the case of animals (in comparison to plants), we have now focused only on the animal kingdom. Thus, in the current work we address the assessment of 6 to 12 year-old children species literacy about native animal species (common and threatened ones), and how this is influenced by different factors. For this purpose, we have employed species identification as a diagnostic tool since it has been proven to be a direct indicator of species in-depth knowledge (Hooykaas et al., 2022). In addition, we have approached the study of children's conservation preferences for local fauna and the factors that might influence it, including species identification ability. Therefore, this is the first work assessing common and threatened native species knowledge and conservation preferences in the region.

Accordingly, the research questions addressed by this research are as follows:

1. What is the level of literacy regarding native animal species of 6 to 12 year-old children? How is this influenced by different factors (e.g., gender, educational level, type of school or hometown population)?
2. What are their conservation preferences regarding common and threatened native animal species (among the ones shown)? Which factors can influence this decision (gender, educational level, type of school –public or private-, hometown population, species' identification accuracy)?

Methodology

Context and participants

The study was conducted in the Basque Autonomous Country, northern Spain, where nowadays there are more than 150 animal species listed in the catalogue of threatened species (Basque Government, 2022). All participants were from the small province of Bizkaia (2217 km^2), where population density is the third highest in Spain and rural areas coexist with highly industrialized ones.

Participants were enrolled in all the 6 different levels of Primary Education (PE) in Spain. Students' age range at each academic level is displayed in Table 1, as well as school curriculum content relating to biodiversity and their conservation (Basque Government, 2016) when the study was conducted (2021/22 academic year). In short, students enrolled in the 1st cycle of PE (PE1, PE2 and PE3) should learn to differentiate living things (animals and plants) from non-living ones, and start observing living beings (directly and indirectly) in order to classify them based on noticeable characteristics. In the 2nd cycle of PE (i.e., PE4, PE5 and PE6), they should learn the characteristics and classification of vertebrate and invertebrate animals, and delve deeper into higher organization levels than the organisms (e.g., population or community), as well as into

lower ones (e.g., cells, tissues). In both cycles, students should develop habits of respect and care towards living beings.

Data collection

All the schools taking part in the study were enrolled in an environmental education program launched by the Provincial Council of Bizkaia. The educators of the program moved to each participating school to conduct a workshop on local biodiversity. We were allowed to administer a questionnaire about native animals to students before starting with the activities of the program, which was considered a good starting point to approach the faunal biodiversity of the province. Questionnaires were administered to students by the program educators themselves after receiving some instructions: they should read the task aloud, explain the children how to conduct it, encourage them to fill in the questionnaire individually and prevent them from tattling on each other. The task was conducted at students' classroom in the presence of their teacher and the educator of the program to answer any student questions. Children had 10' to fill in the questionnaire and, when finished, they had to continue seated and in silence until the rest of the students finished theirs. Afterwards, the questionnaires were collected by the program educators and stored in folders where the educator wrote the name of the school. Questionnaires corresponding to each classroom were stored in different folders.

To gather the data, students were provided an A4 size paper comprising three parts (appendix 1). In the first one, in order to collect students' sociodemographic information, they were asked about their age, the grade level they were attending in Primary Education, and which their hometown was. Afterwards, they had to select their gender (female, male, or other). In the second part of the questionnaire, 10 color photographs of native wild animals from different taxa were displayed, and children were asked to write down which

animal they thought it was. Similar tests have been used recently to assess species literacy (Almeida et al., 2018; Bashan et al., 2021; Colléony et al., 2019; Palmberg et al., 2015). Species were selected with the help of a zoologist who is a full professor at the University of the Basque Country. We selected pictures of adults and made sure that they displayed species-specific morphological characteristics. All species were occurring in the area students lived and birds were breeders/residents in the area. Photographs included two animals of each of the following taxa: mammals, birds, reptiles, amphibians and invertebrates. Species appearing in the photographs and their conservation status are displayed in Table 2. The first species of each group was a non-threatened common species in the area, whereas the second one was listed in the Basque Catalogue of Threatened Species (Basque Government, 2022). In addition, the global conservation status of some of the latter species was of concern according to the IUCN Red List of threatened Species (version 2022-2), such as the European mink that is critically endangered globally or the European pond turtle that is considered near threatened internationally.

