Universidade de Aveiro Departamento de BIOLOGIA
2015

EUNICE MARIA DA SILVA SOUSA

ESTRATÉGIAS PARA A COMUNICAÇÃO DE CIÊNCIA EM BIODIVERSIDADE.

STRATEGIES FOR THE SCIENCE COMMUNICATION OF BIODIVERSITY.

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Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Biologia, Especialização em Comunicação, Divulgação e Ilustração Biológicas, realizada sob a orientação científica da Doutora Ana Maria Rodrigues, Professora assistente do Departamento de Biologia da Universidade de Aveiro e co-orientação do Doutor José Teixeira, CIIMAR-UP.

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“Before returning to our boat, we walked across the town and came to a deep valley.
Here I first saw the glory of tropical vegetation. Tamarinds, Bananas and Palms were flourishing at my feet. I expected a good deal, for I had read Humboldt’s descriptions and I was afraid of disappointments: how utterly vain such fear is, none can tell but those who have seen experienced what I today have. It is not only the gracefulness of their forms or the novel richness of their colours, it is the numberless and confusing associations that rush together on the mind that produces the effect.
I returned to the shore, treading on Volcanic rocks, hearing the notes of unknown birds, and seeing new insects fluttering about still newer flowers.
It has been for me a glorious day, like giving to a blind man eyes, —he is overwhelmed with what he sees and cannot justly comprehend it. Such are my feelings, and such may they remain.”

Charles Darwin, St. Jago, January 16th 1832.

o júri

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palavras-chave

Biodiversidade; comunicação de ciência; livro infantil; educação ambiental; amfíbios; charcos; ciência cidadã; informação geográfica voluntária (VGI); avaliação.

resumo

O presente estudo teve como objectivos contribuir para a compreensão da percepção pública da biodiversidade, encontrar padrões da representação da biodiversidade nos meios de comunicação e promover estratégias para modificar estereótipos acerca da biodiversidade através da utilização da educação ambiental e de projetos de ciência cidadã, criando um publico mais consciente e ativo.

Foram desenvolvidos quatro estudos sobre os seguintes assuntos: 1) compreender as preferências dos adolescentes acerca dos animais, 2) perceber como a biodiversidade é retratada nos livros para crianças do Plano Nacional de Leitura, 3) avaliar o impacto de um projeto de educação ambiental dedicado à sensibilização do público sobre os charcos e a biodiversidade associada, e 4) compreender o potencial de uma ação de ciência cidadã no mapeamento de charcos no território português.

Os resultados dos vários estudos mostram uma visão limitada e distorcida acerca dos seres vivos por parte do público. Este aspecto está de acordo com o retrato da biodiversidade nos livros para crianças, que parecem constituir uma importante fonte de informação sobre a biodiversidade durante a infância.

Este trabalho também descreve a implementação e avaliação de uma produtiva estratégia de educação ambiental que foi capaz de modificar as atitudes do público para com os charcos e a sua biodiversidade, sobretudo em relação aos anfíbios. Finalmente, o presente trabalho também demonstrou que a implementação de uma ação de ciência cidadã foi capaz de envolver os cidadãos em ações de conservação de charcos e criar o primeiro mapa de charcos em Portugal através da utilização de mecanismos de Informação Geográfica Voluntária.

O presente trabalho utilizou metodologia inovadora para análise de dados e avaliação de impacto de projetos que podem ser úteis para o futuro da investigação em comunicação de ciência.

keywords

Biodiversity; science comunication; children books; environmental education; anfíbios; ponds; citizen science; volunteer geographic information (VGI); evaluation.

abstract

The present work aimed to contribute to understand the public perception of biodiversity, to find patterns of biodiversity representation in communication pathways and to promote strategies to modify stereotypes towards biodiversity, creating a more aware and active public through environmental education and citizen science projects.

Four studies were developed under the following subjects: 1) understanding young adults preferences about animals, 2) comprehend how biodiversity is portrayed in children's books from the Portuguese National Reading Plan, 3) evaluating the impact of an environmental education project on the public awareness of ponds and associated biodiversity, and 4) understanding the potential of a Citizen Science approach to map ponds in the Portuguese territory.

The results from the various studies showed a limited and distorted public view and awareness about living beings. This was found to agree with the biodiversity portray patterns in children´s trade books, which seem to constitute important sources of information about biodiversity during childhood. The present work also described the implementation and evaluation of a resourceful environmental education strategy that was able to change the public attitudes towards ponds and associated biodiversity, especially the amphibians. Finally, it also showed that the implementation of a Citizen Science action was able to engage citizens in pond conservation actions and create the first map of ponds in Portugal through the use of Volunteer Geographic Information mechanisms.

The work used innovative methodologies of data analysis and project impact evaluation that can be useful to future research in science communication.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

There is an increasing concern of scientists about the state of the environment worldwide and among all the environmental problems, biodiversity loss is a major focus (Elder et al., 1998; Baillie et al., 2004; Lindemann-Mathies & Bose, 2008; Cardinale et al., 2012).

Although environmental issues began to emerge in the middle of the last century, it was only in the 1980s that biodiversity became an important focus of scientific research and the first main conclusions pointed that biodiversity is being dramatically affected by human alteration of ecosystems (Baillie et al., 2004; Primack, 2010; Cardinale et al., 2012).

Later in the 1990s, biodiversity loss also became an issue of political and social discussion leaded by several international institutions (Lindemann-Mathies, 2002; Díaz et al., 2006; Fischer & Young, 2007; Novacek, 2008; Cardinale et al., 2012). Since then, biodiversity was addressed by many communication pathways to develop public awareness and became a subject of school curricula, journalism, TV documentaries and even museum exhibits.

Today, more than 20 years after the outline of the biodiversity problems, the 1992 Earth Summit, the boom of biodiversity and ecosystem functioning research and the "2010 Biodiversity Year" declared by the United Nations, the biodiversity loss is still increasing and the public awareness and behaviour almost did not change or was not accessed (Wilson, E. O. & Peter, 1988; Elder et al., 1998; Millenium Ecosystem Assessment, 2005b; Díaz et al., 2006; Novacek, 2008; The Galup Organization, 2010).

Taking these topics into account, several questions emerge in the attempt of understanding the relation between humanity and the environment. Despite thousands of evidences showing us that the human behaviour and life style is responsible for a significant percentage of the species endangerment status, habitats destruction and other environmental problems, there were very few studies about the characteristics of the relation between humans and nature that justify human environmental behaviour and several questions remain unanswered or little explored (Kaiser et al., 1999; Tanner, 1999; Kaplan, S., 2000; Stern, 2000; Kollmuss & Agyeman, 2002). What is the public perception of biodiversity in this modern, industrialized world? How does the biodiversity message arrive to the public? Which are the new tools and strategies for changing human attitudes and behaviours towards biodiversity? Most of all, why are those necessary?

The present work focused in understand the public perception of biodiversity and to implement and evaluate strategies that induce valuable and efficient knowledge and attitude change, which may lead to behavioural and life style changes towards biodiversity and the environment.

Thus, in order to glimpse some of the rules and strategies that guide, develop and strength the human relation with biodiversity, this work aimed to answer three main questions:

What is the public perception of biodiversity?

What does the public absorb from their contact (direct or indirect) with biodiversity issues?

Is it possible to upgrade public attitudes and behaviours towards biodiversity through focused science communication strategies? All these questions were deconstructed and translated into the following objectives.

1.1. General Objectives

The main objectives of this work are represented in Figure 1.1 and were:

a. Comprehend the public perception about biodiversity with particular focus on depreciated biodiversity and ecosystems;
b. Understand how biodiversity is showed in communication pathways: focus on books;
c. Create structured and effective strategies to contribute to modify stereotypes through science communication actions:
    i. Promoting positive attitudes through environmental education;
    ii. Encourage public participation, benefiting biodiversity, public and science.
    iii. Evaluate the impact of environmental education projects in changing public perception and attitudes towards biodiversity.

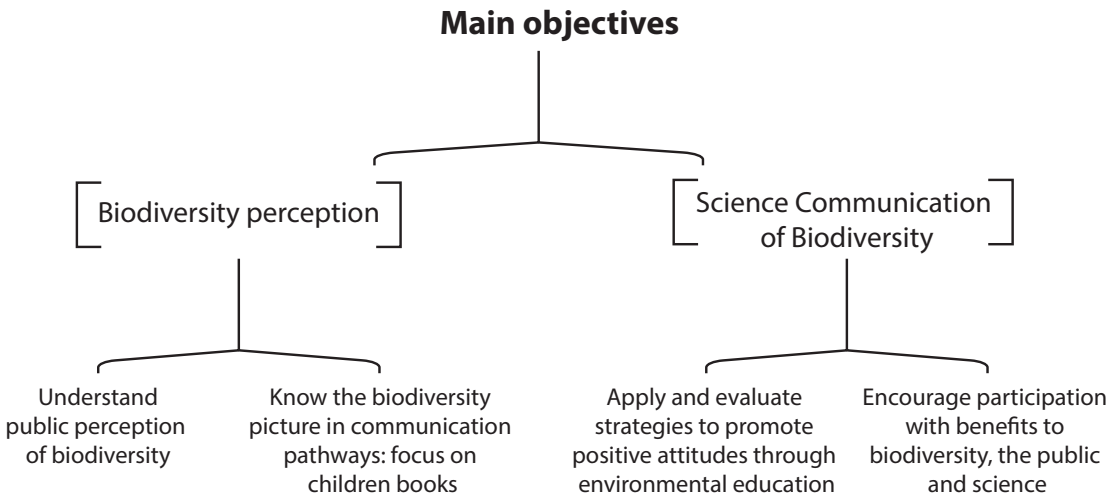

Figure 1.1 Main objectives of the present study.

In order to materialize these objectives several studies were developed.

Objective **a)**: Comprehend the public perception about biodiversity.

Identify the main problems related to the public perceptions about biodiversity:

- Collect and analyse data about the public preferences about biodiversity.
- Identify groups of biodiversity that lack public perception, understanding and awareness.
- Identify the public target sources of information about biodiversity.

Objective **b)**: Understand how biodiversity is showed in communication pathways: focus on books.

Understand the role of communication in biodiversity conservation: uptake of evolution of science communication throughout history; identify the most important communication pathways in biodiversity issues for the public; identification of gaps.

- Identify the public target's group sources of information about biodiversity.
- Analyse information about how biodiversity is presented and promoted by some sources of science communication: search for patterns, stereotypes and misconceptions.
- Identify parallelisms between target groups' perceptions of biodiversity and the messages that dominate science communication sources of information.

Objective **c)**: Create and evaluate structured and effective strategies to contribute to modify stereotypes through science communication actions by promoting positive attitudes through environmental education; encouraging public participation, benefiting biodiversity, public and science; evaluating the impact of environmental education projects in changing public perception and attitudes towards biodiversity.

Propose alterations in the view of science communication strategies about biodiversity by following pathways that, by its type, show to be determinant in constructing mental conceptions, perceptions, attitudes and behaviours about biodiversity.

- Propose science communication actions with this new point of view.
- Apply actions for the modification of attitudes about biodiversity.
- Promote the evaluation of science communication programs effectiveness.

1.2. THESIS ORGANIZATION

Chapter 1

Chapter 1 regards the present introduction to the work, the objectives definition and the thesis organization.

Chapter 2

Chapter 2 comprehends a bibliographic review of previous studies about the different themes addressed during this work. The lack of a strong legacy of studies in science communication involved an integrated review of the works done by previous authors from the most variable areas that feed the background of the newest science communication field. In addition, since biodiversity is the major focus of the present work, a review about biodiversity perception, education and conservation where also included. From this transversal review resulted the state of the art that was the basis for all the following work.

Chapters 3-6

The chapters 3 to 6 comprehend four different studies. The first two were focused in the understanding of the public perception of biodiversity and the contribution of communication pathways to this perception and the two others on the science communication of biodiversity through environmental education and citizen science.

The study flow chart is represented in Figure 1.2. The results of these studies described in these chapters correspond to papers submitted to international journals with the following titles: "Animal preferences follow Human phylogenetic proximity", "A portray of Biodiversity in children's trade books", "Measuring the impacts of an environmental education project on changing attitudes towards ponds and associated biodiversity" and "Citizen Science for habitat and biodiversity conservation: a public inventory of Ponds in Portugal". All papers are under review at the moment.

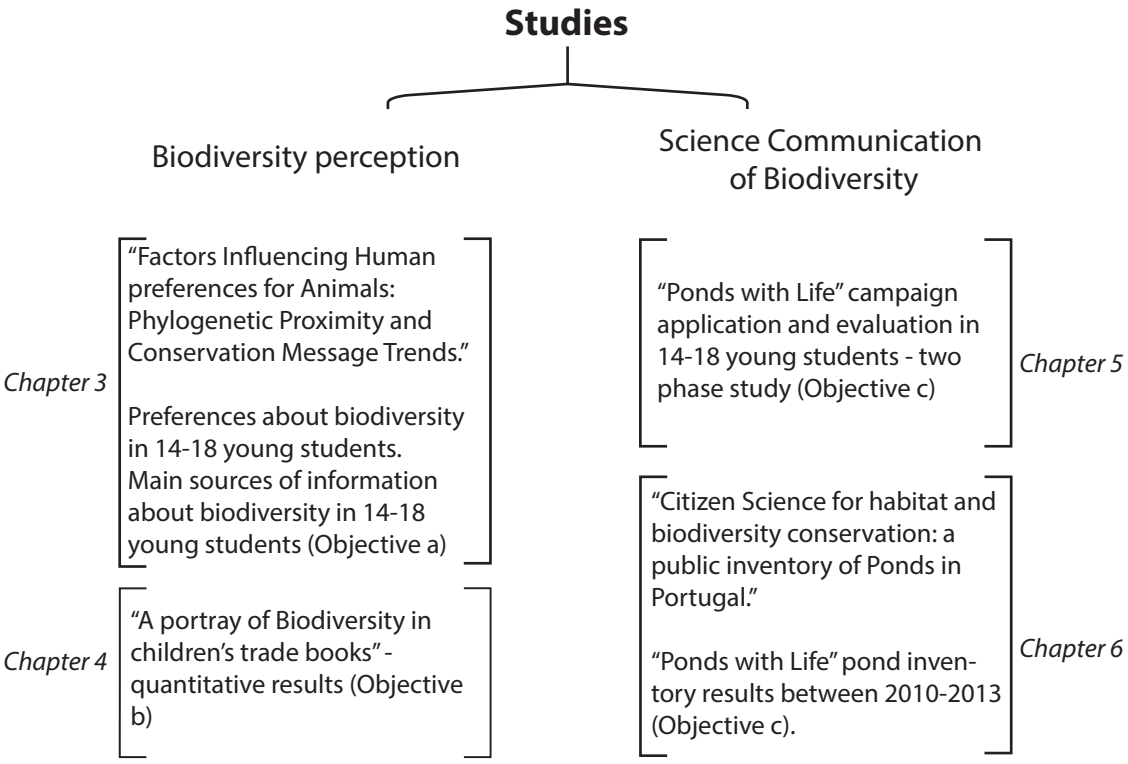

Figure 1.2 Studies flow chart and organization.

Chapter 7

Chapter 7 presents a brief discussion of the entire work. Since all the studies were written to be submitted to international scientific journals, they are individually discussed in the respective

chapters. However chapter 7 comprehends a short discussion and conclusions about the four studies and its contribution to the field of biodiversity science communication in a holistic point of view.

Chapter 8

Chapter 8 presents the list of the references used in the entire thesis document.

Annexes

The annexes chapter includes a collection of documents associated with the studies described in chapters 2-5. It includes tools or raw data used in the collection and analysis that were not necessary for the comprehension of the studies but can provide additional information. Questionnaire forms from the several studies are also integrated. All the annexes tables and contents are presented in Portuguese since it was the language used in all the tools for all the studies including the books, the questionnaires, the student's responses and the websites. This was due to the fact that annexes aim to provide additional raw data and mainly because some ambiguity could be associated to the translation of species common names, and other terms, into English.

1.2.1. Chapters 3-6 summary:

Chapter 3: Factors influencing preferences for Animals.

A questionnaire based on social sciences was applied in order to understand animal preferences within the Portuguese young people trough 14-18 years old. This age period was chosen because, according to Kellert (Kellert, 1985a) it reflects the period of greatest loss of interest in biodiversity issues in which only the strongest convictions will pass to the adults attitudes.

Chapter 4: A portray of Biodiversity in children's trade books.

Since books play an important role in some groups of public as a source of information, especially in young children (More, 1977, 1979; Ganea, Patricia A. et al., 2011; Gonen & Guler, 2011; Williams, J. et al., 2012) and as tools of concept transfer and vicarious experience with biodiversity, 164 children trade books oriented to 6-8 years from the 2011 National Reading Plan list, prevailing for 2011-2012, were analysed in order to understand how biodiversity is portrayed in literature. Several variables were evaluated in the book sample content including biodiversity frequencies, anthropomorphization features or habitat occurrences.

Chapter 5: Measuring the impacts of an environmental education project on changing attitudes towards ponds and associated biodiversity.

The "Ponds with Life" (http://www.charcoscomvida.org/) environmental education project was developed to raise public awareness and engagement in the study of ponds, by promoting the direct contact between the public and nature, researchers and pedagogical hands-on exploration activities. The students were followed in 5 visits to their schools during the development of lectures, workshops, exhibitions, and experimental activities in the classroom, laboratory and field.
A two-stage evaluation scheme was set-up to assess the impact of the project on environmental consciousness, knowledge and attitudes changes towards ponds and the associated biodiversity of school students aged 15 to 18, during the scholar year of 2013/2014. The evaluation included inquiry techniques and innovative methodology for data analysis making use of multivariate hypothesis testing.

Chapter 6: Citizen Science for habitat and biodiversity conservation: a public inventory of Ponds in Portugal.

The Pond Inventory (www.charcoscomvida.org/charcos-em-portugal) is an online mapping tool based on a Google Maps application that was created and embed in the website of the "Ponds with Life" project (www.charcoscomvida.org) to inventory ponds and similar water bodies in the Portuguese territory. This study enables to produce the first map of ponds and similar water bodies in Portugal based in public participation and Volunteer Geographic Information, a type of Citizen Science method(Cohn, 2008; Elwood, 2008).

2. RELEVANCE OF THE STUDY AND STATE OF THE ART

2.1. BIODIVERSITY STATE

Biodiversity is the whole expression of life on Earth, the authentic "world wide web", the interwoven fabric of life (Elder et al., 1998). Biodiversity is the short word for the term "Biological Diversity". According to the United Nations 1992 Earth Summit and the United Nations Convention on Biological Diversity(1992), biodiversity is the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, and also includes the diversity within species, between species and of ecosystems (Wilson, E. O. & Peter, 1988; Hawksworth, 1996).

Although over 1.2 million species are already catalogued it is predicted that about 86% of existing terrestrial species and 91% of species in the ocean are not yet know or described (Mora et al., 2011). It is difficult to calculate the proportion of threatened species since the number of threatened species is increasing every year and also new species are being discovered and described continuously. However, so far, nearly one quarter of the world's mammals, one third of amphibians and more than 1 in 8 of all bird species are considered to be at risk of extinction (Vié et al., 2009).

Biodiversity and ecosystems change over time due to natural causes, which contributes to the progressive evolution of species. However, in the last decades, species extinction had a massive increase mainly caused by anthropogenic drivers (Baillie et al., 2004; Heal, 2005; Primack, 2010). Direct drifters as habitat change, climate change, invasive alien species introduction, overexploitation of natural resources and pollution have different intensity impacts in biodiversity and can show additive effects when combined (Lovejoy & Hannah, 2005; Millenium Ecosystem Assessment, 2005a; Gore, 2006). Other indirect drifters as human demographic, economic, socio-political, cultural, religious, scientific and technological changes, also induce important changes in biodiversity and ecosystems leading to the uncontrolled consumption of natural resources, to a dramatic, sometimes irreversible, pressure on biodiversity (Millenium Ecosystem Assessment, 2005a).

Since the end of the 20th century, several guidelines for nature conservation were established in order to stop biodiversity loss through a variety of mechanisms including protected areas definition, species introduction prevention, slowing climate changes, re-educating the populations or promoting sustainability (Primack, 2010). Among the mechanisms, the identification of biodiversity hotspots and the conservation efforts in those areas, was considered a very important procedure to reverse biodiversity loss (Myers et al., 2000). Twenty-five hotspots were defined by the scientific community covering an area of 12% of the earth's terrestrial surface (Figure2.1).

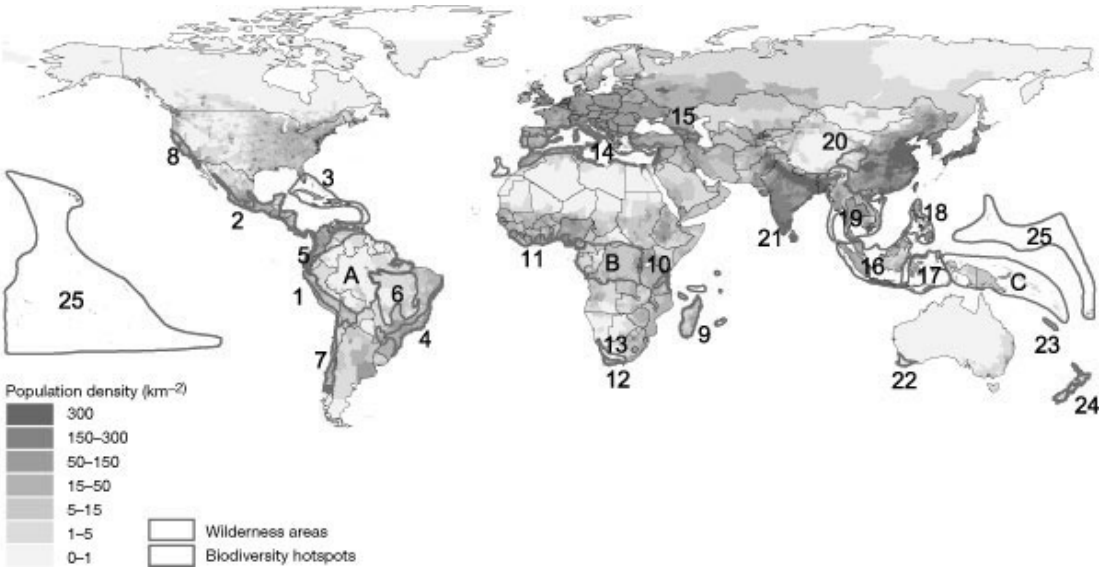

Figure 2.1 Biodiversity Hotspots and population density. Hotspots: (1) Tropical Andes; (2) Mesoamerica; (3) Caribbean; (4) Atlantic Forest Region; (5) Chocó-Darién-Western Ecuador; (6) Brazilian Cerrado; (7) Central Chile; (8) California Floristic Province; (9) Madagascar; (10) Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya; (11) West African Forests; (12) Cape Floristic Region; (13) Succulent Karoo; (14) Mediterranean Basin; (15) Caucasus; (16) Sundaland; (17) Wallacea; (18) Philippines; (19) Indo-Burma; (20) Mountains of South-Central China; (21) Western Ghats and Sri Lanka; (22) Southwest Australia; (23) New Caledonia; (24) New Zealand; and (25) Polynesia and Micronesia. Major tropical wilderness areas: (A) Upper Amazonia and Guyana Shield; (B) Congo River Basin; and (C) New Guinea and Melanesian Islands. In Cincotta, 2000.

In 1995 more than 1.1 billion people (approximately 20% of world population), were living within these biodiversity hotspots with a high growth rate during the 21st century (Cincotta et al., 2000). For this reason, it is very important to invest in public awareness education to develop a society actively involved in biodiversity and environment conservation.

2.2. Characteristics of the Pro-environmental behaviour

Human societies have been built on biodiversity and benefit from the diversity of organisms used in several activities and influencing human well-being (Millenium Ecosystem Assessment, 2005a; Díaz et al., 2006). Biodiversity contributes with ecosystem goods and services, as well as intangible cultural, aesthetic and spiritual values and in a ultimate view, with a sense of identity (Daily, 1997; Heal, 2005; Lindemann-Mathies & Bose, 2008). Moreover, biodiversity contributes to security, resiliency, health and social relations. There are many values attached to biological diversity are many and can be classified in 3 major classes: economic, social/psychological and ecological values (Nunes & Bergh, 2001; Novacek, 2008).

Although biodiversity has an unquestionable economic value, the public perception about it is limited to a utilitarian point of view that includes all the raw materials that we use as food, wood, materials for cloths, pharmaceutics and technology(Novacek, 2008; Kelemen et al., 2011). However, among biodiversity and ecosystem services that have economic relevance there is also non-monetary values related with the role of biodiversity on numerous complex ecologic

processes as pollination, air and water purification, soil production, which are much related with the ecological value of biodiversity, based on the intrinsic importance of biodiversity in the ecosystems (Nunes & Bergh, 2001).

Finally it is widely recognized that biodiversity has social/psychological values like comfort, aesthetics, culture, integrity, stability or resilience. The public is more likely to recognize biodiversity psychological values and economic values but struggle to recognize ecological values because of their complexity (Novacek, 2008).

People do care about the environment but it is consistently not among the top of public concerns and is not reflected in behaviour changes (Elder et al., 1998).

The early models of the environmental behaviour (1970s) proposed a linear progression from environmental knowledge to awareness, then to attitudes and finally to pro-environmental behaviour (Kollmuss & Agyeman, 2002; Prokop, Pavol & Tunnicliffe, 2008). Attitudes are based on feelings, beliefs, knowledge and that predispose our reactions to objects, people and events (Tomazic, 2008). And despite attitudes have been a powerful predictor of ecological behaviour, the most recent researches indicate that the antecedents of behaviour are much more complex (Ajzen, 1985; Kaiser et al., 1999; Tanner, 1999; Kollmuss & Agyeman, 2002; Chawla, Louise & Cushing, 2007).

As *theory of planned behaviour* (Ajzen, 1985) supports, the "intention to act" component is an immediate antecedent of behaviour. Therefore, attitudes do not determine behaviour directly but they surely influence behavioural intentions that shape our actions (Tanner, 1999; Kollmuss & Agyeman, 2002). Other socio-cultural behaviour constrains like gender, socio-economic status, income, political institutions and so on, can also moderate behaviour (Kaiser et al., 1999; Tanner, 1999; Johansson & Heningsson, 2011).

Considering pro-environmental behaviour, authors evidence that perceived control is one of the most important intrinsic norms influencing behaviour and it is associated with individual's perception of behaviour ability: people must believe that they can have an effect through behaviour (empowerment) that they are able to perform (perceived control) (Stern, 2000; Chawla, Louise & Cushing, 2007). Thus, pro-environmental behaviour must be objectively possible, noticeable and individuals must consider the alternative behaviour to be relevant for them. A lack of perceived control lead to helpless feelings and environmental passivity (Kaplan, S., 2000; Lindemann-Mathies & Bose, 2008).

In addition, some studies indicate that people who have satisfied their personal needs are more likely to act ecologically because they are able to care about bigger, less personal, social and pro-environmental issues (Kollmuss & Agyeman, 2002; Manfredo, 2003). All these studies contributed to the comprehension of pro-environmental behaviour suggesting that an "active caring" can only occur if the basic needs as well as needs of motivation, self-esteem, belonging, personal control, self-efficacy and optimism have been satisfied (Kollmuss & Agyeman, 2002).

On the contrary, pro-environmental behaviour is prevented by a multitude of constrains or barriers that assume many forms (Tanner, 1999; Kollmuss & Agyeman, 2002; Chawla, Louise & Cushing, 2007). Some barriers prevent preference for a particular behaviour alternative and depend on lack of previous experience, routine or motivation. Others prevent activation of behaviour such as income, limitations of time, price, legal and political institutions, state of scientific knowledge, available technology, infrastructures, social interaction, information

network and social rules or settlements. Finally there are barriers that prevent the performance of a particular behaviour which are strongly dependent on what individuals think it is more pleasurable or permissible as beliefs or motivations (Frey & Foppa, 1986).

The link between all the factors that determine pro-environmental behaviour is not definitely resolved yet but it is clear that all the addressed factors correlate somehow and are dependent on many other secondary factors. Regarding the studies mentioned above, and although any diagram clearly unflatters the complexity of this issue, the relation between all aspects previously addressed is summarized in Figure 2.2.

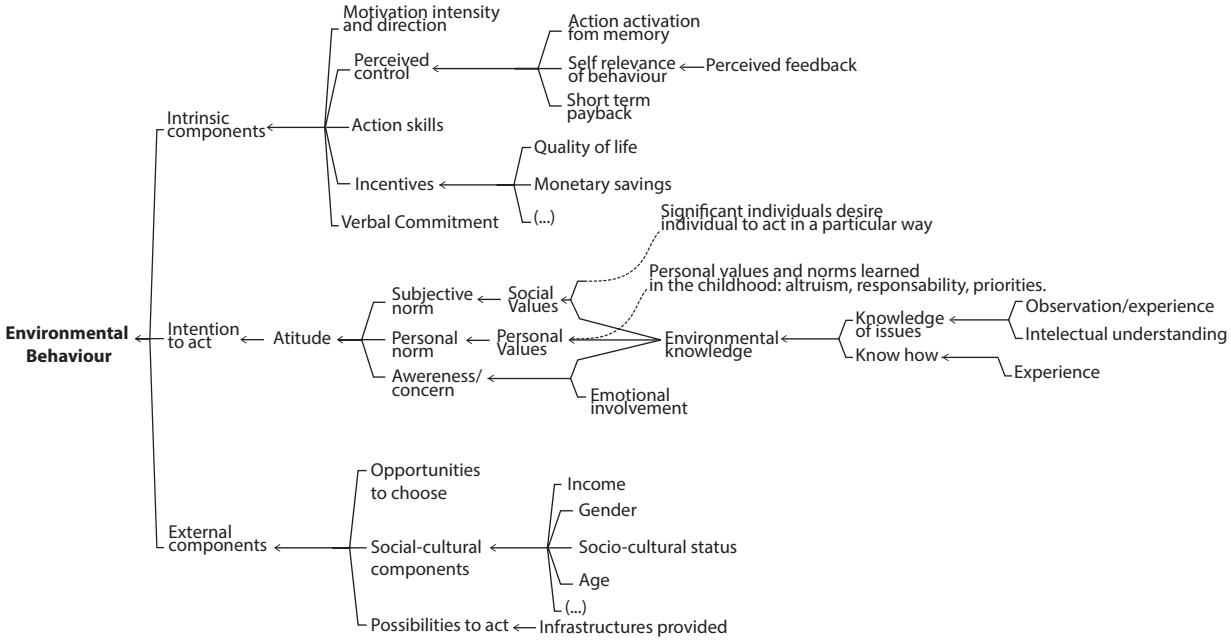

Figure 2.2 Factors that determine Environmental Behaviour. The diagram does not represent all the complexity of the issue because it would compromise its practicability. It also does not represent constrains for environmental behaviour but suggests that the lack of any of the represented factors will constrain it in a higher or lower level. Factor's intensity, direction or strength isn't addressed.

Despite this complex relation, attitudes appear to have a very important role in pro-environmental behaviour and biodiversity perception thus, it became imperative to understand the antecedents of attitudes towards biodiversity.

Several studies focused on the factors behind human attitudes about biodiversity. A wide variety of factors as prior knowledge, values, previous experience, cultural relationship between species and humans, and human's perceptions of individual species as well as other features: physical attributes, size, aesthetics, intelligence, attractiveness, familiar body appearance, similarity and phylogenetic relation to humans, harmfulness, predatory tendencies, tendency to inflict property damage, cultural relation with society, geographic variation, rarity and conservation context, values and nativeness. All these factors were recognized to have some influences on attitudes towards specific species and may redirect conservation actions affect human attitudes towards animals (Kaplan, R. & Kaplan, 1989; Kellert, 1993; Plous, 1993; Kellert, 1996; Czech et al., 1998; Davey et al., 1998; Prokop, Pavol & Tunnicliffe, 2008; Primack, 2010; Fischer, Bednar-Friedl, et al., 2011; Prokop, P. & Fancovicová, 2013; Askew et al., 2014). In addition, several studies suggest

factors as nativeness, endanger, rarity, balance, naturalness, uniqueness can even influence the focus of conservation attention (Kellert, 1989; Prokop, Pavol & Tunnicliffe, 2008; Fischer, Bednar-Friedl, et al., 2011).

On the other hand, the characteristics and circumstances of human perception also influences attitudes towards non-human species. Differences of attitude were found between gender, age, income, education or residence appear to influence the attitude development towards biodiversity (Kellert, 1989, 1993, 1996; Manfredo, 2003; Serpell, 2004).

Moreover, some authors also consider some genetic predisposition to attend to, and be attracted by, the activities of animals and other living things that modern humans have supposedly inherited from their hunter-gatherer ancestors (Biophilia Hypothesis) (Wilson, E. O., 1984; Kellert, 1993; Peter H. Kahn, 1997).

Within factors influencing attitudes towards species, local cultural context can have considerable influence on conservation decisions and outcomes creating alternative conceptions or that are generally resistant to change by conventional education strategies (Prokop, Pavol & Tunnicliffe, 2008; Waylen et al., 2010). Both animals and plants are wrapped of different quantities of cultural and symbolic meaning that greatly influences how people regard and treat them (Serpell, 2004). Currently, several species of amphibians and reptiles are persecuted because of public misconceptions which is greatly contributing to the extinction of several species (Ceríaco et al., 2011). The myths, folklore tales and other cultural values relating with these animals, present them as dangerous and venomous, pass throughout generations and contribute to the nurture the public misconceptions towards them (Serpell, 2004; Novacek, 2008; Prokop, Pavol & Tunnicliffe, 2008; Ceríaco et al., 2011).

2.2.1. PUBLIC ATTITUDES TOWARDS BIODIVERSITY.

The set of all factors mentioned above determine some features previously addressed by other authors about the public attitudes towards Biodiversity.

The word *"species"* is usually linked with animals rather than plants and usually reports to a very limited mental concept of fauna diversity generally referring to vertebrates, especially common, well-know mammals, birds, pets and zoo creatures that usually have four legs, fur and making familiar sound (Bell, B. F., 1981; Wandersee, 1986; Wandersee & Schussler, 2001; Lindemann-Mathies, 2005; Yen et al., 2007).

Besides being considered attractive and commonly used in environmental education, public opinions about plants are mainly neutral, which may suggest a less informed public about this taxonomic group (Bednar-Friedi et al., 2004; Randler et al., 2005; Fischer, Bednar-Friedl, et al., 2011; Reis et al., 2011).

Considering animals, several studies reported that mammals and birds are the most appreciated animals by the public and are described as being beautiful, intelligent, having large size, beautiful colours, being powerful, cute, fluffy, and with a nice personality (Bednar-Friedi et al., 2004; Fischer, Bednar-Friedl, et al., 2011). In addition, when humanoid features are represented, for example, in children books by meanings of anthromorphization features, it usually encourages familiarity and affection for these animals that may be directing their preferences to this group (Morris, 1961; More, 1979; Woods, 2000).

Other biodiversity groups, on the other hand, are invariably disliked. Amphibians, despite being a class of animals toward which the attitude of the public has been scarcely researched, were reported to be categorized as disgusting animals along with some reptiles and invertebrates (Woods, 2000; Randler et al., 2005; Tomazic, 2008, 2011a; Ceriaco, 2012; Askew et al., 2014). Amphibians are also associated with several cultural misconceptions of being ugly, pests, poisonous, useless and to have detrimental impact on wildlife and environment (Tomazic, 2011c; Ceriaco, 2012). Some studies reported that attitudes of disgust or fear towards some animals might be learned through vicarious experience, even if children did not ever direct contact with them (Askew et al., 2014). On the other hand, when amphibian species are used in direct contact environmental education activities, children's affection for them improves considerably (Tomazic, 2008, 2011c).

Reptiles are also described as poisonous, deadly, ugly, scary, dangerous, aggressive, slimy and promoting fear (Knight, 2008; Prokop, Pavol et al., 2009; Tomazic, 2011b; Ballouard et al., 2013). In addition, there are some difficulties between the public making the difference between amphibians and reptiles (Yen et al., 2007). Again, several studies about traditional ecological knowledge showed that cultural factors, like myths or folklore tales, are also influencing attitudes towards reptiles through persecution and extermination (Alves et al., 2008; Prokop, Pavol & Tunnicliffe, 2008; Sasaki et al., 2008; Ceríaco et al., 2011; Tomazic, 2011a; Ceriaco, 2012; Ballouard et al., 2013).

People also express negative feelings of aversion, dislike, or fear towards most of invertebrates and disapprove major economic sacrifices to protect endangered invertebrates (Kellert, 1993; Yen et al., 2007). In addition, people have little knowledge of invertebrates usually limited to agriculture, basic biological characteristics, injury and disease (Woods, 2000; Bednar-Friedi et al., 2004; Fischer, Bednar-Friedl, et al., 2011).

As a pioneer in research about attitudes toward biodiversity, Stephen Kellert developed a typology of nine basic attitudes toward wildlife and biodiversity that could be easily adapted to the general species, specific groups, or perhaps to habitats or even the environment (Kellert, 1996; Hunter & Brehm, 2003; Serpell, 2004). Despite other authors worked over this basic attitudes creating less complex ways of using them, Kellert's basic attitudes are still used as important tools to understand people's basis attitudes towards animals and nature (Serpell, 2004). Kellert's basic attitudes are presented in Table 2.1.

Table 2.1 Basic attitudes towards wildlife and biodiversity proposed by Kellert (Kellert, 1996).

Factor	How does it influence?
Utilitarian	Practical and material exploration of nature.
Naturalistic	Direct experience and exploration of nature.
Ecologistic-Scientific	Systematic study of structure, function, and relationship in nature.
Aesthetic	Physical appeal and beauty of nature.
Symbolic	Use of nature for language and thought.
Humanistic	Strong emotional attachment and "love" for aspects of nature.
Moralistic	Spiritual reverence and ethical concern for nature.
Dominionistic	Mastery, physical control, dominance of nature.
Negativistic	Fear, aversion, alienation from nature.

As Kellert found out, negativistic, aesthetic and utilitarian arguments are the most determinants in attitudes toward invertebrates and could have their origin on cultural associations between arthropods and human disease, agricultural damage and a perceived "monstrosity" related with the morphological differences between humans and the generality of invertebrates (Kellert, 1993; Woods, 2000).

2.3. Connection with Biodiversity

Several studies demonstrated that the scientific knowledge and familiarity with the term "Biodiversity" was used as a measure of public understanding of biodiversity, and concluded that the public was insufficiently informed about biodiversity and needed to be educated focusing environmental concepts (Hunter & Brehm, 2003; Fischer & Young, 2007; The Galup Organization, 2010).

Biodiversity is a term that lives largely in the domain of scientists and conservationists but remains remote and is rarely used by the general public (Elder et al., 1998; Bednar-Friedi et al., 2004; Lindemann-Mathies & Bose, 2008). In addition *"Biodiversity"* is not the user-friendliest word and from a didactical point of view, provides a challenging starting point for public education (Elder et al., 1998; Weelie & Wals, 2002; Randler et al., 2005; Novacek, 2008).

However, understanding biodiversity is not the same as knowing the term "*biodiversity"*(Bednar-Friedi et al., 2004; Fischer & Young, 2007). It was recognized that the public express rich mental constructs about biodiversity mainly based on a general universal concept of life, strongly biased by an idyllic, distanced view of nature in which humans and human threats are absent but lacking any understanding of ecological relations and genetic diversity (Elder et al., 1998; Bednar-Friedi et al., 2004; Christie et al., 2006; Fischer & Young, 2007; Fischer, Bednar-Friedl, et al., 2011; Fischer, Langers, et al., 2011; Kelemen et al., 2011). In accordance to this, the public values towards biodiversity fluctuate between a "protection-use" and "wildlife appreciation" despite we are assisting to a more protectionist point of view towards biodiversity and ecosystem processes and services, comparing to the more materialistic conduct of the first half of the 20th century (Biodiversity Project, 1996; Fulton et al., 1996; Nunes & Bergh, 2001; Manfredo, 2003; Bednar-Friedi et al., 2004; The Galup Organization, 2010).

This disconnected understanding of biodiversity and ecosystems translate a poor connection of the public with nature. Today, about 50% of the world's population lives in urban areas and are disconnected from nature, having little direct contact with local natural environment and biodiversity (Miller, J. R., 2005). Vicarious experiences are progressively substituting direct and real personal experiences becoming important links between the public and nature and gradually transforming the human–environment bond in a virtual relationship, in which the media are key players as information drifters (Kaplan, R. & Kaplan, 1989; Kellert, 2002; Miller, J. R., 2005; Pergam & Zaradic, 2006; Chawla, L. , 2006 ; Ballouard et al., 2011; Zhang et al., 2014). Beyond indirect contact, the connection with nature is somehow superficial and relies on sensory experiments (Bednar-Friedi et al., 2004).

Because of this public concern are apparently related with media trends that influence public opinion and quickly move concern from one or another focus issue (Novacek, 2008). The fact that media messages about conservation issues are usually based on a few iconic, flagship and

charismatic species are may be decreasing the knowledge about local biodiversity (Andelman & Fagan, 2000; Ballouard et al., 2011; Veríssimo et al., 2011). In this context people view nature as exotic, cute, awe-inspiring and it only appears in far, faraway places, which provably they will never experience (Novacek, 2008)(Chipeniuk, 1995; Ballouard et al., 2011). This lack of appreciation of the richness of biodiversity yields a distorted picture of what is really at risk.

2.4. SCIENCE COMMUNICATION

2.4.1. BRIEF STORY OF SCIENCE COMMUNICATION.

Academic scientists always carried out basic research in laboratories, motivated purely by the spirit of inquiry and its application in business or technology, a interaction that usually excludes the wider public (Wilson, J. & Willis, 2004; Science for All Expert Group, 2010). Since the 60s that science and technology started to face the public distrust, controversy and accountability (Watermeyer, 2010) (Carrada, 2006; Watermeyer, 2010). The term "scientific" began to take on negative connotations, to lose its credibility due to negative icons like "DDT" or "Chernobyl" and evoking more doubts than guarantees (Carrada, 2006). Since then and until the end of 90s, scientists and the public became alienated from each other resulting in a weak scientific literacy level of the public, a lack of interest about science and a increasing amount of negative attitudes towards science (Chagas, 1999; European Commission, 2008).

During the last decades we assisted to a citizen scientific literacy promotion movement in Europe in response to the perceived "crisis of trust" felt at the time. As an initial response scientists embarked in the mission to inform the public and elevate scientific literacy (Wilson, J. & Willis, 2004). The United Kingdom was prominent in this movement and started the "The Public Understanding of Science" (PUS) by developing a clutch of initiatives to tackle the public ignorance about scientific issues in the Dobmer's 1985 report for the Royal Society (Society, 1985; Wilson, J. & Willis, 2004; Watermeyer, 2010). The movement was based on the "deficit model" of the public as ignorant and science as unchanging and universally comprehensible (Wilson, J. & Willis, 2004; Carrada, 2006). Science communication was a simple matter of instruction and it was supported by a top-down approach: the only strategy was based on transmitting a large collection of facts that weren't related with the public everyday life and it ignores the public opinion and contribution(Society, 1985; Vieira, 2007; European Commission, 2008). Even the science education curricula were mainly interested in preparing learners to be future scientists rather than endow the public with competences to make a personal judgment about science issues (Vieira, 2007).

The evolution of PUS went along with an evolution of science literacy characterization. In a first moment, science literacy was defined as the level of understanding of scientific issues based in a threshold level of knowledge: basic vocabulary of scientific terms, concepts, processes and methods (Chagas, 1999; Miller, J. D., 2006). The results of this movement quickly showed that science-related issues were related with values and worldviews rather than the lack of scientific knowledge which demonstrates that knowledge is not enough to the public to make useful and valuable contributions to science and technology (McCallie et al., 2009).

The result of many studies about scientific literacy during the 60's and 70's elevated the concept to a "science for all" dimension where science is accessible and linked with daily social problems (Chagas, 1999; Vieira, 2007; McCallie et al., 2009). In 1989, the American Association of the Advancement of Science (AAAS) proposed that a student, to be scientifically literate, must i) be familiar with the natural world as the unique unit of its kind; ii) be conscientious of relevant interdependence between several areas (mathematics, technology and science); iii) understand some key-concepts and science principles; iv) be able to think scientifically; v) know that science, mathematics and technology are human constructs; and finally, vi) be able to use scientific knowledge in their personal and social lives (Vieira, 2007). Since then, the main objective of education was to give learners the power to think and make changes by themselves (DeBoer, 2000). This education field was focused in skills acquisition rather than knowledge and is based in new approaches of formal and informal education strategies (Chagas, 1999; Vieira, 2007).