After the previous part about local species identification, and similar to Ballouard et al. (2011), in the third part of the questionnaire (in the same sheet) children were asked to select 5 animals (among the ones shown) they would like to protect.

A previous pilot test was carried out with children who did not participate in the final study (n=30, five from each grade). The 10 minutes available were sufficient to answer the questionnaire in a relaxed manner, and questions were clear and comprehensible. The task was written in the Basque language, although the responses could be given in any language.

Parents or legal guardians, school directors and teachers were informed in advance about the research objectives and study methods, and had filled in a consent form.

Anonymity was guaranteed to all participants. Children were told that the survey was not an assessment, that they could ask questions at any time if something was not understood, and that participation in the survey was voluntary.

The data was treated in accordance with the Declaration of Helsinki and having received permission from the Ethics Committee on Humans (CEISH) of the University of the Basque Country (UPV/EHU) (CEISH/161/2020).

Data analysis

To assess the correctness or accuracy of species identification, the taxonomic proximity of the animal suggested by the students towards the animal in the picture was analyzed. Hence, it was determined whether the identification was correct at species level, or to a higher taxonomic level (genus, family, order, class, phylum or kingdom). For example, if the picture displayed the European mink and the children named it "rat", the nearest most precise taxonomic level both animals matched was class (*Mammalia*); if they wrote down "wild cat", species mate at order level (*Carnivora*); if students claim it was a "badger", the identification was right at subfamily level (*Mustelinae*); finally, naming "weasel" to the European mink would mean a genus level identification match (*Mustela*).

Subsequently, each taxonomic level match was assigned an identification score. Following similar works (Enzensberger et al., 2022; Gerl et al., 2021), we conferred one point to a species-level match identification, and 0.5 to a genus-level one. However, above genus level, some authors do not confer any points (e.g., Randler et al., 2007), and others confer 0.5 points up to family level identification (Randler, 2010; Randler & Heil, 2021), or even to all the levels above genus (Enzensberger et al., 2022). We decided to give some points whatever taxonomic-level identification match children achieved, since they were

very young (starting from 6 years old) and the information could be valuable for us. Hence, following the same punctuation system as from species to genus, we designed an exponentially decreasing pointing system at each higher taxonomic level, as follows: 1 (species), 0.5 (genus), 0.25 (family), 0.125 (order), 0.0625 (class), and so on. Thus, punctuation raised exponentially (1/2n) the lower or more precise the matching of taxonomic level.

Statistics

Statistical analyses were conducted using R 4.0.3 (R Core Team, 2020). On the one hand, the links between students' identification scores (species literacy or identification ability) and the possible factors affecting it (type of school, educational level, gender and hometown population) were explored via a Linear Mixed Model (LMM), since identification scores followed a Gaussian conditional distribution. And on the other hand, the links between the selection of each animal to be protected and the possible factors influencing it (all the aforementioned plus the identification score of the corresponding species and the total identification score) were investigated by Generalized Linear Mixed Models (GLMMs) with a binomial error structure and a logit link function for each animal species.

All the models were constructed in the package *lme4* and followed a similar procedure (Bates et al., 2015). First, a full or global model where classroom and school were included as nested random effects was built, including all explanatory variables plus their possible interactions as fixed effects. Using a stepwise model simplification procedure and a 0.05 significance level the minimum adequate model was selected based on Akaike Information Criterion (AIC) and the comparison of Model Performance Indices from the *performance* package (Lüdecke et al., 2021). To assess the amount of

variance explained by the fixed effects alone and the combined fixed and random terms of the models, conditional and marginal R^2 values were calculated (Nakagawa & Schielzeth, 2013). Squared scaled Generalized Variance Inflation Factors (GVIFs) were employed to detect any potential issues of multi-collinearity among the explanatory variables, assuming $GVIF^{[1/(2\cdot df)]\hat{}2}<3$ as threshold. Finally, significance and effect size were determined using the *lmerTest* package (Kuznetsova et al., 2017) and the *effectsize* package (Ben-Shachar et al., 2020), respectively. The first one estimates degrees of freedom and provides p-values for mixed models using Satterthwaite's method, and the latter calculates odd ratios.