According to the evolution of education and literacy concepts a perceptible shift occurred from public understanding of science (PUS) to a "Public Engagement in Science" (PES) (European Commission, 2008; Watermeyer, 2010). The term "engagement" is characterized by a mutual learning, encompassing many elements of two-way communication and enhancing a more reflexive approach, the empowerment and skill development by publics, scientists and policy makers (McCallie et al., 2009; Bultitude, 2011). There is a body of evidence showing that this approach generate new forms of social intelligence and create mutual benefits by stimulating new directions for innovation in a win-win mechanism (Dias et al., 2003; McCallie et al., 2009; Science for All Expert Group, 2010; Bultitude, 2011; European Commission, 2011).

By accepting the PES perspective, decisions are no longer made by the scientific community alone or by some government department but more and more often, are the result of a complex negotiation with a several social groups creating legitimacy and a sense of shared responsibility (Carrada, 2006; McCallie et al., 2009).

Despite the progress in science communication basis, the links of public engagement remain fuzzy and unclear, the philosophy of expert leadership and one-way communication still predominates and science literacy remains low (Wilson, J. & Willis, 2004; Carrada, 2006; European Commission, 2008; Science for All Expert Group, 2010). First, decisions usually need some kind of link to the political system but public and politics are split into different worlds, and people use to delegate decisions to the politics (Science for All Expert Group, 2010). In addition the knowledge gap between science communities and society remains and public engagement uncoupled with science literacy and empowerment will have tackled only half of the job and vice versa (Elder et al., 1998; European Commission, 2008). Finally, the dialogue tends to be restricted to certain issues and the task of defining what are the priority issues falls again into the experts, leaving citizens with no capacity to decide and negotiate base questions and priorities, which shows us that one deficit model (PUS), was only replaced by another (Wilson, J. & Willis, 2004). In the last decade, however, the relationships between science and society have begun to change to ensure that the debate takes place "Upstream" - to an earlier stage in the processes of research and development - as new areas in the scientific and technological development process emerge, and not downstream where technologies are just waiting to be exploited but may not be held because of public scepticism brought by a poor engagement (Wilson, J. & Willis, 2004; Carrada, 2006). As a conclusion, within less than 20 years the conversation between science and society has changed

radically from patronizing tones of public understanding to a warmer participated dialogue that is still being drawn (McCallie et al., 2009).

2.4.2. PATHWAYS TO THE PUBLIC

The pathways to the public are diverse, act together and have different impacts. Several studies reported the influence of each type of information and communication sources: personal experience, media, internet, cultural events, museums, books, environmental education, etc.
Personal and community experience is, by far, the most effective source of knowledge, attitude and behaviour formation to us. Personal, free-choice learning is typically characterized as learner-motivated, guided by interests, personal, contextually relevant, collaborative, nonlinear and open-ended (Falk, J. H. & Dierking, 1998; Falk, J. H. et al., 2007; Bell, P. et al., 2009; Rodari, 2009). On the other hand it takes more time, energy and resources and is more conductive to misconception than other types of communication pathways (Elder et al., 1998).
Regarding biodiversity, personal experiences based on local biodiversity and everyday life contact with species from our own backyards and gardens are very effective since the public interests are strongly dependent of their experiences (Vieira, 2007; Lindemann-Mathies & Bose, 2008; Ballouard et al., 2011).
Other important contributors are usually family, friends and teachers (Chawla, Louise & Cushing, 2007; Askew et al., 2014). Schools, for instance, may have important roles in restoration of human-nature connection providing a common denominator in experiences and knowledge about biodiversity, ecological principles and processes (Elder et al., 1998; Brewer, 2002; Randler et al., 2005; Tomazic, 2011a).
The fact that our personal experience in nature is declining, other pathways are now determinant to create attitudes and behaviours towards biodiversity and the environment (Miller, J. R., 2005).
Media is an informal mechanism of exposing facts that currently uses image to empower its messages and forest direct interaction and mutual learning (McCallie et al., 2009).
Media frequently acts as intermediary between scientists and the public. Global problems, for instance environmental problems, became dependent on media projection since they are not personally experienced (Schmidt, 2008; The Galup Organization, 2010). The most popular means for dissemination of scientific knowledge and environmental issues outside formal modes of science education are Websites, Television, radio and newspapers (European Commission, 2005, 2008; Watermeyer, 2010). Media are important intermediaries between scientists and the public. However the relation between scientists and journalist is not pacific: the scientist is not able to explain, and the journalist address the issues superficially and commonly call on pseudo-experts, decreasing the level of scientific credibility (Wilson, J. & Willis, 2004; Gore, 2006; Poliakoff & Webb, 2007; Schmidt, 2008). In addition, some critics point that media is content selective and permanently over-constrained by the logic of the audiences and cost suppression (Carrada, 2006; Schmidt, 2008). It is easy to understand that the use of media to promote science is sometimes subordinated with conflicting values and messages. However, science and communication are can be important allies if media tools are wisely used and communicators are conscious of pros and cons of this type of communication strategy.

Internet is a very important source of information about science and the development of Web 2.0 technology has changed the processes and products of interaction in web encouraging the development of many science communication projects, tools, blogs, webcasts and discussions (European Commission, 2008; McCallie et al., 2009; Sullivan et al., 2009; Kouper, 2010; The Galup Organization, 2010; Watermeyer, 2010; Wiersma, 2010; Ballouard et al., 2011; Worthington et al., 2011). The great challenge about this pathway has been to provide suitable access to adequate information and learning opportunities for a wide range of audiences (Kouper, 2010). The Social Network Sites (SNS) for instance can provide a base to build dialogue between learners and educators but also might create disengagement from individuals' local contexts and miseducation (Watermeyer, 2010).

Popular culture opportunities can introduce information that shape attitudes about science (Elder et al., 1998). The public lecture is considered a one-way communication strategy but it is still the most familiar, easier, confortable and cheap form of science communication (Bultitude, 2011). Other important mechanisms are community discussions as face-to-face forums or science cafés that facilitate the two-way dialogue between scientists and the audience (McCallie et al., 2009; Norton & Nohara, 2009; Bultitude, 2011). However, some experts claim about the lack of specific agendas, the focus in informing the public about science facts rather develop a dialogue and the avoidance of controversial issues (Norton & Nohara, 2009).

Science Centres and Museums that are also one of the most typical pathways of leading informal education of science and have long incorporated engagement perspectives, evaluation programs and revision (Hooper-Greenhill & Moussouri, 2001; McCallie et al., 2009). Several studies showed that museums provide different points of view and multiple domains of knowledge, facilitating learning amongst the least knowledgeable citizens and allowing visitors to learn science through a very personal, free-choice way (Falk, John H. & Storksdieck, 2005). (Falk, John H. & Storksdieck, 2005).

2.4.2.1. Books and the role of storytelling

During the present work, a special focus was done to books and storytelling in science communication. Despite the strength of media and internet in science communication, books still have an important role in science communication by promoting similar tools, perspectives, training, reinforcing intellectual development, recruiting people to science, creating an everyday culture and promoting public discussion and engagement (Carrada, 2006; Lewenstein, 2007; Nepote, 2008).

Until the second part of the 20th century, books were the main tools to explain science. From *The Elements* by Euclides, to the famous *On the Origin of Species* by Charles Darwin, science books were read by the public and typically were best sellers (Nepote, 2008).

The 20th century became "The Era of Scientific Paper" as called by Nepote (2008) when Nature (1869) and Science (1880) scientific journals were created promising to expand the knowledge at a rate and scientific level never seen before. These magazines quickly absorbed the effort of scientific writing and mobilized the science access to a very limited audience. Nevertheless, the 20th century was not sterile regarding science communication books (Lewenstein, 2007). In the

attempt of restore confidence between the public and science after the crisis of trust during the post-war period, several scientists like Carl Sagan, Rachel Carson or Stephen Hawking developed their communication with the general public through science books creating a link to their daily lives (Carrada, 2006; Miller, J. D., 2006; Lewenstein, 2007; Nepote, 2008). The books were in charge again. Why?

Scientific knowledge is delivered through a detached objectivity that usually characterizes the scientific work and which may cause some public insensibility towards science (Serpell, 2004). Spiritual and emotional aspects does not frame in scientific thinking (Vieira, 2007). On the other hand, emotions can create meaning allowing the public to define how science can or cannot be directly related with their lives. Because of this, it is necessary to create stories and contexts in a way that touches human fundamental needs and that the public can identify and relate with their lives (Weelie & Wals, 2002). It does not mean to distort the information but to make it relevant. The use of appropriate "emotional hooks" can create a more effective message deliver (Bultitude, 2011). Storytelling is the mechanism of creating a story to deliver specific messages by capturing the public attention until the very end by the use of context, relations and emotional hooks (Carrada, 2006).

Despite storytelling can be used in a transgerational way they can be especially important to children. Emotions are the first dimension developed in the early childhood and are very important in the attitude development and engagement strategies about the environment and biodiversity (Kellert, 1985a, 1993, 2002; Clayton & Brook, 2005). Children books, for instance, constantly support on stories to transmit messages and are one important source of information in childhood when individuals are not able to access other types of information sources (Ford, 2006). In addition, children between 6-8 years old cross the main period of emotions development especially regarding biodiversity and nature (Kellert, 1985a). The use of stories during childhood to deliver messages and transmit information can be a very important way to create a more engaged audience on science and promote more positive affective perceptions about biodiversity (Wilson, E. O., 1984; Peter H. Kahn, 1997; Serpell, 2004; Clayton & Brook, 2005; Zhang et al., 2014).

2.4.2.2. Environmental Education (EE)

Environmental education (EE) was also addressed in the researches carried out during the present thesis and also deserves a special focus.

Environmental education (EE) is a lifelong process designed to create informed and committed citizenry using multidisciplinary approach, reaching a wide range of audiences and embracing broad range of education strategies (Elder et al., 1998; Kassas, 2002; Lindemann-Mathies, 2002).

For a long time, however, strategies for environmental education were not focused on establishing or changing fundamental values and were mainly supported by Public Understanding of Science (PUS) strategies. Integration of Public engagement of Science perspectives in EE actions are helping to resolve this gap since it is suggested to be not just as space to learn and objective understand scientific facts but also to create, change or reinforce attitudes, emotions, interest, awareness, skills, values and behaviours (McCallie et al., 2009).

The strong focus of engaging strategies on direct experience during environmental education programs and the careful use of vicarious indirect experience enables a more efficient transmission of information and contributes to attitudes change (Bandura, 1986, p. 79; White, 2006; Wagler, 2011). In addition, children's emotional and intellectual development is greatly enhanced by direct contact: (Kellert, 2002; Prokop, Pavol & Tunnicliffe, 2008).
On the other hand, EE suffers from some barriers that are limiting its effect in science communication. For instance, environmental education is often regarded as an optional extra activity in science affairs and school curricula, it does not figure on national priority for any country (including European countries) and it suffers from limited resources, staff and inconsistent funding (Elder et al., 1998). Teachers are commonly responsible to carry out environmental education activities during classes, however, have very little experience with fieldwork, ecology, whole organism biology, and biodiversity (Lindemann-Mathies & Bose, 2008). In addition, teachers have the misconception that environmental education is only taught outdoors and claim that is something that is beyond their abilities, skills, duties and usually have time constraints (Elder et al., 1998; Brewer, 2002; Reis et al., 2011).
Finally, most of the science communication activities do not predict evaluation efforts in order to understand how do those activities help to improve knowledge, attitudes of even behaviour (Rodari, 2009; Bultitude, 2011). Evaluation of biodiversity communication activities is one of the most important tools in the whole process of science education for biodiversity since it provides results and information about the abilities of the tools, the efficacy of the strategies and, ultimately, will provide the reasons for a progressive investment on biodiversity issues (Lindemann-Mathies, 2002; Science for All Expert Group, 2010; Reis et al., 2011).

2.4.2.3. Public participation: Citizen Science

Regarding the engagement perspectives proposed by the Public Engagement of Science movement it is worth to explore the Citizen Science as a public participatory approach in science a subject that is addressed in the work developed in the present thesis.
Until the middle of 19th century scientists were amateurs that usually had another profession since observation skills are transversal to ever human (Silvertown, 2009). Despite the amateurship became negatively connoted, amateurs' role in science remained a very important contribution (Poliakoff & Webb, 2007; Davies, 2008). Today, the word amateur was substituted by the term "Citizen scientist" that is a volunteer who collects, processes, analyses or even interprets data as part of a scientific enquiry usually promoted by a science institution or organization (Cohn, 2008; Silvertown, 2009; Conrad & Hilchey, 2011).
Today, lots of citizen scientists work side by side with professional scientists on Citizen Science projects in every area, commonly developed on-line through Web2.0 engaging mechanisms (Trumbull et al., 2000; Delaney et al., 2008; Silvertown, 2009; Dickinson et al., 2010; Worthington et al., 2011; Shirk et al., 2012; Gura, 2013).
The main advantage of Citizen Science for research is that this methods can help researchers to address problems that otherwise will be impossible to resolve (Cohn, 2008; Gura, 2013) (Devictor et al., 2010). In addition, it contributes to public science education and to the development of

scientific thinking, self-confidence among other skills (Trumbull et al., 2000; Brossard et al., 2005; Miller, J. R., 2005; Bonney et al., 2009; Devictor et al., 2010; Conrad & Hilchey, 2011).

Several factors and motivations contribute to volunteer participation in citizen science projects, most of them related with the perceived efficacy of the volunteer actions in decision-making, in science development and progress, enhancement, responsibility, morality, possibility to express self-values, development of career skills, establishment of social relationships, enhancement of personal development of skills and abilities, or even increasing self-esteem (Douglas & Rollins, 2007; Jordan et al., 2011; Worthington et al., 2011; Hobbs & White, 2012).

Volunteer participation in ecological studies greatly influence the scale of the research and the relationship between the public and scientists and may constitute the only practical way to achieve the geographical and temporal scales required to document and monitor several ecological patterns with a low cost implementation and a finer resolution (Cohn, 2008; Delaney et al., 2008; Schmeller et al., 2009; Sullivan et al., 2009; Devictor et al., 2010; Dickinson et al., 2010; Hobbs & White, 2012).

Volunteered Geographic Information (VGI) is a concrete type of citizen science supported by the engagement of large numbers of citizens all over the world that can compile, provide, mash-up or interpret information about any point of the Earth's surface using a range of interactions enabled by the evolving Web 2.0 and geographic information systems (GIS)(Goodchild, M. F., 2007; Delaney et al., 2008; Wiersma, 2010; Worthington et al., 2011).

In general, citizen science projects can make a difference to scientific knowledge and evolution in many scientific areas, also developing a more aware, active, engaged and empowered public. Depending on motivated, interested and active volunteers, these projects need however to be well planned, designed to recruit, motivate, train and empower volunteers in order to achieve accurate, reliable and publishing results.

On the other hand, the scientific community still seem reluctant to accept citizen science due to the lack of certification, defined methods and the possibility of biased data and the little control over the methods (Douglas & Rollins, 2007; Cohn, 2008; Delaney et al., 2008; Bonney et al., 2009; Schmeller et al., 2009; Dickinson et al., 2010; Worthington et al., 2011).

However, concerning results, some research showed that volunteers are capable of producing very good results similar to those of trained researchers (Douglas & Rollins, 2007; Cohn, 2008; Delaney et al., 2008; Schmeller et al., 2009).

3. FACTORS INFLUENCING HUMAN PREFERENCES FOR ANIMALS.

3.1. ABSTRACT

Vicarious experiences based in media information are becoming important links between the public and nature and these experiences are shaping preferences and guiding people's awareness to biodiversity protection. In this study the main information sources of biodiversity of 14-19 years old students were the TV and the Internet. Phylogenetic proximity to Humans was an important factor affecting students' favourite and least favourite animals. Although this factor seems be an important protagonist in the preferences of the students, important exceptions suggest that the influence of the global message of conservation is, itself, distorting the image of the biodiversity in the public by overvalue exotic, far away, flagship mammals and birds as well as some other charismatic fauna Most of all, the global message appears to be standardizing the public preferences for animals all over the world as the preferences found in this study shown to be similar to the ones emphasized by a similar study undertaken in Australia.

KEY WORDS: Vicarious experiences; preferences; biodiversity; phylogenetic proximity; media conservation messages.

3.2. INTRODUCTION

Presently, the majority of the world's population lives in urban areas, having little direct contact with local natural environment and biodiversity. Vicarious experiences are becoming important links between the public and nature (Miller, J. R., 2005). However, the decrease of direct experience is gradually transforming the human–environment relation virtual, in which media are key players as information drifters (Ballouard et al., 2011). Unfortunately media frequently show a distorted reality, leading messages about conservation focused on a few, iconic, "flagship" or "likeable" species, namely exotic or other appealing animals (Andelman & Fagan, 2000; Lindemann-Mathies, 2005; Ballouard et al., 2011; Veríssimo et al., 2011). Despite the importance of flagship fauna in conservation strategies and their selection as umbrella species for protection of a largest range of other species, their use in conservation messages, is guiding people awareness and preferences to biodiversity protection, especially in children growing in a media information society (Serpell, 1999; Andelman & Fagan, 2000; Woods, 2000; Snaddon et al., 2008; Ballouard et al., 2011; Veríssimo et al., 2011).

It is known that humans find some animals more appealing than others (More, 1979; Stokes, 2006; Knight, 2008). Unfortunately, public preferences and attitudes towards biodiversity are conditioning species conservation because there's a tendency to invest more in protection of likeable species than in the less appealing ones (Serpell, 1999; Miller, J. R., 2005; Lindemann-Mathies & Bose, 2008). Therefore, conservation efforts are probably skewed due towards human preferences (Stokes, 2006).

Previous works showed a major preference and awareness for animals rather than plants, and a greater interest for larger exotic taxa, mammals, birds as well as for companion animals (More, 1979; Bednar-Friedi et al., 2004; Lindemann-Mathies, 2005; Ceríaco et al., 2011). In the other

hand small and less showy animals as well as amphibians, reptiles and invertebrates are commonly unappreciated (Kellert, 1993; Driscoll, 1995; Knight, 2008; Ceríaco et al., 2011; Ceriaco, 2012). In fact mammals, the smallest group of vertebrates are greatly over represented in media messages, conservation efforts and investments when compared with other biodiversity groups (Woods, 2000; Batt, 2009).

Human attitudes also depend on a variety of other factors that act as attitude modifiers, some of which are intrinsic to the animal as size, aesthetic, morphology, similarity to human, behaviours, and others are extrinsic, for example, human social and cultural attributes, as sex, age, education, residence, income, historical legacies, religion or cultural practices (Manfredo, 2003; Serpell, 2004; Knight, 2008; Lindemann-Mathies & Bose, 2008; Ceriaco, 2012). As a result, even within mammals, some species are disliked, such as the wolf or the bats that are often unappreciated by the public mainly due to cultural reasons (Prokop, Pavol & Tunnicliffe, 2008). Even within the less appreciated groups, as invertebrates, some animals are valued by the public because of its utilitarian value, appealing aesthetics, social organization or considerable representation in children literature, like the bee, ant, butterfly, ladybug and firefly (Kellert, 1993; Wagler & Wagler, 2012).

Following the works of More (More, 1979) on children wildlife preferences, which evidenced the distorted public perception of biodiversity, the environmentalist movement highly increased their efforts on environmental education and awareness campaigns(More, 1979). The climax of these efforts led the United Nations to declare the year (2010) and decade (2010-2020) on Biodiversity as an attempt of changing preferences and attitudes.

The main objective of this study was to identify patterns concerning most and the least favourite animals to Portuguese students (14-19 year old), the factors that are contributing to such preferences, as well as the main information drivers associated with Biodiversity.

3.3. METHODS

Students visiting the fairs organized by the University of Porto (UP) in 2012 and 2013, which was aimed towards presenting its several courses and institutes, carried out a questionnaire about their most favourite and least favourite animals, their most important sources of information about biodiversity and information about gender and age. The questionnaire was performed in a small stand about biodiversity with several hands-on activities. Thus, it was assumed that most of the students that went to the stand are somehow attracted by Biology courses and especially by biodiversity issues. The questionnaire layout is available in the Annex 1 of this thesis.

Participants' data was provided and analysed anonymously. Oral consent was given by the participants after a member of our team have read the questionnaire header indicating the objective of the study. Considering minors involved in our study (14-17 years old), the oral consent was given on behalf of them by their guardians.

Our working hypothesis were:

- Biodiversity taxa are similarly represented in the favourite and least favourite lists of animals referred by the students.
- The number of references of each biodiversity taxon is equally distributed in the favourite and least favourite animal lists.

In addition, this study aimed to analyse the phylogenetic relationship to humans of the more and the least favourite animals referred.

The main data analysis consisted in basic descriptive statistics including mean, standard deviation, and frequency analysis. Chi-square significance tests were used to detect differences between favourite and least favourite lists or groups of animals (Zar, 1984). The responses were analysed using IBM's SPSS v.20 (Internacional Business Machines, Released 2011).

In order to better understand the taxonomic relationship between the 30 most and least favourite animals mentioned in the questionnaires (Top30), as well as their phylogenetic relationship to humans, the taxonomic Identification Numbers (IDs) closest to the term used by the students to refer each animal, for example "frog", were searched in the National Centre for Biotechnology Information (NCBI) database (http://www.ncbi.nlm.nih.gov) and used to generate a taxonomic common tree in the Taxonomy Browser of the NCBI database. The extracted file was displayed and processed in the iTOL - Interactive Tree Of Life v.2.1 available from the website http://itol.embl.de(Letunic & Bork, 2006, 2011).

3.4. RESULTS

During the 2012 and 2013 UP fairs 81 and 99 responses were collected, respectively, resulting in 180 questionnaires (133 females and 47 males). Participants were between 14 and 19 years old and were mainly from urban areas.

The most common sources of information on biodiversity were the Internet (70.6%) and the television (63.3%); yet other sources including films and documentaries (36.7%), school classes (35%) and books (33,3%) were also relevant for the students (Figure 3.1). Environmental education (EE) and workshops seemed to have a marginal impact (4.4%) as sources of information; a similar observation was valid for family and friends (7.2%).

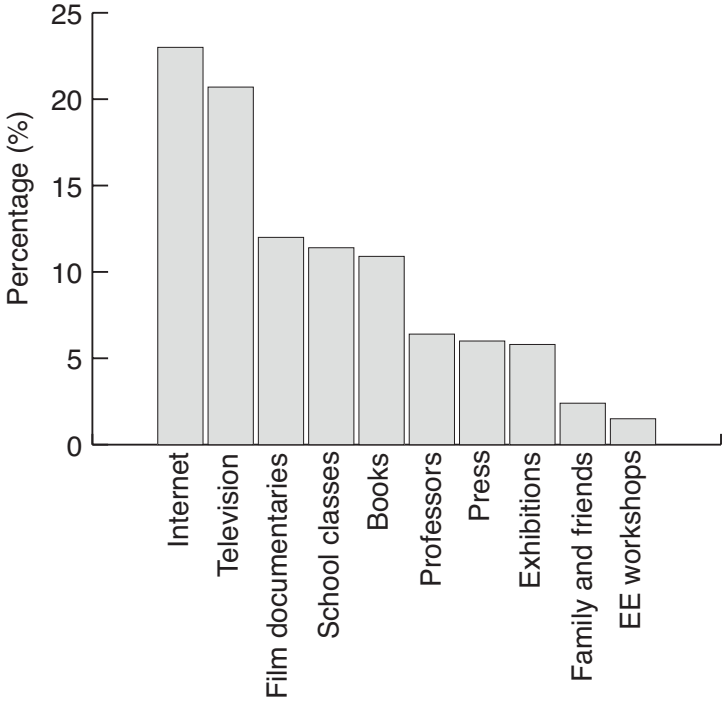

Figure 3.1 Most important information sources on biodiversity.

One hundred and seventy six different animals were mentioned in the questionnaires. The lists of the favourite and least favourite animals mentioned by the students during this study are available in the Annex 2 of this thesis. The majority were vertebrates (77%) including mammals (40%), birds (15%), fish (10%), reptiles (8%) and amphibians (4%). Only 23% were invertebrates: arthropods (16%) and "Other" taxonomic groups (7%) (Figure 3.2a). Considering students' preferences 112 animals were classified as favourite animals, 124 as least favourites but 60 animals were common to both favourite and least favourite lists of animals a the shark, dog, cat or the lion. Figure 3.2b) and 3.2c) show the percentages of each taxonomic group, on both favourites and least favourites lists of animals. There was no significant difference between the number of animals of each taxonomic group with regards to the favorite and least favourite lists of animals. However, the number of arthropods was significantly larger in the list of the least favourite animals ($\chi^2 = 5.592; \mathrm{p} \leq 0.05$).

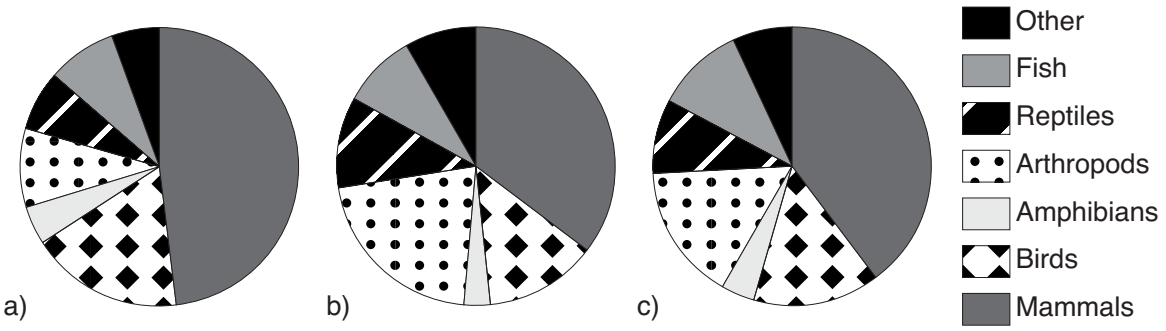

Figure 3.2 Biodiversity group contribution to the total list of animals (a); favourites (b); and least favourites (c) referred to the questionnaire. "Other" includes groups referred with low frequency (ex. annelids or molluscs). Differences between favourite and least favourite animals of each group are not significant (χ2) with exception of arthropods that is significantly more represented in the least favourite list of animals.

Regarding the number of times that each animal was mentioned by the respondents (frequency), the top 30 favourite and least favourite animals represent about 71% and 70% of the total references (713 and 630) in the questionnaires, respectively. Focusing on the top 30 favourite animals, 70% correspond to mammals, 15% to birds, 10% to fish and 5% to reptiles. Although some groups were referred by general terms as "birds" or "fish" the most common corresponded to specific animals, namely domesticated animals, companion animals (ex. dog, cat, horse, and rabbit) or flagship species (ex. dolphin, shark, whale, and penguin).

Concerning the top 30 least favourite animals, arthropods were the most noticeable group in the list (40%) followed by mammals (25%) and reptiles (15%). Fish, birds, amphibians and other groups equally contributed with 5%. Organisms from this list also included some domesticated and companion animals like the cow, chicken and even dog, and only two animals, the crocodile and the shark. Humans were only referred 3 times as least favourite animals.

Figure 3.3 shows the frequencies of the biodiversity groups for the favourite (a) and least favourite (b) animals referred in the questionnaires. The frequencies of each biodiversity group followed the main features found in the top 30 lists. Moreover, differences between favourite and least favourite taxonomic groups were significant for all groups (χ^2; $\alpha = 0.05$): differences

between frequency of favorite and least favorite mammals were clearly statistically significant ($\chi^2 = 229.995; p \leq 0.0001$). Favourite mammals were mainly represented by pets and flagship animals as the dolphin, lion, tiger, monkey, giraffe, bear, cheetah, leopard, panda, whale or lynx, among others. Domesticated animals as the horse or the rabbit were also very appreciated. In the other hand, less appreciated mammals were the mouse, the rat, some companion animals (dog and cat) and some cattle like cow, goat or pig. The lion and the monkey were some of the animals that were present in both lists.

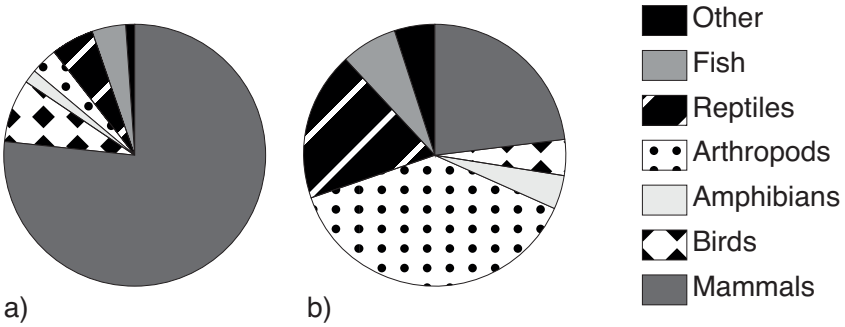

Figure 3.3 Frequencies of the biodiversity group referenced as favourites (a) and least favourites (b) in the questionnaire. "Other" includes modestly referred groups (annelids or molluscs). All differences between favourite and least favourite in each group are significant with the exception of fish (χ^2;α=0,05).

Differences between the frequency of favourite and least favourite birds were also statistically significant ($\chi^2 = 7.997; p \leq 0.01$). Favorite birds were mainly exotic charismatic species: penguin, parrot, and undefined "passeriformes", all constitute 60% of the total favourite bird frequencies. These were followed by other charismatic species as swallows and eagles, as well as domesticated birds (canary, duck, chicken). In the other hand, chicken, seagull and dove were the least favourite birds followed by eagles, swallows, crows, owls and some less common species as ostrich and peacock.

Differences between the frequency of favourite and least favourite reptiles were also considered clearly statistically significant ($\chi^2 = 64.701; p \leq 0.0001$). Almost 55% of the favorite frequencies were due to turtle that was followed by the snake (18%), the chameleon (9%), the lizard (7%) or the crocodile (2%). On the other hand, reptiles contribution as the least favorite animals, mainly represented by the snake, the lizard and crocodile that were responsible for almost 88% of the least favourite frequencies.

Differences between frequency of the favorite and least favorite fish were also statistically significant ($\chi^2 = 5.564; p \leq 0.05$). The undefined term "fish" and the shark contributed to 79% of the favorite fish frequencies followed by some exotic fishes as sunfish, clownfish or seahorse. The shark also contributed to the least favorite fish list 55%) followed by lamprey, piranha and eels.

Despite being modestly referred in the questionnaires, the differences between frequency of the favorite and least favorite amphibians were considered statistically significant ($\chi^2 = 8.690; p \leq 0.01$). The toad and the frog figured as the most favorite (80% of the frequencies) but also as the

least favorite (87% of the frequencies) amphibians. Salamanders were usually mentioned as favorite while newts were referred as the least favorite amphibians.

Differences between the frequency of the favourite and the least favourite arthropods were also clearly statistically significant ($\chi^2 = 248.537; p \leq 0.0001$). The more likeable arthropods were usually butterflies (34% of the frequencies) followed by spiders, bees, ladybugs, ants and crickets. On the other hand, the least favourite animals included more organisms mainly represented by the spider (28%), the fly (12%), the cockroach (11%), the bee (9%) and the mosquito (8%).

"Other" taxonomic groups, with little frequencies in the students' responses, also presented significant differences between the favourite and the least favourite frequencies ($\chi^2 = 22.890; p \leq 0.0001$). Favorites were the octopus (33%) and the earthworm (22%). On the other hand, the least favorite of this group included the earthworm (39%), the jellyfish (16%) and the snail (11%).

The taxonomic common tree of the Top30 favorite and least favourite animals referred by the participants in the present study is shown in Figure 3.4. Favourite animals are included in groups that are phylogenetically closer to humans. Least favourite animals, on the other hand, are included in groups that are phylogenetically distant from humans, as arthropods or "others". Generally, mammals and birds were loved animals while reptiles, amphibians, some fish, arthropods and other biodiversity groups were generally disliked.

However, there were some clear exceptions to phylogeny proximity. The cattle in general (cow, goat, sheep and even pig) as well as small mammals like the rat and the mouse are mammals that were usually disliked.

Within the most regarded birds, the chicken, the crow, the dove, the seagull, the goose and the ostrich were also an exception. There were also some exceptions within the disliked taxonomic groups: the turtle (reptiles), the butterfly (insects), and the fishes were mentioned as favourites by the participants.

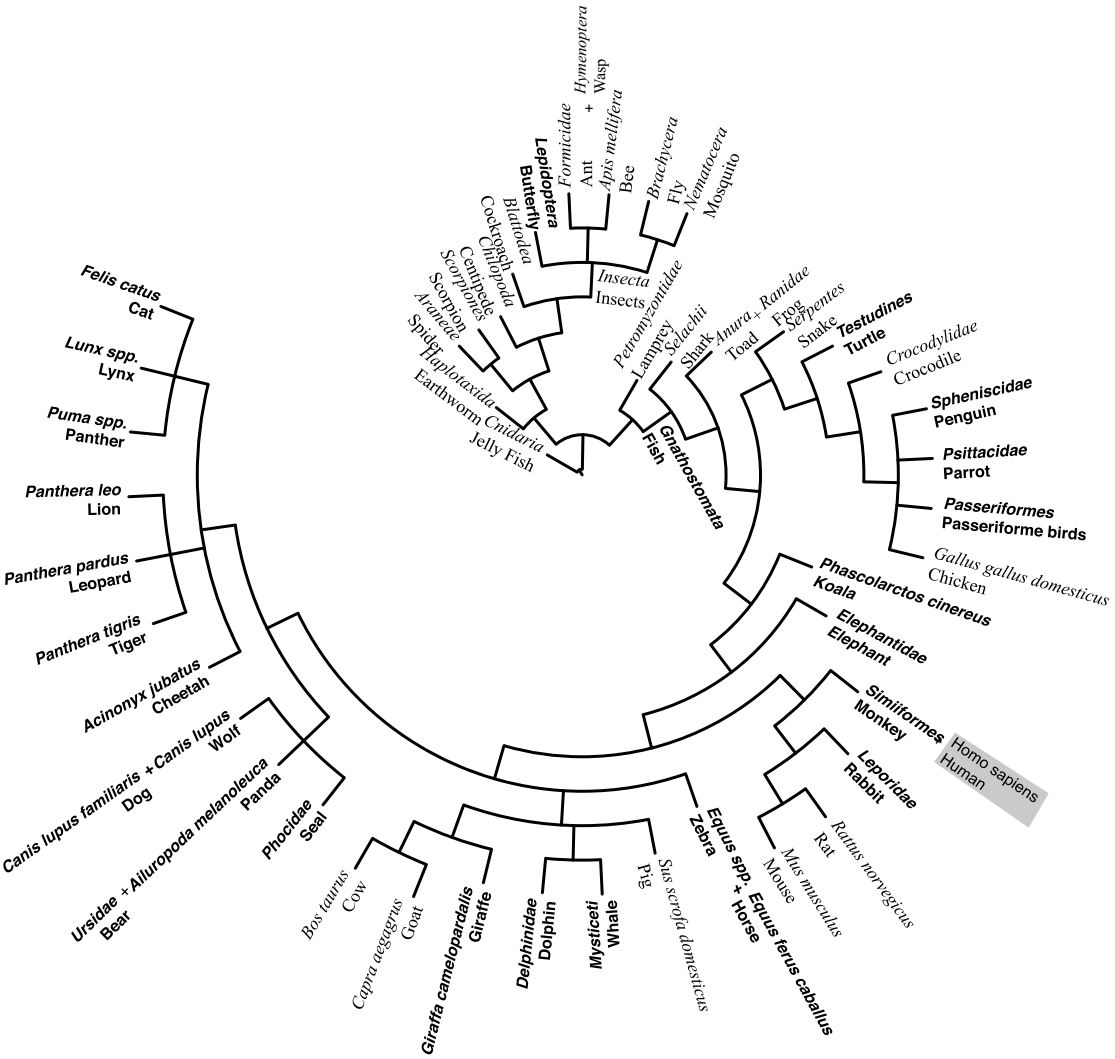

Figure 3.4 Taxonomic diagram of the Top30 favourite and least favourite animals referred in the questionnaires. Different fonts were introduced to better associate favourites (non serif bolded font) and least favourite (serif regular font) animals. Humans are marked with a non-serif font and a grey shadow.

3.5. DISCUSSION

The data used in this study was obtained at University fairs that intended to publicize to college students their courses. This can explain the age of most of the respondents, ranging from 14-19 years old that, according to Kellert (Kellert, 1985a), is a very good age to observe the impact of the education on biodiversity during childhood. The same author defends that the most promising age to create emotions and positive perceptions about biodiversity is between 6-9 years old. During adolescence it is recognized a significant disinterest about nature issues and biodiversity (Kellert, 1985a, 2002). However, the strongest perceptions should persist and characterize adolescent attitudes and preferences about biodiversity. On the other hand, adolescence is a clearly important period to develop values, one of the three most important keys on communicating nature: knowledge, emotions and values (Kellert, 1993).

In the present study it became clear that girls between 14 and 19 years old seemed to be more interested in biology/biodiversity issues than boys, since they visited more frequently the biodiversity stand which is reflected in the fact that the present study was based more on girls than boys' responses.

Concerning the sources of information about biodiversity, Internet and TV were observed to be the most important and this may influence preferences about animals. As, Ballouard et al., (Ballouard et al., 2011) showed, children focused on Internet information about biodiversity seem to have preferences for exotic flagship species that proliferate on the virtual context of Internet. This trend was also confirmed in the present study.

TV was the second most important source of information in the present study. However, TV is apparently greatly decreasing their programming on nature, usually limited to few hours for week in film documentaries or magazine formats (Williams, J. et al., 2012). Moreover, responses about TV can be related with the third most important sources of information about biodiversity, film documentaries, followed by books and school classes. However, books also follow the trend of media representation of biodiversity and school classes appear to be mainly focused in creating knowledge and less dedicated in developing attitudes and values about biodiversity.

The present study showed that pre-university young people clearly devalue the role of workshops as sources of information about biodiversity despite the development and implementation of Environmental Education activities or workshops during the last decades (Elder et al., 1998; McCallie et al., 2009). The fact that those are small-scale communication pathways reaching few individuals at a time can justify these results. Furthermore, Kellert (Kellert, 1985a) defends that adolescents usual have more social concerns about relations and personal development that limits the interest, personal investment and effectiveness of messages about nature and biodiversity which can justify the low importance of those activities for the age range of the present study (14-19).

Students did not recognize the value of the community organization (portrayed by the family and friends) as a "spread the word" mechanism, contrary to what is documented by several authors that considered it the most important source of values (Elder et al., 1998; Ballouard et al., 2011).

Regarding preferences, most of the favourite organisms in this study were vertebrates, especially mammals and birds. On the other hand, less favourite animals included, not only vertebrates as reptiles, but also a lot of invertebrate organisms as arthropods. Favourite animals usually included companion animals, and flagship, exotic species usually portrayed in mass media messages of biodiversity and conservation. Local biodiversity was usually devalued.

In this study, there was a relation between phylogenetic proximity and human preferences towards animals as previously suggested by other authors (Kellert, 1996; Stokes, 2006; Batt, 2009). Nevertheless, there were some exceptions to this preference trend that suggest the role of other factors influencing preferences over the phylogenetic proximity. It was clear that there were some animals that were more loved or more disliked by the participants independently of their taxonomic group.

Even within mammals, the most liked biodiversity group, the present study emphasize some exceptions like the mouse and the rat that were negatively perceived probably by association with pests, diseases, dirty environments or potential health risk (Batt, 2009; Prokop, Pavol & Tunniclife, 2010). Students also negatively perceived several cattle animals as sheep, goat, ox,

bison, cow, bull or even the pig. Some authors defend that the use of those animals as raw materials may conducted to a relationship of superiority and power of humans over them, which can also happens with companion animals (Johnson, 1996; Hermsworth, 2003).

One of the most curious exceptions to the preference pattern was associated with humans themselves and monkeys. Some monkeys referred in the questionnaires, as the baboon, were human phylogenetic relatives negatively perceived by the respondents. Although several studies suggest that humans usually prefer species that are perceived to be more similar to them, they also react negatively if any animal reminds our "creaturelikeness" and mortality. Some studies with chimps showed that reminders of similarity with humans affected negatively participants' attitudes towards them as they are forced to compare animal acts to their own (Beatson & Halloran, 2007; Batt, 2009).

Humans were only referred three times in the questionnaires. This result may be attributed to the non-human perception of animals proposed by previous studies, which suggests that non-human species can be considered as an enormous out-group that characteristically do not fit within the anthropocentric point of view (Batt, 2009).

Within birds, another loved group, the chicken, the crow, the dove, the seagull, the goose and the ostrich were less appreciated.

There were also some loved animals within the most disliked biodiversity groups. Arthropods were generally disliked probably, as Kellert suggests (Kellert, 1993), because their morphology is so different from our own species. However, our study showed clear exceptions for this trend when colourful arthropods like adult butterflies and ladybugs were considered. However, previous studies showed that children usually dislike the butterflies larval stages which demonstrates the influence of the appearance of these animals and the probably also the lack of knowledge about their life cycles and characteristics (Wagler & Wagler, 2012).

Reptiles also had interesting exceptions to the general negative portray associated with this biodiversity group: the turtles and chameleon. Again, colour may also have some impact on chameleon preferences. On the other hand, turtles are companion animals for many children and adults and have positive references in folklore, tales and children books while other reptiles are usually negatively portrayed (Knight, 2008; Ceriaco, 2012; Ballouard et al., 2013; Prokop, P. & Fancovicová, 2013).

Amphibians were mentioned with low frequency by the students. Generally, attitudes towards amphibians are negative as previously reported in several studies, mainly explained by cultural factors (Tomazic, 2008, 2011c; Ceriaco, 2012).

Within fish, respondents clearly preferred exotic fishes that usually have determinant colours, forms or features. Sharks stand out by being on both top 30 of favourite and least favourite animals as occurs with some other animals that are commonly associated to potential danger or harm (lion, tiger or the snake). In fact, other authors referred the development of divergent emotions of fear and fascination about these animals (Woods, 2000; Batt, 2009).

The evidence of several exceptions to the human phylogenetic proximity basis for preferences found on this study confirm that this is not the only factor that determines human preferences for animals.

Moreover, a comparison of the results from the present study with the ones in a study by Barbara Woods (Woods, 2000) about animal preferences in Australia was particular interesting and draw

the attention for an important factor on preferences about animals: the contribution of conservation messages from media. In fact, the comparison between these two studies show that the present study, which is based on the animal preferences of Portuguese students, showed very similar results to the animal preferences referred in Australia (Woods, 2000). The top 30 favourite animals of both studies 20 animals are similar in both studies. In addition, 19 out of the top30 least favourite animals of both studies are also the same. This conclusion shows that despite phylogenetic proximity undergoes important influence in preferences about animals in comparison to other intrinsic animal characteristics previously mentioned, media might be considered one of the most important factors influencing public preferences for animals. Moreover, communication and global conservation messages might be standardizing the public preferences all over the world and could be distorting the reality of biodiversity and direct the public wish to protect species towards media trends (Andelman & Fagan, 2000; Woods, 2000; Stokes, 2006; Snaddon et al., 2008; Ballouard et al., 2011; Veríssimo et al., 2011).

Currently, as documented by previous studies, knowledge, attitudes and preferences towards biodiversity are not very different from the ones verified before the United Nations year (2010) on Biodiversity (Kellert, 1985b, 1985a, 1989, 1993; Woods, 2000). Some differences however begin to be noticed towards some animals, for example, the wolf that begins to be valued by the participants of the present study (Table 1)(Kellert, 1985b; Serpell, 2004; Prokop, Pavol et al., 2011). However, efforts from different communication pathways should be coordinated to be effective and not disrupt each other's work.

3.6. CONCLUSION

Several factors, associated with preferences and phylogenetic proximity, seem to play a role along with other physical and cultural attributes. However, the global message of conservation is, itself, distorting the image of the biodiversity in the public by overvalue exotic, far away, flagship mammals and birds as well some other charismatic fauna. Most of all it appears to be standardizing the public preferences for animals all over the world. Thus, it seems that the efforts from the last years associated with the United Nations year (2010) on Biodiversity were not able to greatly modify the children and adolescent perceptions of biodiversity. However, depending in a concerted action between all information pathways and the increase of direct experience through Environmental Education activities established during all the rest of the Decade on Biodiversity (2010-2020), considerable changes could be expected in people that, today, are passing through childhood and adolescence.