In addition, Kruskall-Wallis non-parametric tests followed by Mann-Whitney post-hoc with Bonferroni correction were conducted in order to determine whether differences existed in the number of answers given by students from different PE levels.

Results

In total, the data of 1975 students attending 50 different schools (35 public and 17 private) and corresponding to 66 classrooms were analyzed. They were enrolled in all Primary Education levels: PE1 (n=164), PE2 (n=340), PE3 (n=545); PE4 (n=245); PE5 (n=447), PE6 (n=234). They belonged to 81 different towns, ranging from 77 to 345,122 inhabitants (appendix 2). Regarding gender, 47.5% were boys, 46.2% were girls, 0.6% identified themselves as other gender (non-binary), and the rest did not specify their gender. Almost half of the students (42%) attended private schools, and the rest attended public ones.

Native species identification

Children, on average, proposed a name (independently of its correctness) to 7.6 animals from the photographs, and the number of animals receiving a name augmented along with the students' educational level ($p<0.001$). Most answers in blank were registered for the European mink (44.0%) whereas the photograph showing the least blanks was the one corresponding to the smooth snake (4.3%). The diversity of names given to each animal was very heterogeneous (see Table 3), with the European mink being the one receiving the greatest variety of names (49), and the European pond turtle the least (10).

Regarding the identification accuracy (taxonomic matching), wild boar achieved the highest mean identification score (IS), and the white-throated dipper and the common pill-bug the lowest. In general, children achieved a higher mean identification score when naming the common non-threatened animal of each taxa, with the exception of invertebrates (similar values for each of them). It can also be observed that mammals achieved the highest identification scores, distantly followed by amphibians, reptiles and birds. Invertebrates were the least accurately identified animal group. Altogether, children scored a mean of 1.99 points (out of 10) when trying to identify all the animals in the pictures (sum of identification scores).

Factors influencing species identification

The LMM analysis revealed that the school grade the students were enrolled in (PEL) was the main factor significantly and positively affecting the total sum of identification scores (Table 4). In fact, matches at broad taxonomic levels (i.e., kingdom, phylum, subphylum, class or order) were more frequent among the youngest children from the first cycle of Primary Education, whereas matches at more specific levels than suborder (i.e., family, subfamily, gender or species) were higher overall among older

students from the second cycle. Nevertheless, identification score and, consequently, species literacy, was not only influenced by students educational level, since other explanatory variables such as students' hometown population (POP) and gender (G) also presented significant associations (Table 4). Thus, although the effect sizes of these variables were rather small, students living in towns with a smaller population were able to identify native species more accurately than those living in more urbanized areas and male students presented overall higher identification skills than female students. Moreover, the interaction between educational level and hometown population (PEL*POP) had also a significant and positive effect reflecting that the effect of students' hometown population is dependent on their educational level or age. Finally, it is worth noting that, even if the effect sizes were relatively small, the model's total explanatory power is substantial (conditional R^2).

Selection of animals for protection

The animal most frequently selected by students was the European mink (70.1%), followed by the fire salamander (60.2%) (Table 3). The less selected animals were the common pill-bug (31.1%) and the natterjack toad (30.3%).

Factors influencing species conservation preferences

Regarding conservation preferences, the GLMMs showed that the studied variables did not present a clear pattern explaining why certain species were preferred over others, nor were they able to elucidate the factors influencing the selection of threatened species for conservation over common ones (Table 5). Nevertheless, the statistical analysis showed that most of the studied factors influenced students' willingness to protect certain species one way or another, with the exception of the type

of school (public/private) students were enrolled in. Overall, the bulk of factors related to species' identification both individually (ISx) and together (SIS) influenced the selection of the highest number of species (six), and showed the highest amount of significant effects (seven). In particular, the sum of the total identification scores (SIS) achieved by students was the independent explanatory factor positively affecting the highest number of species for protection (four). This variable partially explained the selection of the European mink, the white-throated dipper, the fire salamander and the common pill-bug; that is, both common and endangered species. The strong effect of this variable in the selection of the European mink and the fire salamander was especially noteworthy.