4. A PORTRAIT OF BIODIVERSITY IN CHILDREN'S TRADE BOOKS

4.1. ABSTRACT

Indirect experiences are important in the public perception of nature and may influence attitudes towards conservation. Biodiversity and the environment are frequently presented in children books and promote children's attitudes and emotions about biodiversity. In this work we examined how biodiversity was portrayed in 164 books directed at six-eight years old children. Living beings and habitats were found in 98% and 80% of the books and included 441 different organisms in a total of 21786 occurrences. The living beings in the books weren't representative of the global biodiversity and were dominated by few iconic nonhuman organisms, mostly mammals, especially companion animals or other domesticated animals. The representations were strongly biased towards anthropomorphization of nonhuman animals that inhabited in limited common habitats. This may contribute to the idea that all biodiversity lives in forests and humanized habitats, and are limited to nonhuman animals under human mastery or to few inaccessible megafauna.

KEY WORDS: children's books, biodiversity, conservation demands, habitats, environmental education.

4.2. INTRODUCTION

Whenever direct contact with the natural world is scarce, indirect experiences about biodiversity and habitats may be of great importance to generate attention and publicity for conservation (Miller, J. R., 2005; Snaddon et al., 2008; Ganea, Patricia A. et al., 2011). Media, as one of the most relevant sources of information, has become the most important tool for vicarious experience about biodiversity and can act as a tool for public awareness (More, 1977; Kellert, 2002; Stokes, 2006). TV, Internet, books, press and other communication pathways have now a tremendous influence on people's perceptions and preferences about nature (Woods, 2000; Ballouard et al., 2011). However, most media are decreasing the time allocated to nature, environment and biodiversity programs (Williams, J. et al., 2012). Moreover, media conservation messages are often skewed as they usually use a few charismatic megafauna species, such as pandas, tigers, elephants or dolphins, as flagship species for public awareness, due to their ability to influence human preferences (Kellert, 1985a; Woods, 2000; Stokes, 2006; Snaddon et al., 2008). Public preferences and desires for conservation are often associated with organism aesthetics and stereotypes and are closely related with the possibility of contacting and understanding them (Lindemann-Mathies, 2005; Ballouard et al., 2013). Preferences and attitudes towards biodiversity inspire and condition species conservation and welfare since it is easier to invest in the protection of likeable species than in less-loved ones (Serpell, 1999; Woods, 2000; Miller, J. R., 2005; Batt, 2009; Fischer, Langers, et al., 2011). Conservation efforts are thus skewed to human preferences and the survival of several species will depend on them (Stokes, 2006). Environmental education

can thus have a crucial role in the development of the public perception of conservation strategies (Kassas, 2002; Weelie & Wals, 2002; Waylen et al., 2010; Fischer, Langers, et al., 2011).

Childhood is a very important period in creating attitudes about biodiversity, and childhood experiences can significantly influence attitudes in the later adult (Kellert, 1985a; Ballouard et al., 2013). Species have an extraordinary role in children's lives: nonhuman animals predominate in children's TV programs and books, and are strongly captivating to children (Bettelheim, 1976; Serpell, 1999; Rice, 2002). Books are a very important source of information (More, 1977; Ford, 2006; Gonen & Guler, 2011; Williams, J. et al., 2012): they are important tools of concept transfer and for vicarious experiences with nature (Rice, 2002; Ganea, Patricia A. et al., 2011). Several studies however have reported inaccuracy and misconceptions in children's books (Prokop, Pavol et al., 2011; Williams, J. et al., 2012) and suggest that inaccuracy can influence children's perceptions of biodiversity (More, 1977; Ford, 2006; Hug, 2010). This is particularly important under the age of 8, when children have difficulties in separating fiction from reality, or accurate from inaccurate information (Rice, 2002; Wells & Zeece, 2007). Misconceptions can also frighten children and develop feelings such as a fear for particular species or habitats, such as a fear of the wolf and the forests they live in (Prokop, Pavol et al., 2011; Williams, J. et al., 2012).

Anthropomorphization can be another source of biodiversity misconception. Its effects are not fully understood and some authors argue that it negatively interferes with generalization and inadequate transfer of human capabilities, especially into nonhuman animals. Other authors argue that, despite this negative effect, anthropomorphization can be advantageous for children since it promotes empathy for nonhuman animals, develops a sense of awareness, better understanding and involvement (Hug, 2010; Ganea, Patricia A. et al., 2011). According to Kellert (1985), 6-8 years is the age period in which children develop tremendous interest for organisms and nature as well as emotions and awareness about living beings (Serpell, 2004; Lindemann-Mathies, 2005; Gonen & Guler, 2011). Also, from 5 years of age, children are able to transfer information from books to reality and daily life, including misconceptions that they are not able to detect (Ganea, Patricia A. et al., 2011; Gonen & Guler, 2011; Prokop, Pavol et al., 2011). Since biodiversity is an ill-defined term (Weelie & Wals, 2002), the period from pre-school to second grade (eight year old) is a common target for teaching through children's literature, since narrative seems to better explain the vast and multi-conceptual theme of biodiversity (Rice, 2002).

The present study aimed to understand how biodiversity is portrayed in books for children of six to eight years old. The presence and frequency of living beings and habitats were analyzed in the text and images of the book sample, as well as their importance in the stories and anthropomorphization. The data allowed testing for significant differences between the frequency of the main taxonomic groups in the real world and in the children's books, and for bias in favor of the frequency of vertebrate animals when compared to invertebrates. The relative portrayal of habitats and of the origin of the species mentioned in the books was also compared between authors from different nationalities.

The analyzed books were from a list of recommended books for six-eight years old children by the National Reading Plan of the Portuguese government (PNL – Plano National de Leitura), a strategy implemented by some OCDE countries following the last PISA study (Program for International Student Assessment) in order to increase literacy in the population. The books in the PNL list are

authored from a range of nationalities and can have a high impact on individual reading choices and also in the scholar, family and/or library contexts (Costa, A. F. d. et al., 2011).

4.3. METHODS

A total of 164 books from the 2011 National Reading Plan list, prevailing for 2011-2012 scholar year were analyzed. These included Portuguese (58%) and authors of other nationalities (42%) and were recommended for oriented reading in the classroom and autonomous reading for the first and second grade (six-eight years old children).

Taking account of the biodiversity concepts proposed by the United Nations Environment Program and the Convention on Biological Diversity, the various species of nonhuman animals and plants found in text and images were listed as elements of biodiversity and named according to the terms used in the books or the closest identification achievable by their representation in images. The variables used to describe the elements of biodiversity and the habitats in the books are characterized in the Table 4.1. The variables proved to be obvious during the data collection and did not cause difficulties during coding. However, in order to avoid any difficulties in decision-making, the coding procedure was centered in a basic occurrence counting. Therefore, the number of times a nonhuman animal or a plant was mentioned in the text or shown in images was counted per book and registered as text or image occurrence respectively. Some coding guidelines were established in order to help decision-making. Namely, proper names of characters referring to biodiversity elements were always counted as occurrences. In addition, subject pronouns referring to biodiversity elements were not counted as occurrences. The sum of text occurrences and image occurrences gave the total text occurrence and total image occurrence (total abundances) of each element of biodiversity in each book. The mean abundance, or mean occurrence, of biodiversity elements per book was calculated by dividing the total abundance in the book by the total number of biodiversity elements in the same book. These values were used to obtain the overall mean occurrence, of biodiversity elements in the book sample. The same procedure was applied to text and image occurrences individually. The variety of ecosystems was listed as habitats and classified as natural or anthropomorphized. Only the content of the stories were considered in the analysis, meaning that images or text from the cover and back cover were not included.

The data allowed statistical testing of the following null hypotheses (H_0):

H_{01} - The main taxonomic groups of species in children's books show a frequency distribution that corresponds well to global biodiversity.

H_{02} - The main taxonomic groups of species represented in children's books do not show a biased frequency in favor of vertebrates, when compared to the proportion of vertebrates and invertebrates in the real world.

H_{03} - The origin of the elements of biodiversity (categories in Table 4.1) in children's trade books is independent of the author's national origin (Portuguese versus other nationalities).

All null hypotheses were tested employing Chi-square analysis of frequencies significance tests (Zar, 1984). The frequency distribution of taxa per major groups of organisms on Earth was

collected from the IUCN 2010 Red list document of summary statistics (Source: IUCN 2010Redlist.http://www.iucnredlist.org/documents/summarystatistics/2012_1_RL_Stats_Table_1.pdf).

The data matrix registering the habitats in the book sample (presence/absence data) was submitted to multivariate ordination analysis, using Principal Coordinates Analysis (PCO), following the calculation of a resemblance matrix among habitats using the Bray-Curtis similarity coefficient. The Bray-Curtis similarity varies from 0 to 1 (or 0 to 100, in percentage). A similarity of 0 between two habitats denotes that they are always mentioned in different books, whereas a similarity of 100 between two habitats would be obtained if they were mentioned only in the same books. The similarity matrix among all habitats mentioned in the book sample was then exploited by ordination analysis, allowing representing in a diagram with two dimensions, axis 1 and 2, the largest possible proportion of the variance of the full data set. In the ordination diagram, the more similar habitats will be represented closer to each other, meaning they tend to be mentioned in the same books. The opposite happens when habitats are represented away from each other in the diagram (Clarke et al., 2014). The similarity between habitats shown in the ordinations diagrams was complemented by superimposing their frequency, represented as circles of different sizes, the larger the more frequent. The calculation of the correlation between the respective Bray-Curtis similarity matrices, using the Spearman non-metric correlation coefficient allowed achieving the relative portrayal of habitats in Portuguese and other nationality authors. All the multivariate analyses were performed with the PRIMER v6 software (Clarke & Gorley, 2006).

Table 4.1 Coding And Description For The Variables Used To Characterize The Biodiversity Elements And Habitats In The Book Sample.

Coding for Biodiversity elements		
Frequency	occurrence	number of times a biodiversity element appeared in text or illustrations, per book and in total.
	presence/absence	limits the number of times each element is referenced in the same book only to its presence in the book.
Character	main character	when the biodiversity element acts as protagonist
	secondary character	while not protagonist, the biodiversity element is essential to the storyline
	minor character	when the biodiversity element is only used to illustrate the social and environmental space
Image plan	main plot	when the biodiversity element appears in the first plan of the image
	secondary plot	when the biodiversity element appears in

		the second plan of the image but not part of the scenario
	scenario	when the biodiversity element acts as scenic context helping the characterization of the environment and profile of the characters
Anthropomorphization	human thought	ability of consciousness analyses and reasoning
	speech	use of human language
	human behaviour	ability to perform human activities or behaviours
	use of objects	ability to use human objects
	bipedal posture	two-footed position (when it isn't the natural position of the biodiversity element)
	facial expressions	human expression of emotions
	human body characteristics	human body parts in the biodiversity elements representations (ex.: human hands)
Origin	native	autochthonous taxa that, despite it became impossible to identify the corresponding species name, at least one species of the identified group is native to Portugal
	exotic	Portuguese exotic species, including exotic invasive species as well as naturalized and introduced species
	extinct	Extinct species or groups of species
	uncertain	not understood by the scientific community
	undefined	not possible to create a concise origin attribution ex.: green plants
Coding for Habitats		
	artificial	refers to anthropomorphized habitats in which nature is almost or totally inexistent. Includes houses, buildings, cities or any human altered habitat.
	natural	desert; river; lake; savannah; polar; ocean; pond; coastal zone/beach; agricultural landscape; garden; temperate forest; mediterranean forest; tropical forest; taiga; tundra; prairie; steppe; coral; swamp.

4.4. RESULTS

Biodiversity in the stories:

In the 164 books analyzed, 160 (98%) had the occurrence of at least one element of biodiversity in the text or in the images. A total of 441 different elements of biodiversity were identified: 168 plants and 273 nonhuman animals, of which 92 mammals, 69 birds, 39 arthropods, 32 fish, 14 reptiles, 3 amphibians and 24 other groups including mollusks and annelids. The total number of biodiversity occurrences was 21786, of which 8952 were text and 12834 were image occurrences. The total number of presences was 3220: 2232 in the text and 2357 in the images.

The number of elements of biodiversity per book ranged from 3 to 882, with a mean of 133 ± 129.5 (standard deviation) occurrences per book. The number of elements of biodiversity present in the books also showed a wide range, from 1 to 93, with a mean of 20 elements per book. The mean abundance of the same biodiversity element in a book was 8. Despite the large number of occurrences, most were related to a restricted number of elements of biodiversity: only 16 biodiversity elements gathered more than 50% of the occurrences.

The 10 dominant elements of biodiversity regarding the number of occurrences are shown in Table 4.2. The most mentioned were undefined species of trees, flowers and plants as well as undefined species of birds, fish and mammals, mainly companion animals and other domesticated animals for labor and food production. In the text, companion animals, other domesticated animals, foxes, wolves and crocodiles gathered most of the occurrences, while in the images the undefined groups of plants, including flowers and trees, followed by undefined birds, companion animals and some other domesticated animals were the most important (Table 4.2).

The elements of biodiversity were grouped as arthropods, fish, amphibians, reptiles, birds, mammals, plants and other groups. Figure 4.1 shows the distribution of the occurrences among these groups in the text, the images and globally. Considering the text, mammals gathered 45% of the occurrences, followed by birds (17%) and plants (16%) (Fig.4.1a). In the images, plants comprehended 37% of occurrences followed by mammals (31%) (Fig.4.1b). On the whole, text and images, mammals corresponded to 37% of the occurrences, followed by plants (29%), birds (16%) and arthropods (8%) (Fig.4.1c). The major contributors to mammal occurrences, representing more than 50% of the total occurrences, were: cats, rabbits, dogs, mice, wolves, foxes and horses. Other nonhuman animals as lions, elephants, monkeys, donkeys and pigs, however also contributed to 50% of the presences. In the bird group, most of the occurrences (>50%) were due to undefined birds, mainly chickens and ducks, while for presences (>50%) the list also included the egg (bird's egg), doves, parrots and seagulls. In the arthropods, butterflies, bees, ants and flies, together comprehended more than 50% of the occurrences. When considering presences, the list included spiders, crickets and mosquitos. Fishes (3%), reptiles (3%), and amphibians (1%) were scarcely represented and most of the occurrences (>60%) were due to undefined fish. If presences were considered, the most mentioned (60% occurrences) within reptiles were crocodiles and turtles but also snakes. In addition to being scarcely frequency in the book sample, amphibians were only represented by toads, frogs and salamanders. The toad had

more than 50% of the occurrences and, together with frogs, more than 50% of presences. The other groups corresponded to 2% of the total occurrences and comprehended many taxonomic groups that included mushrooms, snails, seaweeds, starfishes and octopus.

Table 4.2 Top 10 Biodiversity Elements Responsible For Total, Text And Image Occurrences Plus Total Presences In The Book Sample.

Total Occurrences		Text Occurrences		Image Occurrences		Total Presences	
Undefined trees	1470	Cat	614	Undefined trees	1286	Undefined trees	123
Undefined flowers	1293	Undefined birds	372	Undefined flowers	1136	Undefined plants	105
Undefined birds	1154	Rabbit	371	Undefined birds	782	Undefined flowers	103
Cat	1095	Fox	315	Undefined plants	709	Undefined birds	92
Rabbit	957	Dog	314	Rabbits	586	Cat	76
Undefined plants	774	Wolf	299	Cat	481	Dog	69
Dog	605	Crocodile	273	Undefined fish	369	Mouse	64
Undefined fish	490	Gallinaceous[a]	266	Dog	291	Undefined fish	63
Gallinaceous[a]	481	Mouse	261	Sheep	248	Rabbit	59
Mouse	475	Horse	197	Butterfly	217	Horse	54

In terms of images, mammals were the major contributors for the main plot (43%) followed by birds (17%). Scenarios were dominated by plants (40%), especially undefined plants, followed by mammals (25%) and birds (13%) (Fig.4.1d and e). Arthropods were also well represented in images, either as 11% of presences or 8% of scenarios. Reptiles and amphibians were scarcely represented in images although relatively more as minor characters than as scenario (Fig.4.1e and f). Concerning the species groups in the stories (main, secondary, or minor characters), mammals played the main character in 40% of the stories, followed by birds (19%), mainly chickens and roosters (gallinaceous) and plants (18%). Several stories highlighted a tree or a flower as the main character, and arthropods (15%) (Fig.4.1f and g). Minor characters were usually played by plants (31%) and by mammals (27%). Fishes, despite their small contribution (5%), were mostly represented as minor characters. Reptiles were equally represented as main characters (4%) and as other characters (4%) and amphibians played mostly the main character (2%).

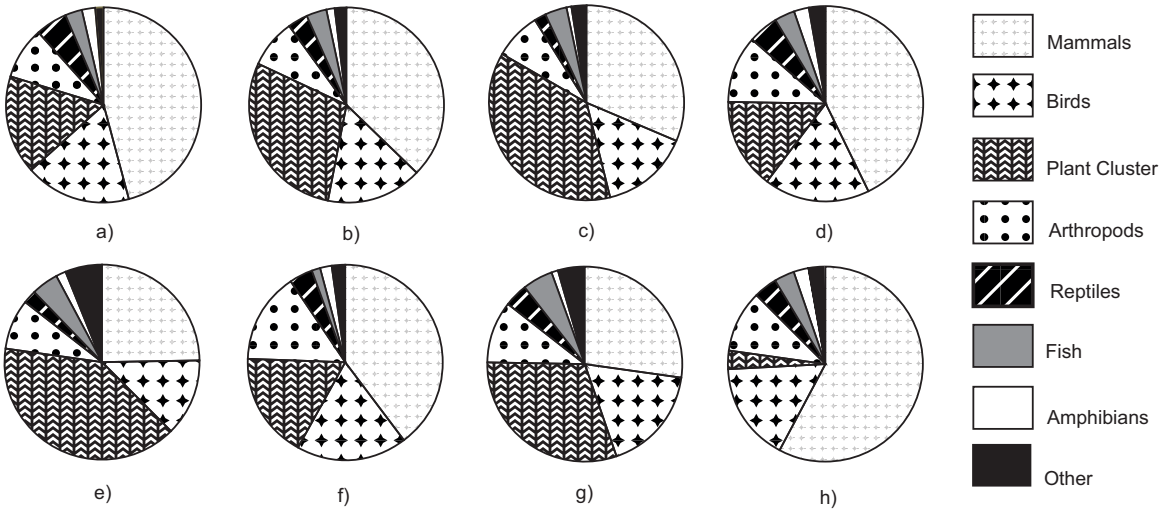

Figure 4.1 Distribution of occurrences per biodiversity groups (fantastic animals or biological traces were excluded): a) in the text b) in images and c) total; Presences of biodiversity groups in d) the main plot and e) the scenario, f) as main characters and g) as characters and h) in anthropomorphization categories. "Other groups" include annelids, mollusks, algae and lichens. Plants cluster include undefined plants, trees, flowers, vegetables and fruits.

Biodiversity on Earth and in the book sample:

Figure 4.2 shows the distribution of taxa per major groups of organism on Earth a) and in the book sample b). The comparison showed statistically significant differences (H_{01}, $\chi^2 = 8043.404; p \leq 0.0001$). Major differences were due to over-representation of plants and vertebrates and under-representation of invertebrates, comparing to their real distribution of taxa on Earth. The most over-represented groups were mammals and birds, while arthropods were the most under-represented. By classifying the nonhuman animals simply as vertebrates and invertebrates, the differences between their frequencies in the real global biodiversity and in the book sample were also statistically significant (H_{02}, $\chi^2 = 2494.445; p \leq 0.0001$) (Fig.4.2).

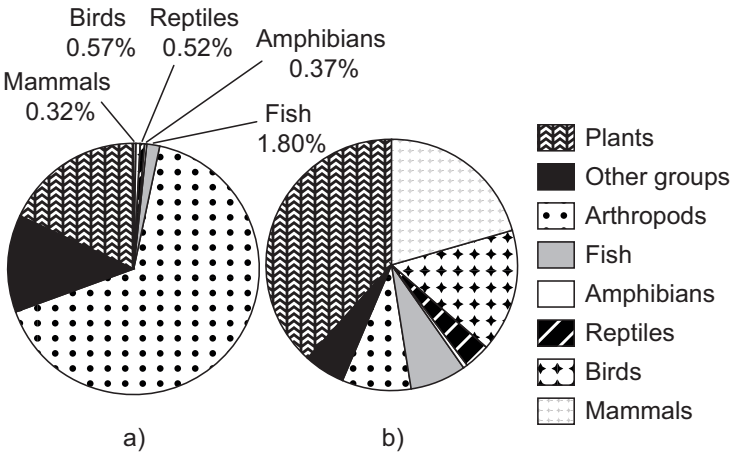

Figure 4.2 Distribution of taxa per major groups of organism on Earth a) and in the book sample here analyzed b). (Source: IUCN 2010 Redlist.
http://www.iucnredlist.org/documents/summarystatistics/2010_1RL_Stats_Table_1.pdf)

Anthropomorphization, authors' nationality and biodiversity elements origin:

Anthropomorphization was present in all major taxonomic groups, but was dominant in mammals (58% of presences), followed by birds (16%) and arthropods (10%) (Fig.4.1h). It consisted mainly of facial expressions (31%), human behavior (17%), speech (16%), use of human objects (16%) and bipedal position (10%) (Fig.4.3a). In mammals, all the anthropomorphization categories were substantially used and evenly distributed. Fishes and the "other groups" presented the most important percentage of facial expressions. Human behavior and bipedal posture were low in fish when compared to the other groups.

Plants were the only group for which facial expression was not the most important anthropomorphization category, whereas speech had the highest relative proportion (Fig.4.3a).

Regarding the origin of the elements of biodiversity, about 48% were autochthonous to Portugal and 43% were exotic (Fig.4.3b). Considering occurrences, the proportion of exotic and autochthonous occurrences was very similar (34% and 35%, respectively).

About 59% of the authors in the book sample were Portuguese and 41% were from other nationalities (29% Europeans, mainly UK, France, Italy and Germany and 12% were from other continents). Focusing on the origin of the elements of biodiversity, differences between author nationalities (Portuguese versus other nationalities) were statistically significant (H_{03}, $\chi^2 = 408.79; p \leq 0.0001$) (Table 4.1). Major differences included the fact that Portuguese authors used undefined and uncertain elements of biodiversity more commonly while other nationality authors referred more exotic and autochthonous elements (Fig.4.3b).

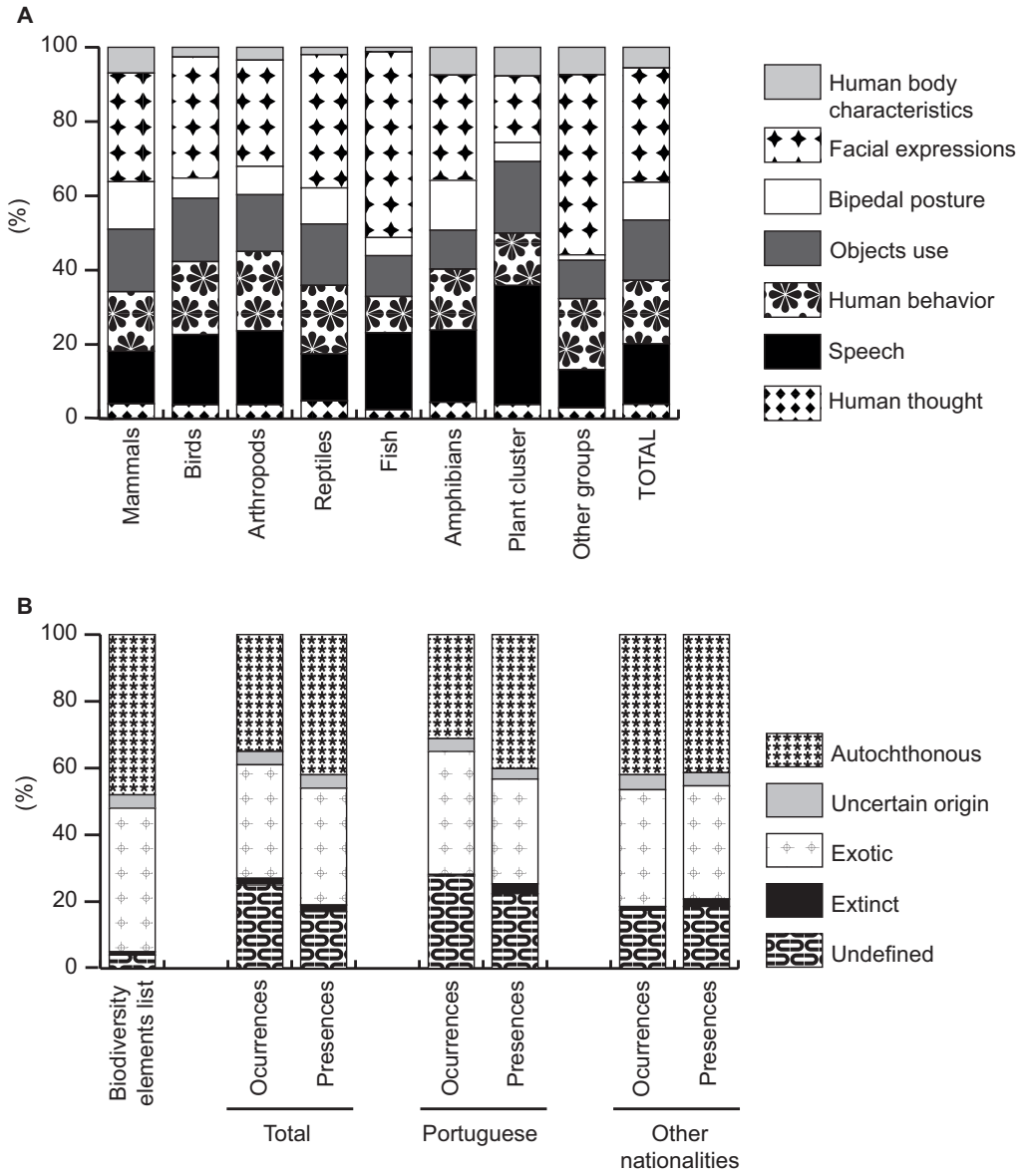

Figure 4.3 Relative importance of anthropomorphization categories per biodiversity group (a) and the relative proportion of the origin of the biodiversity elements in the total book sample and in the sub-samples corresponding to Portuguese and authors of other nationalities. The first column corresponds to the list to the origin of the biodiversity elements mentioned in the book.

Habitats:

Habitats were represented in 93% of the books (152 out of 164). Natural and artificial habitats were present in about 80% and 70% of the book sample respectively. Natural habitats included 19 types while no distinction was made within artificial habitats (see Table 4.1, also for the definition of artificial habitat). Forests were the most frequent natural habitat (36%) and included Temperate and Mediterranean forests (it was impossible to distinguish between them). After forests, the most frequent habitats were somewhat anthropomorphized and included gardens and agricultural landscapes, both present in about 30% of the books. Oceans and rivers were also

frequent and were present in 30% and 20% of the books. All the other natural habitats (desert, lake, savannah, polar, pond, coastal zone, tropical forest, taiga, tundra, prairie, steppe, coral and swamp) were present in less than 15% of the books.

Figure 4.4 shows the ordination analysis diagrams of the data matrices concerning the habitats registered per book. Some of the habitats were only present in very few books and they were considered as a single class, named "other habitats" (gathering taiga, tundra, prairie, steppe, coral and swamp), leaving a total of 14 different habitats in the 152 books. The Bray-Curtis similarity between habitats was calculated for the total data and separately for the sub-sets of Portuguese and other nationality authors. The three were represented in ordination diagrams, Figure 4.4a) corresponding to the sub-set of Portuguese authors, Figure 4.4b) to other nationality authors and Figure 4.4c) to the whole dataset. The closer the circles in the ordination diagram the more similar the habitats they represent, meaning they tend to be mentioned in the same books. The opposite happens when habitats are represented away from each other in the diagram. In the three analyses, two main groups of habitats were represented on opposite sides of axis1, gathering the largest proportion of total variance. They corresponded to two subgroups of habitats with distinct number of presences in the books, identified in the ordination diagrams by the size of the circles (see Fig. 4.4). The habitats more often used by authors, represented by the larger circles, included artificial habitats and well-known natural habitats, namely Temperate and Mediterranean forests, gardens, agricultural landscapes, and, to a lesser extent, oceans and rivers (Fig.4.4c). This trend was clearer in Portuguese authors (Fig.4.4a) than in authors of other nationalities who, proportionally, invested much more in artificial habitats than Portuguese authors (Fig.4.4b). This was confirmed by the stronger Spearman correlation between the Bray-Curtis similarity matrices representing the total book sample and the Portuguese authors books ($\rho = 0.831; p \leq 0.01$), when compared to the total book sample and other-nationality authors books ($\rho = 0.674; p \leq 0.01$), as well as the low correlation between the habitat data matrices from Portuguese and other nationality authors ($\rho = 0.241; p \leq 0.02$).

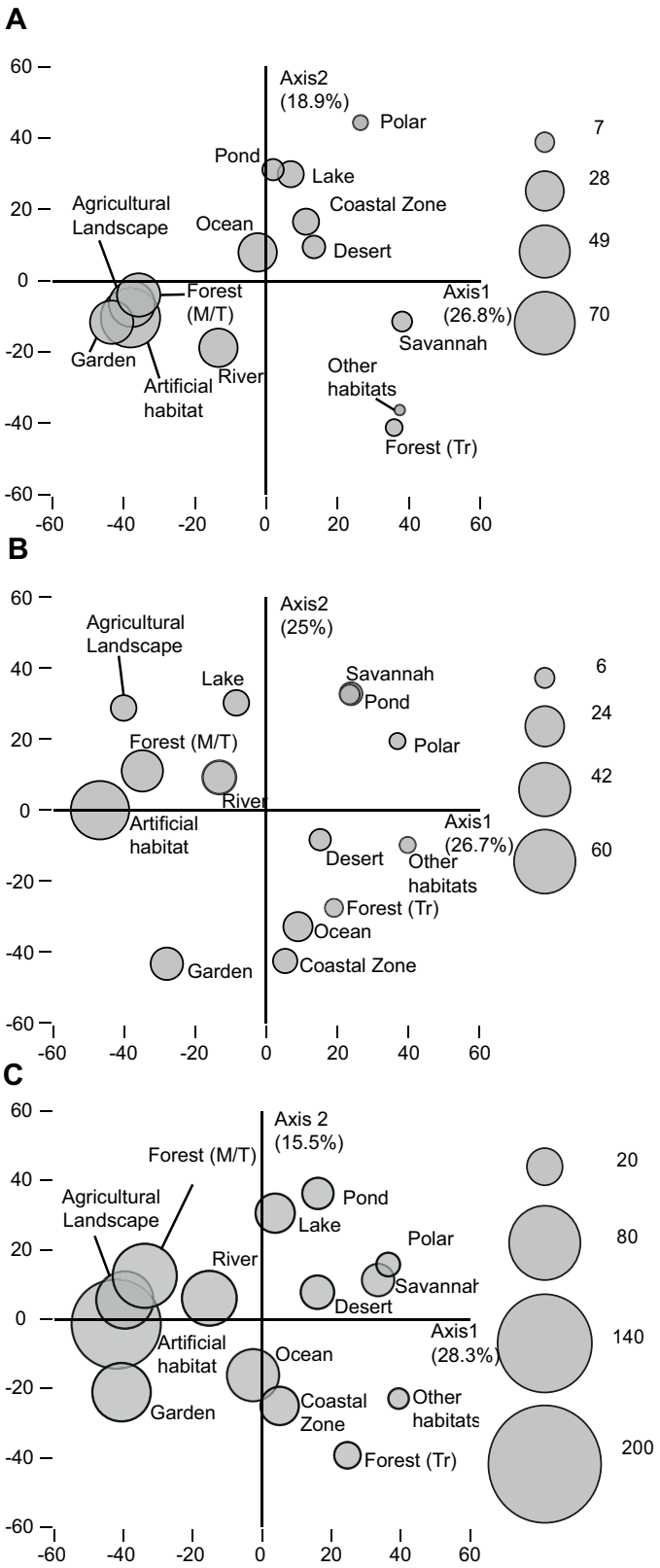

Figure 4.4 Principal Coordinates analysis (PCO) of a Bray-Curtis similarity resemblance matrix between habitats in the books written by Portuguese authors a), by authors of other nationalities b) and in the total book sample c). The circles size reflects the frequency of each habitat. Forest (Tr) – Tropical forest; Forest (M/T) - Mediterranean and Temperate forests.

4.5. DISCUSSION

Various authors have noticed that a significant part of children's books include animal or plant species or habitats (Ford, 2006; Williams, J. et al., 2012). The results from this study support such conclusions, as almost 98% of the 164 books analyzed included biodiversity elements and about 80% mentioned natural habitats. The results from this study are however against the first hypothesis (H_{01}). The biodiversity elements' frequency distribution was not representative of the global species diversity, as has been suggested by others (Gonen & Guler, 2011) and significant differences were observed between the global species diversity distribution among major taxa groups and the one represented in the book sample. The results are against the null hypothesis H_{02} and showed that, generally, plants and all vertebrate groups, especially mammals, were over-represented in both text and images and arthropods, as also as other invertebrate taxa (included in "other groups"), were largely under-represented in the book sample, considering their contribution to global species diversity.

The distributions of the occurrences were dominated by few biodiversity elements. Most of them, shown in the Top 10 list, included mammals, especially companion animals and domestic animals as well as undefined groups of plants. In addition to being more frequent, mammals were also the major contributors as the main characters in the stories, while keeping high frequencies as other characters and in the scenario. Even so, major mammal main characters and the main plot were again provided by a limited number of nonhuman animals, mainly companion animals and domesticated animals for labor or food production.

Humans usually don't appreciate arthropods and invertebrates mainly due to their morphology, which is very different from vertebrates (Kellert, 1993; Knight, 2008). Arthropods were poorly represented in the book sample when compared to their proportion in global species diversity. They were mainly represented by butterflies, bees, ants and flies, possibly due to aesthetic factors like color (bees and butterflies) as a relevant factor in preferences (Stokes, 2006; Wagler & Wagler, 2012), by cultural associations of effort and perseverance (ants and bees) or by direct and more intense contact with the human population (ants and flies).

Within the vertebrates, reptiles and amphibians were the less represented groups. Reptiles are considered as one of the species groups least liked by the general public. They were mostly represented in the main plot of the images but did not play a specific type of character in the text. Crocodiles were the main contributors to the frequencies of this group, which contributed to a high exotic origin of the occurrences in the group, as mentioned in other studies (Prokop, Pavol et al., 2009; Tomazic, 2011c; Ballouard et al., 2013).

Amphibians were one of the less-used groups. They were generally mentioned only broadly so it was difficult to distinguish between species. Within Anura, authors hardly or incorrectly distinguished frogs from toads both in text and in images. This lack of accuracy may interfere with children's information transfer from books to reality and could explain negative attitudes towards amphibians mentioned in several studies (Tomazic, 2008; Ceriaco, 2012).

Although plants presented a relevant role in the books analyzed, they were more important in images, namely in scenario, as "undefined plants", being impossible to identify to a more specific taxonomic level. Some studies have shown that people are usually more interested in nonhuman animals than in plants (Wandersee, 1986; Lindemann-Mathies, 2005). Children also like nonhuman animals more than plants, are better informed about them and want to know and

protect nonhuman animals rather than plants (Wandersee, 1986; Wandersee & Schussler, 2001). Such preference could be based on a fascination for movement, eye contact, communication by sound, behavior learning and interaction, none of which are provided by plants. This preference may also be based in children's capacity for empathy for certain species, which appears to be culturally shaped (Stewart & Cole, 2009). Non-flowering plants or flowering plants at their non-flowering periods also have a small chromatic impact in children. Because of this, people tend to perceive plants as a part of the animals' "lifeless" habitat, and not as individuals (Lindemann-Mathies, 2005). Concerning fish and birds, "undefined fish" and "undefined birds" were also the main contributors to the total of frequencies in each group although birds presented a more important role in the main plot and as main characters than plants or fish. Birds were usually represented by passerines, juveniles, and using very simple graphics. Fish were also poorly characterized and usually represented by bony fish only. It was surprising that birds, being animals more easily observed in their natural habitats were so poorly represented at the level of the species. The same occurs with fish in the case of Portuguese authors, despite the extensive Portuguese shoreline and oceanic history. As with plants, cultural factors may be responsible for these undefined representations. Contact with fish is difficult due to the characteristics of their habitat, which reduces a direct contact to aquariums, the fish market or after cooking. Whichever the reason, it is known that representations interfere with transfer of information in children (Ganea, Patricia A. et al., 2011) and the representation of groups of organisms as "undefined" may contribute to a poor perception of organisms.

In conclusion, this pattern shows that with the exception of plants, the taxonomic groups phylogenetically closer to humans are over-represented in the book sample. Vertebrates, especially mammals and birds, were over-represented whereas invertebrates and other outlying taxonomic groups were under-represented in the book sample comparing to their global species distribution. The trend to represent living being closest and more similar to humans is even strengthened by an intense anthropomorphization of the characters in the stories in all major groups of organisms, a major artificial feature of biodiversity in children's books (Ganea, Patricia A. et al., 2011). The most important anthropomorphization categories were facial expressions, human behavior, speech and the use of objects, and were mostly applied to mammals, a group that is phylogenetically closer to man and preferred by children (Lindemann-Mathies, 2005). Anthropomorphization makes the organisms physically and behaviorally more similar to humans and therefore even more preferred by children (Woods, 2000; Batt, 2009), but devalues and distorts their own characteristics as living beings. It is unclear if anthropomorphization is used to make organisms similar to humans or to provide evidence of phylogenetic similarities to humans. Some authors argue that some anthropomorphization categories promote empathy for nonhuman animals and sense of awareness. Many other authors consider that anthropomorphization creates misconceptions about species and their relations with Humans (Wells & Zeece, 2007; Ganea, Patricia A. et al., 2011; Ganea, P. A. et al., 2014). In fact, by observing the use of anthropomorphization categories in the book sample, we suggest that, whereas speech ability may marginally interfere with information transfer about an organism's characteristics and habits, since it plays a major role in message transfer and understanding, other categories such as human behavior and object use, alters the organism's characteristics as well as their habits. This distorts the information transmitted about all the species groups and can

transfer inaccurate facts that negatively interfere with generalization and cause inadequate transfer of human capabilities into another organisms, as argued by several authors (Hug, 2010; Ganea, Patricia A. et al., 2011; Ganea, P. A. et al., 2014).

Concerning the origin of the biodiversity elements in relation to the origin of the authors, several differences are visible, although it cannot be stated that Portuguese authors refer more commonly autochthonous species that other nationalities which is against the null hypothesis H_{03}. Portuguese authors included in their stories undefined and uncertain elements more commonly than authors of other nationalities. An undefined view of biodiversity, systematically applied in books, seems to have considerable impact in children's conception of organisms. It was noticed that other nationality authors, used autochthonous biodiversity elements more commonly than Portuguese authors but also exotic biodiversity elements, as a consequence of fewer situations of undefined and uncertain taxa definition. This shows that, other nationalities' authors, although not focused on their countries' species, usually defined better the species in their books than Portuguese authors, which reduced the level of alienation about species that is more common in Portuguese author's books.

Finally, habitats were present in most of the books, which is in agreement with the fact that biodiversity but also the environment are very commonly used in children's books (Ganea, Patricia A. et al., 2011). The organisms often appeared associated with a natural but also a partially humanized habitat. Artificial habitats were the most frequent habitats in the book sample, usually sharing their presence with natural habitats. Forests were very common, which recalls the enchanted forest from fairy tales (Bettelheim, 1976). Excepting the forest, the most portrayed habitats included some human interference, as agricultural landscape or gardens, and usually appeared together. Authors invested more on well-known habitats like gardens, fields, forests, rivers or the ocean and this was especially relevant in Portuguese authors. This may be because of the recent development of Portugal compared to other European countries, an aspect that may be seen in the books with mainly pictures of rural Portugal until the middle of the 20th century, a period of the growth of several of the Portuguese authors that contributed for this book sample. Other nationalities' authors, on the other hand, although investing on those habitats, appear to be more persistent with artificial habitats. These results confirm recent studies showing that authors invest more in less natural environments, with built environments being increasingly portrayed in children's books (Williams, J. et al., 2012). Often such partially artificial habitats are devoid of a negative interference from humans, leading to an image of peaceful coexistence of man in nature which, although untrue, is common in people's perception of biodiversity (Fischer & Young, 2007; Fischer, Bednar-Friedl, et al., 2011; Fischer, Langers, et al., 2011).

Overall, this study showed that children's books presented a distorted image of biodiversity, leading to erroneous transfer of information. Biodiversity was limited to a few defined species of nonhuman animals, mostly mammals, especially companion animals or domesticated animals for labor or food production as well as charismatic megafauna, which were commonly portrayed as main characters, showing anthropomorphization skills and inhabiting well-known habitats, which were often artificial. Other species groups such as invertebrates, reptiles and amphibians were generally forgotten. The books could be limiting the connections between human-animal species to a human-pet relationship and so interfere with children's information and emotion transfer

(Johnson, 1996; Ganea, Patricia A. et al., 2011; Ganea, P. A. et al., 2014). The fact that approximately half of the biodiversity elements were exotic supports the conclusion that the biodiversity available from vicarious experiences is limited to a few, likeable, domesticated (e.g., companion animals) or to far (e.g., elephant) and inaccessible groups of species (Ballouard et al., 2011) which can have negative effects in conservation actions (Kassas, 2002; Lindemann-Mathies, 2005). Several studies also showed that children prefer nonhuman animals over plants, especially vertebrates with physical and behavioral similarities to humans, particularly companion animals and other charismatic megafauna (Wandersee, 1986; Kellert, 1996; Stokes, 2006). This has lead authors to conclude that some crucial relation must exist between the content of children books and their attitudes and preferences (even preferences for conservation) that children develop about species (More, 1979; Prokop, Pavol et al., 2011). This relationship is still poorly understood. As reported in other studies species are being primarily used as a tool for engaging children in the social situations of the stories by the overuse of anthropomorphization features, while its role promoting biodiversity was often neglected (More, 1977; Williams, J. et al., 2012). Education for biodiversity through vicarious experience is crucial and highly recommended in order to contribute to the success of conservation actions (Miller, J. R., 2005; Waylen et al., 2010; Ballouard et al., 2011). So, without neglecting the children's writers freedom and imagination, efforts must be made in order to address biodiversity not only as a tool to develop skills and emotions in children but also as a target for learning and the transfer of information about conservation and nature protection (Bednar-Friedi et al., 2004; Randler et al., 2005; Fischer, Langers, et al., 2011). This study was focused on the set of books analyzed from a list recommended by the National Reading Plan of Portugal that have a high influence in individual, scholar, family and library reading choices. We hope that it could contribute to advance research and discussions on communication pathways in the society, in particular on how media addresses biodiversity and conservation issues for children.

4.6. CONCLUSIONS

Biodiversity and environment were found to be frequent in children's books. However, the information about biodiversity and the environment in these books is strongly distorted, which may negatively influence children's attitudes towards conservation. This constitutes a serious concern at a time when vicarious experiences in biodiversity are crucial and highly recommended in order to contribute to the success of conservation actions. Without impairing authors' creativity, efforts must be made to introduce these values into their writing strategies for children. Since the impact of this effort can only be expected in the long term, all communication pathways that promote direct and vicarious experiences in biodiversity should be stimulated. Environmental activities in particular should be able to promote direct contact, critical thinking and an understanding of biodiversity, devoid of prejudices and misconceptions and may have an important role redirecting the perception of children about life on earth and their conscious choice for conservation.

5. MEASURING THE IMPACTS OF AN ENVIRONMENTAL EDUCATION PROJECT ON CHANGING ATTITUDES TOWARDS PONDS AND ASSOCIATED BIODIVERSITY.