The subsequent factors showing individually a greater influence on species selection for protection (three species, each) were the identification scores achieved for each species (ISx), the primary education level students were attending (PEL) and students' gender (G). All the detected effects for ISx and PEL on animal selection were positive, and both variables partially explained the selection of two threatened species and one common one. Conversely, gender influenced the selection of two common species and a threatened one, and its effect was quite heterogeneous depending on the species. Male gender was negatively related to the selection of the wild boar and the smooth snake in comparison to females, and also in comparison to other genders in the case of the latter, and positively with the selection of the European pond turtle in comparison to females.

Finally, students' hometown population (POP) revealed a sole significant negative relation with students' protection preference, showing a higher predilection for the orange-spotted emerald the smaller students' hometown was.

Discussion

The poor native animal species knowledge detected in the current study (students reaching a mean of 19.9% of the potential identification score for all animals altogether) is in agreement with some previous observations stating that teenagers from the region have a limited species literacy (Barrutia et al., 2022; Díez et al., 2018; Pedrera et al., 2023). However, the present results reflect that this phenomenon has deep roots, being already present at early elementary schooling, and involves knowledge of both common and threatened native species in the region. This is deeply concerning, since children are usually very skillful in identifying and cataloguing species (Balmford et al., 2002), and this tends to drop off later, principally because of the low interest of youngsters when entering puberty (Bebbington, 2005). Hence, unless these children receive some training to help them increase their native ecological knowledge, they will reach adulthood as native species illiterates who cannot make proper decisions on local biodiversity issues.

This low awareness of native species seems to be a generalized syndrome in westernized countries (Genovart et al., 2013; Pilgrim et al., 2008) and can be a consequence of the "extinction of experience" (Pyle, 1978), that is, the current disconnection of citizens from nature (Soga et al., 2016). According to the NUTS (Nomenclature of Territorial Units for Statistics) classification (Eurostat, 2022), the study area (ES213) is predominantly urban, and urbanization has pressed children to have fewer opportunities to experience local fauna (Soga et al., 2016). Furthermore, urbanization *per se*, as a land-use change, is having a profound impact on biodiversity (IPBES, 2019), further minimizing children's chances of interacting with native wildlife. To all this, it must be added that people no longer need to know the names of local species in order to survive (Pilgrim et al., 2008), and that this traditional ecological knowledge does not pass from one generation to the next anymore, which has led to the societal extinction of native species names (Jarić et al., 2022).

Despite overall identification scores being low, mammals were the taxa achieving the highest identification scores, and the common wild boar (a large mammal) was the best identified among all the animals in the photographs. This observation coincides with the assertion that the most charismatic animal species for the Western public are large, often exotic, terrestrial mammals (Albert et al., 2018), and thus, these are the animals people better identify (Gerl et al., 2021; Hooykaas et al., 2019; Huxham et al., 2006; Jaun-Holderegger et al., 2022; Robles-Moral et al., 2022). Also, the high identification scores achieved by the wild boar can be the result of being a hunting species (Peterson et al., 2017). On the other hand, invertebrates' identification scored lowest, as they have in other studies (Bashan et al., 2021; Hooykaas et al., 2019; Huxham et al., 2006), which may be a consequence of the relatively low level of interest citizens have in this animal group (Palmberg et al., 2015).

The main factor associated with students' total identification scores was the primary school level they were attending. It has already been mentioned in a previous section that, in relation to biodiversity knowledge, the school curriculum in the Basque Country becomes more enriched when students go from the first cycle to the second cycle of Primary Education. Thus, this can partially explain the higher species knowledge of these students. In any case, personal experiences out of school can also have a positive effect on biodiversity literacy. Indeed, according to some authors, parents and the wider family can have more influence on children's knowledge of species than the school (Gatt et al., 2007; Lindemann-Matthies et al., 2017; Remmele & Lindemann-Matthies, 2018). The increase in the identification scores achieved by children as they grew older could also be linked to their developmental stage, since particularly the final period of Primary Education is usually marked by a major increase in cognitive, factual understanding, and knowledge of animals (Kellert, 1985).

Students' hometown population also had a weak although significant effect on the total identification score achieved by students, reflecting that the smaller or more rural a student's hometown was, the higher their knowledge of native fauna was. This result is in agreement with previous observations in the study area assessing 11 to 14 year-old teenagers (Barrutia et al., 2022; Díez et al., 2018; Pedrera et al., 2023), and also with other works conducted in westernized countries (Enzensberger et al., 2022; Palmberg et al., 2015). Most probably, as contact with nature is inversely proportional to urbanization (Zhan et al., 2014), the lower a student's hometown population was in this study, the more rural their surroundings would be, offering children more opportunities to interact with nature. Nevertheless, this effect was weak in the current work, probably because other factors can neutralize the influence of people's provenance on ecological knowledge, such as the predominantly urban character of the region (Eurostat, 2022), the convergence of rural and urban lifestyles nowadays and the stronger effect of the educational level as observed in other works (Bermudez et al., 2017, 2018; Gerl et al., 2021; Hooykaas et al., 2019).

Regarding gender, it has frequently been observed that boys outperform girls in their knowledge of species (Campos et al., 2012; Huxham et al., 2006; Jaun-Holderegger et al., 2022), although these effects appear to be increasingly diluted nowadays in westernized countries (Hooykaas et al., 2019, 2022) due to girls currently not experiencing the same gender socialization processes as in the past. In the present study, we have also observed that males identified slightly more accurately native animals than females, although the effect was very weak. In any case, this could be a consequence of boys having a stronger interest in wildlife (Fančovičová & Prokop, 2011), or due to cultural reasons, such as the hobby of hunting (Peterson et al., 2017).

When it comes to students' preferences for protecting the observed animals, we detected no tendency towards selecting the ones with a concerning conservation status. Among the three most selected animals, two were common and non-threatened in the area, and among the three least selected, two were threatened/endangered. Hence, factors other than conservation priority knowledge came into play in these students' selection of species for conservation. The highest preference for the European mink, one of the most endangered mammals in Europe, was not related to an overall higher familiarity or identification of this species, since it was the animal students had most problems to give a name to (most blank answers). Thus, its selection can be partially the result of humans' innate tendency to lavish attention and affection on animals with anthropomorphic infantile physical features, such as broad forehead, forward-facing rounded eyes, or a little, pointed nose (e.g., Martín-Forés et al., 2013; Smith et al, 2012). Also, the preference for protecting the salamander may be a consequence of children having a significantly stronger willingness to protect aposematic animals over inconspicuous, cryptic ones (Prokop & Fančovičová, 2013). On the contrary, the least chosen animals were the common pill-bug and the common toad, which can be a consequence of their discrete coloration but also because of emotions such as fear or disgust aroused by these taxa (Fančovičová & Prokop, 2017; Jimenez & Lindemann-Matthies, 2015; Soga et al., 2020).

In any case, we have statistically confirmed that there are some factors significantly linked to students' conservation preferences, with the strongest and the more frequent ones being species identification accuracy related factors (species specific, and the overall sum of identification accuracy). Indeed, individual species identification accuracy together with the total sum of species identification scores achieved by students accounted for the partial explanation of the selection of six species for conservation, three common and three threatened. Native fauna identification scores even predicted (although weakly)

the selection of the most unpopular species for conservation (the common pill-bug and the natterjack toad). Hence, it seems that species identification skills could partially shape peoples' conservation preferences in our study. These results may partially be explained by the fact that, when people can identify a species, their relationship with it becomes more respectful and intensive, receiving higher affinity levels and appreciation (Lindemann-Matthies, 2005; Schlegel & Rupf, 2010). However, this finding differs from the conclusions drawn from other works (e.g., Panisi et al., 2022) in which no link between species identification and conservation preference was detected. Maybe, the identification accuracy score method employed in the current study may have helped in finding these relations. It would also be interesting to check if ecological knowledge of species explain people's preferences for certain species protection, since knowing the name of a species does not mean students know everything about its ecology and conservation status, although it has been suggested that species identification skill can be a strong predictor of species in-depth knowledge (such as origin, habitat, diet, or behavior) (Hooykaas et al., 2022).

To finish, students' gender, PE level or hometown size also partially explained the selection of some species, but the effect was inconsistent and overall weak. Therefore, we conclude that the partial effects of the factors studied in the current work do not fully explain children's predilections when selecting species for conservation purposes. Thus, these resulting models with low explanatory power could mean that other factors not studied in the present work must also account for students' preferences, most probably cultural or subjective ones, such as aesthetic and emotional factors, personal values and beliefs, or the cultural significance of species (Castillo-Huitrón et al., 2020; Mota Pereira et al., 2023; Panisi et al., 2022). Consequently, future works should delve deeper into the reasons of these children for selecting some species over others.