5.1. ABSTRACT

Ponds provide vital ecological services. They are biodiversity hotspots and important breading sites for rare and endangered species, including amphibians and dragonflies. Nevertheless, their number is decreasing due to habitat degradation caused by human activities. The "Ponds with Life" environmental education project was developed to raise public awareness and engagement in the study of ponds, by promoting the direct contact between the public and nature, researchers and pedagogical hands-on exploration activities. A two-stage evaluation scheme was set-up to assess the impact of the project on environmental consciousness, knowledge and attitudes changes towards ponds and the associated biodiversity of school students aged 15 to 18. The evaluation included inquiry techniques and innovative methodology for data analysis making use of multivariate hypothesis testing. The results showed that the project improved the students' knowledge and their attitudes towards ponds and associated biodiversity, especially amphibians, otherwise a rather neglected group of animals. The students preferred hands-on activities with direct contact with biodiversity to classroom activities or scientific presentations. Ponds proved to be interesting model habitats and living laboratories to foster environmental education since they have a small size but encompass a diverse biodiversity and allow the establishment of a rapid ecological succession, they can be found in urban areas or be successfully constructed in school grounds and provide excellent conditions for numerous practical biodiversity exploration activities.

KEY WORDS: Ponds and biodiversity conservation; amphibians; environmental education; hands-on activities; project evaluation.

5.2. INTRODUCTION

Ponds are small shallow water bodies, which can be natural or artificially generated, permanent or temporary and characterized by an accentuated hydroperiod (Zacharias et al., 2007; Céréghino et al., 2008; Zacharias & Zamparas, 2010; Pinto-Cruz et al., 2011; Bagella & Caria, 2012). They exist in all continents and are considered biodiversity hotspots due to their importance as breeding sites for amphibians, dragonflies and other invertebrates, as well as key habitats for diverse fauna and aquatic plants (Beja & Alcazar, 2003; Zacharias et al., 2007; Pinto-Cruz et al., 2011; Bagella & Caria, 2012). The different pond types harbour not only a higher number of species, but also of unique and rare species than lakes, rivers, streams and other freshwater ecosystems (Williams, P. et al., 2004). Mediterranean temporary ponds, in particular, comprises many endemic species and are protected by the directive 92/43 CEE by European Commission Natura 2000 network (habitat 3170) and by the Ramsar Convention on Wetlands (Bord et al.,

2000; Céréghino et al., 2008; Zacharias & Zamparas, 2010; Pinto-Cruz et al., 2011; Bagella & Caria, 2012; Ferreira, M. & Beja, 2013).

Despite their biodiversity and ecological services, the number of ponds is decreasing, especially in the Mediterranean region (Ferreira, M. & Beja, 2013). Ponds are usually neglected by the public and are very susceptible to degradation, caused namely by intensive agriculture and urban development (Beja & Alcazar, 2003; Zacharias et al., 2007; Zacharias & Zamparas, 2010; Ferreira, M. & Beja, 2013). Portugal has several climatic and geomorphological characteristics that favour the occurrence of natural ponds, including Mediterranean temporary ponds. Local studies however also indicate an accentuated loss of this habitat and its associated biodiversity (Costa, J. C. et al., 1998; Ferreira, A., 2000; EPCN, 2008; Ferreira, M. & Beja, 2013).

Amphibians are among the species of highest conservation concern given that nearly one-third of species (32.4 %) are globally threatened (Ferreira, M. & Beja, 2013; International Union for Conservation of Nature, 2014). Many authors have documented the link between habitat loss, namely breeding sites, and amphibian decline and extinction (Gallant et al., 2007; Sodhi et al., 2008; Hof et al., 2011). Habitat change is globally the major contributing factor to amphibian decline, affecting around 87% of the threatened species (Chanson et al., 2008). Amphibians are also among the least appreciated vertebrates by the general public, being often victims of negative values and misconceptions resulting from the direct interpretation of folklore and ancient myths (Ceriaco, 2012).

Biodiversity loss is one of the main concerns of the scientific community and constitutes an important issue of the educational curricula in many countries, including Portugal. Many researchers emphasized the importance of outdoor environment and biodiversity and ecology educational strategies in order to develop concepts, construct attitudes, and the overall personality (Falk, J. H., 1983; Armstrong & Impara, 1991). Direct contact with biodiversity and a better understanding of its importance and threats are essential to raise public awareness and engage the population in community-driven biodiversity conservation and monitoring programs. However, most of the population lives in urban areas and the direct contact with nature is decreasing, limiting the efficacy of education towards environmental and biodiversity awareness (Miller, J. R., 2005). From this point of view, hands-on activities in proximity habitats may help to overcome this gap by providing experiences to students, enhancing their literacy and their active participation in conservation demands.

"Ponds with Life" ("Charcos com Vida") is an environmental education project developed in Portugal with the purpose of raising public awareness and engagement in the study and pedagogical exploration of ponds and associated biodiversity conservation. Project details, general information about pond importance, construction, management and biodiversity, a set of pedagogical activities for pond exploration as well as the first National Pond Survey can be obtained in the project website (www.charcoscomvida.org).

The sub-project "Choose Science – Ponds with Life" was specially designed for 15-18 year old students from high schools. It included activities throughout a school year allowing a direct contact with ponds and the associated biodiversity as well as with researchers. The program featured at least five visits of one member of the "Ponds with Life" team during a school year (2013/2014) and the development of several activities, including pond adoption or construction in the school area or neighbourhood, guided activities as scientific lectures, workshops and hands-

on experimental activities in the classroom, laboratory and fieldwork, associated to the biological monitoring of the adopted pond. In addition, an amphibian itinerant exhibition was displayed for one month in each participating school, contributing to inform and engage the school community in the conservation of ponds and this less appreciated group.
This study performed a two-stage evaluation analysis aiming to better understand the impact of environmental education projects and of its pedagogical approaches on public perception and attitudes changes towards ponds and associated biodiversity.

5.3. METHODS

Project implementation:

The project was implemented during the 2013-2014 scholar year in eight schools from different cities of Central and North Portugal, of which six were able to participate in all project activities and evaluation. The project team performed five visits to each school and developed eight activities, including science dissemination lectures and support sessions to adopt or construct a pond, to manage and monitor ponds, to developed a field activity and a classroom practical activity and to organize and install an itinerary exhibition on amphibians and train the students to play roles as monitors and animal keepers for this event.
The lectures included three themes related with ponds and associated biodiversity: the first introduced the project, the pond habitat definition, importance, conservation status and its biodiversity; the second addressed amphibian and reptile conservation and took place while the itinerary exhibition on amphibians on display in the school; and the third lecture was about scientific research being developed in ponds, in areas such as genetics, evolution and biodiversity conservation, which was presented by a researcher working in that field.
The amphibians' itinerary exhibition "Anfíbios - uma pata na água, outra na terra" ("Amphibians - a paw on the water, another on land") aimed to aware the school community towards amphibian, including their biology, ecology, evolution, adaptations, diversity, importance, threats and conservation. This exhibition included roll-up informative panels, two terrariums with live autochthone Portugal amphibians representing the two main taxonomic orders, frogs (Anura) and salamanders (Caudata). During the exhibition periods, the students participating in the project were responsible for the maintenance of the exhibition including feeding and monitoring the animals under the supervision of their teachers/tutors.

Project evaluation:

The project evaluation consisted of two questionnaires delivered and filled one before the beginning of the project, during the first visit to the schools, and the other at the end of the final visit to the schools. The pre- and post-project questionnaires layouts are available in the annex 5 of this thesis. Both questionnaires were anonymous and included sociodemographic questions about the age and sex of the participants, a group of true/false questions concerning their knowledge about ponds and associated biodiversity, Likert scale groups of questions, one about attitudes towards specific pond biodiversity groups (frogs, salamanders, turtles, other reptiles,

odonata, other macroinvertebrates and plants) and another about attitudes towards ponds. The answer scale went from "totally dislike" (coding value 1) to "like very much" (coding value 5) with a central response of "indifferent" (coding value 3). The questionnaires also included two additional groups of Likert scale questions about attitudes towards ponds and amphibians, adapting the basic attitudes about the environment and biodiversity described by Kellert (Kellert, 1985b, 1993, 1996), broken into different categories described by the following nine types: aesthetic, dominionistic, ecologistic, humanistic, moralistic, naturalistic, negativistic, scientistic and utilitarian (Kellert, 1985b, 1993, 1996). Another group of Likert scale questions was included in the two questionnaires concerning environmental consciousness, as defined by the revised New Environmental Paradigm scale (NEP) described by Dunlap (Dunlap et al., 2000; Manoli et al., 2007; Dunlap, 2008), with answers also coded from 1(most negative opinion) to 5 (most positive opinion). The pre-project questionnaire also included multiple-choice questions about previous knowledge and contact with ponds.

Data from the questionnaires was provided and analysed anonymously and, apart from the age and sex of the participant, only included questions focusing the study objectives. The school boards and professors approved the evaluation strategy prior to the project implementation. Oral consent to use the data for scientific purposes was given by the participants and their teachers after a member of our team read the questionnaire header indicating the study objective.

Data analysis:

Data from the pre- and post-project questionnaires were analysed using descriptive statistics (mean and frequency analysis) with IBM SPSS statistics for Mac, version 20 and Microsoft Excel for Mac 2011 (Internacional Business Machines, Released 2011; Microsoft, Released 2011). The pre- and post-project responses were also tested for significant differences using multivariate analysis methods. Each question was answered with a code 1 to 5 according to the Likert scale and, despite the categorized nature of this codification, the values were primarily treated as quantitative namely to calculate basic descriptive statistics (such as the mean) showing the evolution in the students' response before and after the project implementation. In addition, the Likert scale results were organized as a set of five category presence-absence variables (values 1 and 0) with the presence (value 1) attributed to the variable representing the value code selected by the student. As an example, if question 3 was replied by a student with the code 4, the question was organized as variables 3.1 to 3.5 and the presence attributed to 3.4. All the responses were merged into a data matrix, in which the students corresponded to the objects of study, or samples and their answers to the variables. A resemblance matrix among the samples was obtained using the Jaccard similarity coefficient, with the software PRIMER v6 with the add-on PERMANOVA+ (Clarke & Gorley, 2006). The resemblance matrix was simplified by calculating the centroid or centre of gravity, for each group of students per school and time period (pre- and post-project). This resemblance matrix was submitted to ordination analysis using non-metric multidimensional scaling (NMDS), and tested for the null hypothesis of no significant differences between the time periods (pre- versus post-project), using a one-way Analysis of Similarities (ANOSIM) (Clarke & Gorley, 2006). ANOSIM produces the statistic R, which relates the within to the between group similarities, in a triangular resemblance matrix between samples, in this case

obtained with the Jaccard similarity coefficient. The R statistic varies from -1 to +1 and is equal to +1 when all the similarity values within the replicates of the same group are larger than all the similarity values between replicates from different groups, so rejecting the null hypothesis. R approaches the value 0 when the null hypothesis is true. The R statistic is accompanied by a significance value obtained by calculating the probability of the observed R within a series of R values obtained after a permutation procedure (Clarke & Gorley, 2006). In this case, with two groups being compared (pre- versus post-project), each with six replicates (the centroids representing the students from the six schools that completed the assessment), there are a maximum of 462 permutations, allowing to reject the null hypothesis at p=0.002, when the observed R was larger than any of the permuted R-values (1 out of 463 = 0.002).

The null hypothesis was tested separately for the groups of questions dedicated specifically to i) evaluate the attitudes towards biodiversity groups, ii) the general attitude about ponds and iii) the basic kellert atitudes about ponds and amphibians. For the questions representing the attitudes towards biodiversity groups, upon rejection of the null hypothesis including the responses with all taxonomic groups, the test was run separately with each to verify for which biodiversity groups the attitudes differed from the pre- to the post-project periods.

5.4. RESULTS

Two hundred and two (202) pre-project and 131 post-project valid responses were obtained, given that not all the students completed the whole set of activities.

The students who answered the pre- and the post-project questionnaires were on average, 16 and 17 years old respectively (most students celebrated their birthday during the period of the project implementation). Considering the gender, in the pre-project questionnaires 63% of the participants were girls and 37% were boys while in the post-project the percentages were 66% and 34%, respectively.

About 80% of the students were acquainted with the pond habitat before attending the project activities. However, previous contacts with ponds were mainly acquired by indirect means, such as the Internet (62%), books or journals (61%), television (44%) or other media. Pre-project direct contact was obtained through visits to ponds during school activities (52%) or walks in Nature (50%).

The questions dedicated to assess prior knowledge about ponds and associated biodiversity showed that students answered correctly 60% of the pre-project questions, of which 67% related to pond ecology and 52% to biodiversity. In the post-project questionnaires 66% responses were correctly answered. This result showed significant improvements in the subject knowledge ($\chi^2 = 17.696; p \leq 0.0001$). The percentage of correct answers related to pond ecology was still higher (73%) than those related to pond biodiversity (60%), but the increase was larger in the latter (8%).

Table 5.1 summarizes pre- versus post-project Likert scale mean values as well as the ANOSIM R-statistic values considering the various questions.

Regarding attitude towards ponds, the mean Likert scale values increased from indifferent to a good attitude, following the project implementation. A statistically significant difference between pre- to post- project responses was shown by ANOSIM (Table 5.1). The last bars from Figure 5.1 a)

and 5.1 b) illustrate Likert scale categories and respective mean value in pre- and post-project responses considering attitudes towards ponds, showing a clear pattern of perception improvement after the project, particularly evident at the lowest values of the Likert scale. Figure 5.2 a) shows the non-metric MDS ordination analysis of the school centroids for the same data.

Table 5.1 Likert scale mean values and ANOSIM R-statistic and associated significance for the comparison between pre- and post-project questionnaires responses. ns = non significant.

	Pre-project Likert scale mean value	**Post-project Likert scale mean value**	**ANOSIM** R-statistic	**ANOSIM** Significance (p)
Attitudes towards Biodiversity	3.13	3.60	0.409	0.002
Frogs and toads	3.06	3.60	0.435	0.004
Salamanders and newts	2.75	3.67	0.657	0.002
Turtles	3.98	4.11	0.039	0.559 ns
Snakes and lizards	2.59	3.15	0.244	0.058 ns
Dragonflies	2.97	3.43	0.116	0.160 ns
Other macroinvertebrates	2.58	3.10	0.131	0.130 ns
Plants	4.03	4.17	0.165	0.996 ns
Attitudes towards Ponds	3.48	4.02	0.465	0.006
Kellert basic attitudes towards Ponds	3.09	3.24	0.233	0.041
Kellert basic attitudes towards Amphibians	3.22	3.57	0.263	0.022
Environmental consciousness	3.60	3.56	-0.017	0.550 ns

Regarding attitudes towards the biodiversity groups, there was also an evolution from an indifferent to a medium-good attitude following project implementation. Figure 5.1 a) and 5.1 b) illustrate Likert scale categories and respective mean value in pre- and post-project responses considering attitudes towards the different biodiversity groups suggesting a general improvement in attitudes. In fact an evolution in attitudes was confirmed by the significant difference between schools centroids from pre- to post- project in the ANOSIM multivariate analysis (Table 5.1).

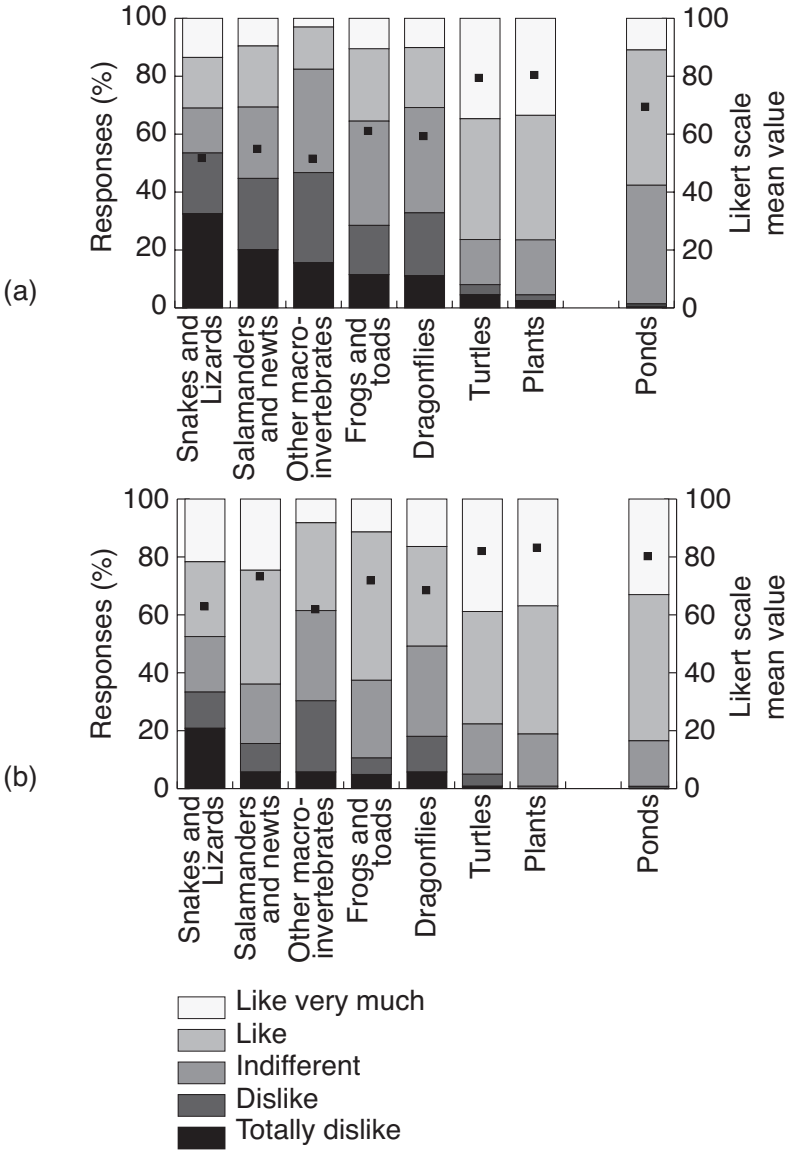

Figure 5.1 Likert scale response categories (right axis) in (A) pre- and (B) post-project questionnaire responses regarding attitudes towards the various biodiversity groups and the pond habitat. Likert scale mean values are indicated over each bar as a black square symbol (left axis).

Figure 5.2 b) shows the ordination diagram of the school centroids demonstrating the differences between pre- and post-project responses. However, not all biodiversity groups rejected the null hypothesis, as shown in the ANOSIM test results presented in Table 5.1. For some groups, the attitudes of the students before and after the project implementation remained unchanged. This was particularly clear for the groups with higher perception values before the project implementation, such as the Plants and the Turtles. Other groups, namely the Amphibians, such as Urodeles (Salamanders and Newts) and the Frogs, rejected the null hypothesis indicating that the attitudes of the students towards these biodiversity groups changed significantly due to the project activities.

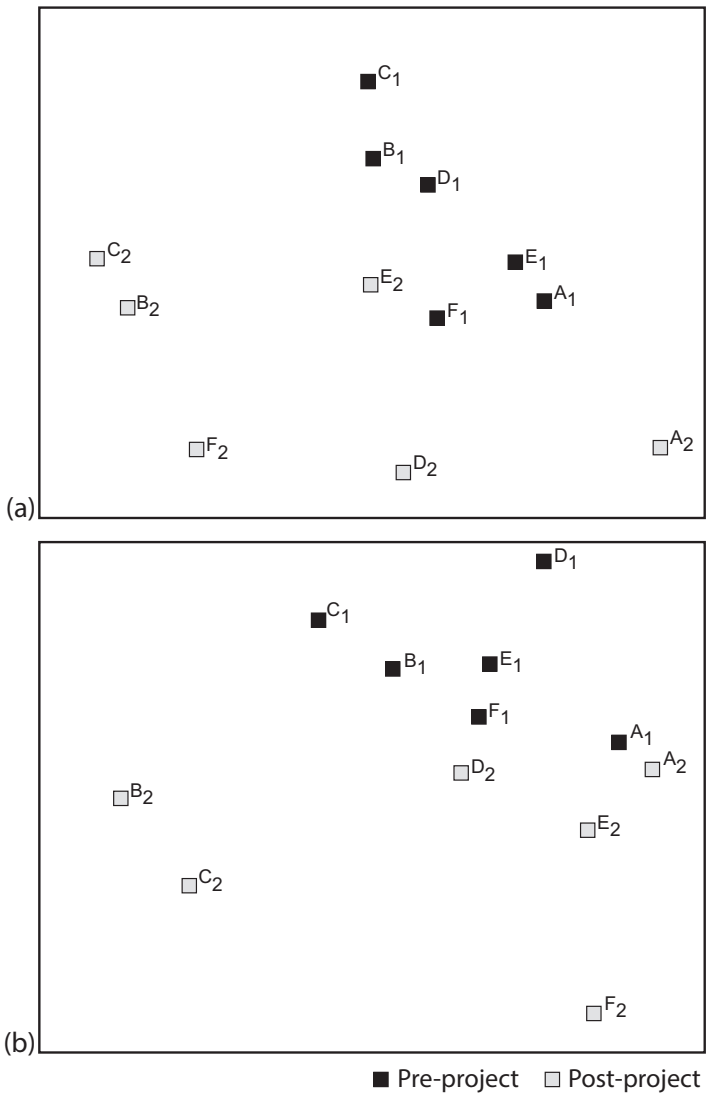

Figure 5.2 Ordination diagram (NMDS) representing the schools centroids (A-F) for the pre- and post-project responses (1 and 2, respectively), relative to the attitudes towards ponds as a habitat (A) and pond biodiversity (B).

Considering basic attitudes defined by Kellert adapted towards amphibians and ponds, a global analysis of Likert scale mean values showed an evolution from a medium to a medium-good mean value following project implementation. The differences in school centroids between pre- and post-project responses were also shown to be statistically significant (Table 5.1).

Finally, considering environmental consciousness, the mean Likert scale value of students' responses from all schools was almost the same in the pre-project and post-project questionnaires with a medium-good position. Likewise, no significant differences were observed in the ANOSIM test for this descriptor (Table 5.1). A brief analysis of the responses related to environmental consciousness, the NEP scale sentences related with the human capacity to solve environmental problems and intelligently explore new natural resources were given the least

positive answers from the students, while the most positive were associated with Human impact in nature and the environment.

5.5. DISCUSSION

The present study showed that the implementation of the environmental education project "Choose Science - Ponds with Life" during one school year was able to modify the knowledge, awareness and attitudes towards ponds and their biodiversity, particularly towards amphibians, in high school students between 15-18 years old.