Conclusions and educational implications

Disconnection from nature in wealthy countries, the lack of a proper biodiversity education, and the decline of many animal populations due to the current pressure of human activities on natural habitats, are resulting in a low knowledge of laypeople about native biodiversity. Current species extinction rates are much higher than in the past, when there was no anthropic effect. However, citizens usually do not know which species are endangered in their area, and their conservation preferences are biased by other factors rather than conservationists ones. They feel more attracted towards mammals, which is reflected in their knowledge and conservation preferences towards this animal group, eschewing groups which are less appealing to them, such as invertebrates. All this directly affects conservation campaigns and policies which is deeply concerning, since other taxa such as amphibians are in major risk of extinction.

However, in the current study, species identification accuracy was partially linked to a higher preference to protect certain species, including unpopular ones. Consequently, we conclude that more efforts towards enhancing species identification skills and promoting species knowledge should be conducted both in formal and non-formal education. In addition, conservation education should feature the appropriate information about effective conservation priorities, such as species with declining or threatened populations, or those with important ecological or evolutionary roles. In fact, some works have revealed that young people are willing to protect and prevent species loss, but they lack the necessary information regarding biodiversity preservation (Christ & Dreesmann, 2023; Gavrilakis et al., 2023). In this sense, although it had already been proposed in the last century (e.g., Noss et al., 1997), scientists are only recently realizing and ratifying that one of the keys to preserving biodiversity lies in the protection or adequate

management of species' habitats (O'Connor et al., 2021), as habitat loss is one of the main pressures on biodiversity nowadays (IPBES, 2019). From an educational point of view, teaching/learning about conservation linking species and their habitats, including the possible anthropogenic threats for habitat conservation, has several advantages: (i) teaching/learning can be properly contextualized; (ii) it offers an opportunity to learn based on real problems (Problem Based Learning) that are close to the students, that can be accomplished collaboratively and using inquiry as the main strategy to address it; (iii) it provides the opportunity to handle different information (such as anthropogenic effects on the environment) for a successful promotion of a committed eco-citizenship; and finally (iv) it is an excellent opportunity to teach/learn biodiversity place-based, in nature.

If these educational efforts are conducted from early ages, they can have a double impact on conservation attitudes and politics, as they will not only change children's knowledge and preferences towards species conservation, but also those of their parents, since children have a direct influence on the pro-environmental behaviors of close relatives (e.g., Deng et al., 2022; Lawson et al., 2019; Peterson et al., 2019). Hence, providing a proper biodiversity education to children would ensure more aware present and future generations towards biodiversity, and a more proactive eco-citizenship, opening the door to a hopeful future in the face of this serious problem of biodiversity loss and global change.

Limitations of the study

A limitation of this work, and probably of most works of this kind, could be the different vocabulary used by children (laypeople) and taxonomists when naming an organism (Patrick, 2017). The former name organisms at a superficial level whereas taxonomists possess a multilayered understanding of species which enable them to further

discriminate between the members of a group hierarchically. This can have implications in the current study when defining the taxonomic level of the animal mentioned by the student, and consequently in the identification score achieved. On this occasion, we have followed strict criteria when classifying students' responses into their corresponding taxonomic level because we sincerely think that imprecise species naming of laypeople can have severe consequences in their ecological knowledge and resulting biodiversity conservation preferences. For instance, it might have consequences when differentiating an alien species from a native one. For that reason, we also think that the methodology employed in this work (assigning $1/2^n$ exponential score values to each taxonomic level match) is the most appropriate one for this purpose.

Another limitation of the study was the age of youngest students (around 6 years old), who had difficulties conducting reading and writing exercises. In any case, the task was short, uncomplicated and did not require much writing. However, a contextualized task, rather than filling in a paper without a context, would have been preferable.

The selection of the species could also have a significant effect on children's results (both in the identification and conservation preferences). Hence, it would be interesting to conduct this type of research by focusing on a single taxon and/or using morphologically/evolutionarily more closely related species, preferably sharing the same ecological niche.

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