Pre-project contact of the students with ponds was mainly through indirect means, such as the internet, television and books. Other authors already recognized that contact with nature is becoming more and more dependent of indirect pathways as media (Miller, J. R., 2005; Ballouard et al., 2011). Direct contact with ponds was moderately common although limited to walks in nature or to existing ponds in schools. However, the previous consciousness and recognition of ponds as important habitats were very limited as showed by the results of knowledge and attitudes towards this habitat and associated biodiversity. This suggests that previous direct contact with ponds was poor and limited to nature appreciation.

Considering knowledge about ponds and biodiversity, the number of correct answers was higher in the post-project questionnaires than in the pre-project. In both questionnaires, the knowledge about the habitat was always higher than about biodiversity, which indicated scarce knowledge about the species associated with the pond habitat. Knowledge cannot be considered a vehicle to attitude change although some authors proposed that prior knowledge can have great impact in attitude acquisition (Kollmuss & Agyeman, 2002; Jordan et al., 2011). Also, knowledge acquired in environmental education programs may not last and projects based on knowledge acquisition only may not be as effective as those focused on attitudes. The project "Choose Science - Ponds with Life" extended over one full scholar year, with the possibility to with the possibility of extending that connection with the "Ponds with Life" project, having the potential to maintain the acquired knowledge for longer and thus being able to effectively contribute to attitude development/changes.

Considering attitudes towards ponds as a habitat were mainly indifferent before the project was implemented shifting to good with most of the students admitting to like ponds by the end of the project. This significant change in attitude toward ponds was also confirmed by Kellert attitude values adapted to ponds that also resulted in significant changes between pre- and post-project responses.

Regarding attitudes towards different groups of pond biodiversity, the general evaluation demonstrated that there was a small but significant increase of positive attitudes following the project implementation. This result was mainly due to attitude changes towards the groups of amphibians: frogs and salamanders, which were in the pre-project situation negatively connoted by the students, salamanders in particular. In addition, a significant increase of positive attitudes was also found using Kellert's factors applied to amphibians. These results demonstrated that although amphibians were usually negatively connoted and a neglected group of animals, their easy detection, identification and particular biological characteristics, including morphological variety and adaptation to aquatic habitats, reproduction, larval and metamorphosis phases easily

observed in water bodies close to urban areas, allow an easy engagement with the public and make them good models for environmental education activities, as indicated by other authors (Tomazic, 2008, 2011c; Ceriaco, 2012). The attitude change towards amphibians detected in this work also benefited from the temporary exhibition about amphibians and that most of the lectures, classroom and field project activities were somehow associated with this biodiversity group.

Differences in student attitudes towards Odonata and other macroinvertebrates were not statistically significant. This suggests that human attitudes towards invertebrates characteristics may be important barriers for environmental education and attitude change (Kellert, 1993; Woods, 2000). Several authors refer namely their morphology, so different from ours, as an important cause for the usually observed negative attitudes (Kellert, 1993; Wagler & Wagler, 2012). Others indicated that cultural heritage that associates invertebrates with danger and disease can also justify this resilience in attitudes towards invertebrates (Serpell, 2004; Prokop, P. & Fancovicová, 2013). Finally, some authors indicate that phylogenetic distance from humans that culminates in different morphology and behaviour may also have an impact in human attitudes towards invertebrates (Stokes, 2006; Batt, 2009).

Scaled reptiles, although did not achieve significant differences between pre- and post-project questionnaires, also demonstrated an important increase in positive attitudes by the participants. The fact that these animals were not always easy to observe may justify the absence of significant differences. In addition, cultural heritage is responsible for several negative attitudes towards reptiles and without intensive educational actions people may not be prepared to protect them (Knight, 2008; Prokop, Pavol et al., 2009; Tomazic, 2011b; Ballouard et al., 2013). This was not however generalized to turtles, as they were already appreciated by students before the project implementation, explaining the low change between the pre- versus post-project attitudes, which show no significant differences. Previous works already demonstrated differences between attitudes towards turtles when compared to other reptiles, which may be related with the fact that turtles are usually adopted as pets, have no venomous species and show often positive connotations in books and media (Woods, 2000; Prokop, Pavol & Tunniclife, 2010; Ceríaco et al., 2011; Ceriaco, 2012).

Plants, as turtles, were also among the most appreciated groups of species considered in the pre-questionnaires, and so did not achieve a significant positive increase in attitudes following the project implementation. However, some authors suggested that attitudes towards plants are empty of strength and despite the public having positive attitudes towards them, they also consider plants as lifeless and worthless (Wandersee, 1986; Lindemann-Mathies, 2005).

Regarding environmental consciousness of the participants did not change significantly due to the implementation of the project and kept a medium-good level, according to the NEP scale (Dunlap, 2008). This was not under the main goals of the project “Choose Science - Ponds with Life” and it enhances that the positive results achieved by such specific awareness projects are mainly circumscribed to its direct objectives. The pre-project questionnaires showed that students were environmentally conscious particularly regarding the impact of humans in nature and the environment. A closer analysis showed however that many shared the belief that humankind will be able to solve any environmental problem and intelligently exploit new natural resources. Although students were conscientious of the most important environment problems and

recognized the human impact on the ecosystems, they also overemphasized the human capacity to solve those problems by retaining the idea that humans were specially gifted and unscathed by the rules of nature. This has been reported by other authors, as well as the fact that, in most of the public mental concepts of nature, humankind is seen as separated from the rest of nature and having a separate species condition (Fischer & Young, 2007; Batt, 2009). This also indicates that a medium-good environmental consciousness may not translate into attitudes or behaviour towards a better environment (Ajzen, 1985; Frey & Foppa, 1986; Kaiser et al., 1999; Tanner, 1999; Kollmuss & Agyeman, 2002; Chawla, Louise & Cushing, 2007; Jordan et al., 2011).

Overall, these results indicated that the environmental education strategy proposed in this work had important outcomes in education and attitudes towards biodiversity and the environment, especially when considering amphibians and other groups of species that can be easily observed and manipulated (Kassas, 2002; Lindemann-Mathies, 2002; Weelie & Wals, 2002; Chawla, Louise & Cushing, 2007; Tomazic, 2008; Hug, 2010). In addition, ponds confirmed to be good habitat models from an educational point of view as they allow a variety of outdoor hands-on exploration activities about habitat and ecological functioning. Ponds showed to be important tools to restore direct contact with nature and numerous life forms, including flagship and bio-indicator species, in urban areas and schools gardens. Although small in size they allow a holistic comprehension about ecosystem constitution and functioning, ecological succession, relationships between species and management through conservation strategies.

Finally, the present study used an innovative methodology for the project evaluation, by transforming the Likert scale results into categorical presence-absence variables, in order to build a similarity matrix among students solely on the patterns of the responses that was then analysed by multivariate methods (NMDS and ANOSIM). These methods, although more commonly used to analyse ecological data sets, proved to be very efficient to emphasize the impacts of the project towards attitudes on pond and amphibian conservation.

Moreover, it demonstrated that ponds are important habitats form an educational point of view: although small in size they allow a holistic comprehension of the ecosystem constitution and functioning, the ecological succession, the relationships between species and management through conservation strategies.

5.6. CONCLUSION

This study showed that an environmental education project based in direct contact with nature and long-term activities development might have important results to increase positive attitudes towards depreciated biodiversity and habitats. In this case, ponds were used as model habitats and living laboratories, and the project proved to increase the student's knowledge about ecological functioning, habitat monitoring, physical characteristics and associated biodiversity, especially amphibians. This habitat showed good potential for environmental education about ecosystems and to restore direct contact with nature, namely due to its small size, high richness and easy observation of biodiversity and facility to found or construct in urban areas.

6. CITIZEN ENGAGEMENT IN HABITAT AND BIODIVERSITY MONITORING: A PUBLIC INVENTORY OF PONDS IN PORTUGAL

6.1. ABSTRACT

Ponds are biodiversity hotspots, valuable habitats and breading sites for several fauna and aquatic flora. Despite their importance, the number of ponds is decreasing dramatically in the Mediterranean region due to habitat degradation by human activities. Nonetheless, there isn't still an accurate notion of the number, spatial location and evolution of ponds within the Portuguese territory, which is decisive to delineate adequate conservation actions. This study reports the results of the first pond inventory and mapping in Portugal using Volunteered Geographic Information methodologies (VGI) to collect data about water bodies' location and characterization. Although some bias can be introduced by irregular volunteers dispersion in the field, project dissemination efforts and volunteer motivation, this project showed that wetlands are appropriate study objects for citizen science projects, allowing to efficiently collect accurate and scientifically relevant data about habitat location and monitoring.

KEY WORDS: citizen science; wetlands; biodiversity; mapping; VGI.

6.2. INTRODUCTION

Ponds are small shallow water bodies, permanent or temporary, from natural origin or artificially generated by humans, characterized by accentuated hydrological dynamics (Zacharias & Zamparas, 2010; Pinto-Cruz et al., 2011; Bagella & Caria, 2012).

Ponds are considered biodiversity hotspots encompassing a high number of species, are valuable breading sites for amphibians, dragonflies and other fauna and flora and have a higher richness and number of vulnerable species than other wetlands, such as rivers or lakes (EPCN, 2008; Pinto-Cruz et al., 2011; Bagella & Caria, 2012).

Although the importance of pond conservation for biodiversity and ecosystems is largely recognized by the scientific society and the Ramsar Convention on Wetlands, only Mediterranean temporary ponds are protected by the directive 92/43 CEE within Natura 2000 network (habitat 3170), due to their high number of endemic species that are evolutionarily adapted to those habitats (United Nations Educational, 1971; Zacharias & Zamparas, 2010; Pinto-Cruz et al., 2011).

As a consequence, the number of ponds seems to be decreasing dramatically in Europe, ranging from losses over 50% in countries like Sweden and Poland, up to 90% in the Netherlands, Switzerland and some parts of Germany (Hull, 1997; Wood et al., 2003). In Portugal, a local study by Ferreira and Beja (2013) determined that about 50% of the temporary ponds were lost in the study area of SW of the country between 1999 and 2009(Ferreira, M. & Beja, 2013).

Ponds are extremely vulnerable to degradation by human activities because of their small size and their physical and ecological characteristics. Changes in land use due to intensive agriculture as well as urban development are often identified as the main causes of pond degradation and loss, but sediments extraction, drainage, forest monocultures, invasive species introduction, use of

pesticides or other contaminants and climate change also constitute important threats to pond integrity. In addition, ponds are often neglected by the public and commonly negatively connoted (Beja & Alcazar, 2003; Zacharias et al., 2007; Céréghino et al., 2008; Ferreira, M. & Beja, 2013).

An accurate knowledge about the spatial location of ponds within a territory is decisive to adequate monitor their distribution, ecological characteristics and long-term abundance (Pinto-Cruz et al., 2011). However, despite the global location of big wetlands is well understood, the exact number and location of ponds is mostly unknown due to their scattered distribution, small size and consequent highly demanding inventory field work (Céréghino et al., 2008; Soti et al., 2009; Pinto-Cruz et al., 2011). The use of aerial photography and satellite observations were reported as useful tools for pond location, but, despite obvious advantages, they also revealed important limitations: i) challenging classification and validation methods; ii) substantial human resources; iii) expensive spatial and radiometric high resolution imagery; iv) temporal imagery acquisition limited to wet seasoning; v) air photography best suitable for smaller areas (Soti et al., 2009; Ferreira, M. & Beja, 2013). In the present study a volunteer fieldwork data collection was used to help to fill the enormous gap about pond inventory and mapping in Portugal.

The occurrence of ponds in Portugal is wide in all the territory. The continental territory is divided in two main biogeographic regions: Eurosiberian (north) and Mediterranean (south) with contrasting temperature and annual rainfall values (Costa, J. C. et al., 1998). Lithologically, the territory is highly variable originating an extensive variety of soils, with different characteristics, namely permeability (Ferreira, A., 2000). Most of the mountain ranges are located in the north and centre, while the south is mostly plain with some sparse low altitude elevations. These physical factors play a key role on the occurrence, typology and distribution of ponds in Portugal, with Mediterranean temporary ponds being mostly restricted to the south of the country. Manmade ponds also vary immensely across the territory, reflecting current and past uses of ponds by local communities, namely related to traditional agriculture (EPCN, 2008).

"Charcos com Vida" ("Ponds With Life") is an environmental education project developed in Portugal with the purpose of raising awareness, to promote conservation and the study of ponds. Additionally, aiming to produce the first pond inventory and mapping in Portugal, an online survey was integrated in the project's website allowing to collect information about the location and characterization of ponds and other small water bodies that fulfil similar ecological functions.

The Pond Inventory is open to public participation, benefiting from the advantages of citizen science projects, especially Volunteered Geographic Information (VGI) to collect data from a large area at a reduced cost (Goodchild, M., 2007; Goodchild, M. F., 2007; Elwood, 2008). Volunteered Geographic Information (VGI) is a citizen science method where online tools are designed to create, assemble and disseminate geographic data provided by volunteers harnessing citizen science data collection and the possibilities of Web 2.0 phenomenon of user-generated real-time content (Goodchild, M., 2007; Wiersma, 2010).

Citizen Science projects became popular by taking into account the public knowledge as free source of information to assist professional research in collecting, submitting, visualizing, analysing or discussing data (Bonney et al., 2009; Silvertown, 2009; Shirk et al., 2012; Gura, 2013). The value of citizen science is already recognized by the scientific community as a tool for conservation practices, allowing to do work that otherwise would be impossible in a wide range of applications, including species distribution studies, rare or invasive species detection and habitat

characterization (Delaney et al., 2008; Bonney et al., 2009; Schmeller et al., 2009; Conrad & Hilchey, 2011).
Volunteers themselves also benefit from citizen science by increasing their scientific literacy, acting as scientists, playing an active role in conservation and restoring contact with nature (Trumbull et al., 2000; Miller, J. R., 2005; Jordan et al., 2011; Hobbs & White, 2012).
Despite all advantages associated with citizen science methods, they still suffer from some limitations, namely little control over: i) applied methods, ii) data collection and validation mechanisms, iii) volunteers profile and iv) geographical dispersion over the study territory. Although all those factors may lead to biased data, when correctly applied, citizen science methods have shown to be able to obtain valid results similar to those performed by trained researchers (Douglas & Rollins, 2007; Cohn, 2008; Devictor et al., 2010; Wiersma, 2010). The present study summarizes the data obtained during 3 years of the Ponds with Life's Pond Inventory (2010-2013) using on-line VGI methods that allowed creating the first national map of ponds in Portuguese territory.
The main objectives of this study were:
- To create the first map of pond and other similar water bodies location in the Portuguese territory using VGI methods.
- Analyse the public participation patterns and constrains in the pond mapping and inventory.

6.3. METHODS

The Pond Inventory (www.charcoscomvida.org/charcos-em-portugal) is an online mapping tool based on a Google Maps application that was created and embed in the website of the "Ponds with Life" project (www.charcoscomvida.org) firstly coordinated by CIBIO (Research Centre in Biodiversity and Genetic Resources) and then by CIIMAR (Interdisciplinary Centre of Marine and Environmental Research) at University of Porto. The Pond inventory was created to catalogue the ponds and similar water bodies in the Portuguese territory. The Inventory did not require any registering procedure, and included a map displaying inventoried ponds and a pond inventory form. The pond inventory website and form is available in the image of Annex 6 of this thesis. Informed consent for participation was obtained from all individual participants through the acceptance of the Inventory form conditions.
The general procedure to include a new pond in this online inventory was by visually pinpoint the geographical location of the water body in the map or by adding the known geographic coordinates of the pond in the form. Participants must also add some personal information (name and e-mail contact), pond identification, type of water body, an optional photo and brief description of the habitat, when possible.
The manager proceed to the validation process of the entries by localizing the pond entry in the Google Maps and Google Earth applications and visually checking if it corresponds to a small stagnant water body and if it was correctly mapped. The context of the surrounding ecosystem, the participant description of the habitat and the photo were also used in the validation process every time the visual checking in Google Maps application is not possible. Only when it was possible to confirm the water body presence (sometimes it implied a visit of the project team to

validate the existence of ponds), the manager assigned a unique code to pond identification and the new entry appeared on the map as an inventoried pond.

The project dissemination and support procedure was designed to be primarily web-based trough the site and social network. However, press releases and TV interviews were also done when possible. Press flyers and posters were distributed all over the country mainly to schools and associations. Some project formations and sporadic physical face-to-face support was done to some groups of participants.

The results of the first three years of the inventory were collected from the database and analysed in EXCEL for Mac 2011 v.14.3.2 (Microsoft, Released 2011) and ArcGIS® software by Esri Desktop 10 for Windows 2010 software. Maps throughout this article were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license.

Geographic Information System (GIS) software and the information from the database entries were used to produce a map of pond distribution. Demographic and administrative data was obtained from the Portuguese Statistics Institute (Instituto Nacional de Estatística, 2011) as well as the official administrative map of Portugal (Direcção-Geral do Território, 2012) and were both combined with the inventory data.

Maps of pond distribution and demography were combined using GIS in order to explore possible relationships between these two variables. Data attributes extracted from the overlapping process in GIS was then analysed in EXCEL and used to assess the correlation between population and pond densities using Pearson Correlation Coefficient and Linear Regression by the minimal squares method.

Data from the Portuguese Protection Areas(Instituto de Conservação da Natureza e das Florestas, 2013a), Nature 2000 Network areas(Instituto de Conservação da Natureza e das Florestas, 2013d, 2013c) and Ramsar (Instituto de Conservação da Natureza e das Florestas, 2013b) shapefiles, were merged into a single layer using GIS and overlapped with pond distribution to determine the number of ponds within Portuguese protection areas.

6.4. RESULTS

Between November 2010 and March 2014, 1726 small water bodies entries by 152 different participants were validated in the inventory website. Data are available on-line in the Ponds With Life website (http://www.charcoscomvida.org/charcos-em-portugal). Figure 6.1 shows that ponds represented about 50% of the entries, followed by tanks (18%) and wells (12%). “Other types” corresponded to 12% of the entries and includes fountains, ponds in water lines, dams, water mines or lakes. From the 1726 inventoried water bodies only 4 were classified as extinct.

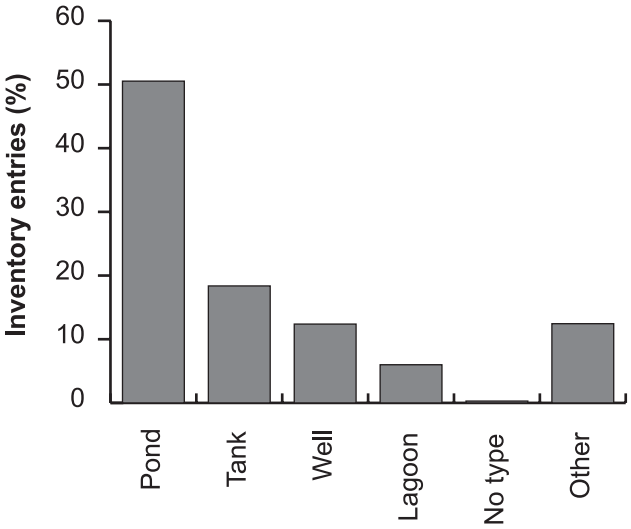

Figure 6.1 Pond type classification by the participants in the pond inventory. 50% of the entries are identified as ponds.

A description was added to 555 (32%) entries and a photo to 471 (27%). From the photos content we concluded that most participants correctly classified the correspondent water body type. The majority of the photos allowed to infer about the habitat state, surrounding area, land use and sometimes even about the presence of exotic species or water quality (like eutrophication).

Descriptions varied from amateur to a more scientific and accurate explanation and included data about water body dimensions, hydroperiod, presence of amphibians, reptiles, aquatic invertebrates, aquatic and marginal plants, presence of exotic and invasive species, water source and land use of the surrounding area.

Participant types are represented in Figure 6.2. Some private companies that were interested in applying the project in their properties were responsible for most of the entries (31%). However, about 98% of the data collected in this type of participant was only due to one company (Altri Florestal), a project partner, which is surveying pond presence in its properties. The project team and collaborators (mostly Biology students) was responsible for 27% of the entries followed by individuals (19%), universities (12%) and schools (2.6%).

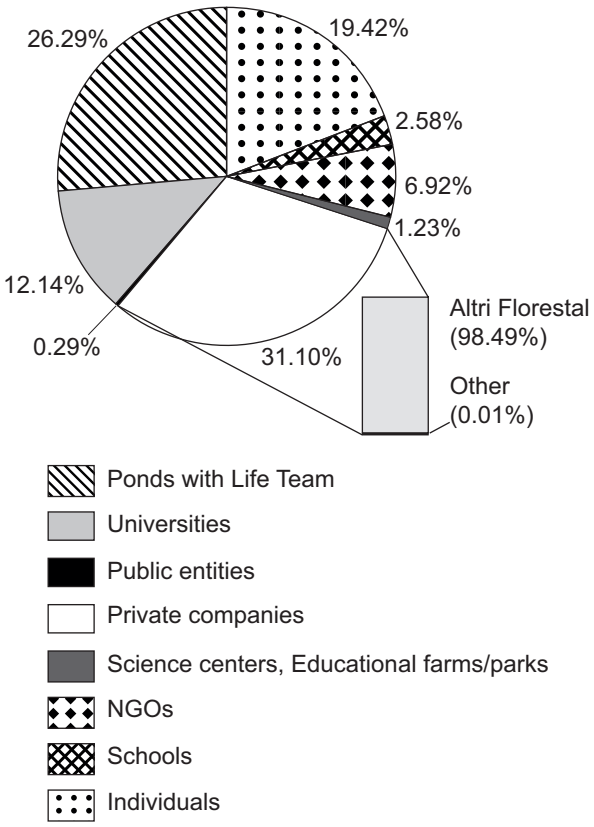

Figure 6.2 Main categories of inventory participants.

The inventoried ponds were distributed all over the territory although not homogeneously (Figure 6.3), with some regions with higher density than others. The north, littoral and centre districts were the ones with the largest number of ponds. Regarding insular autonomous regions, 66 entries were collected from the archipelago of Azores where it was possible to implement the Ponds With Life project with some local associations and the traveling and direct monitoring of a team member. No water bodies were inventoried in the archipelago of Madeira where no direct implementation of the Ponds With Life project was possible.

Pearson Correlation coefficient revealed that there is a strong positive correlation between population density and number of inventoried ponds for the total dataset. Linear regression (Figure 6.4) also confirmed that population density significantly predicted pond density scores as well of a significant proportion of variance (43%) in pond density.

About 20% of the inventoried ponds were included in areas under some legal protection.

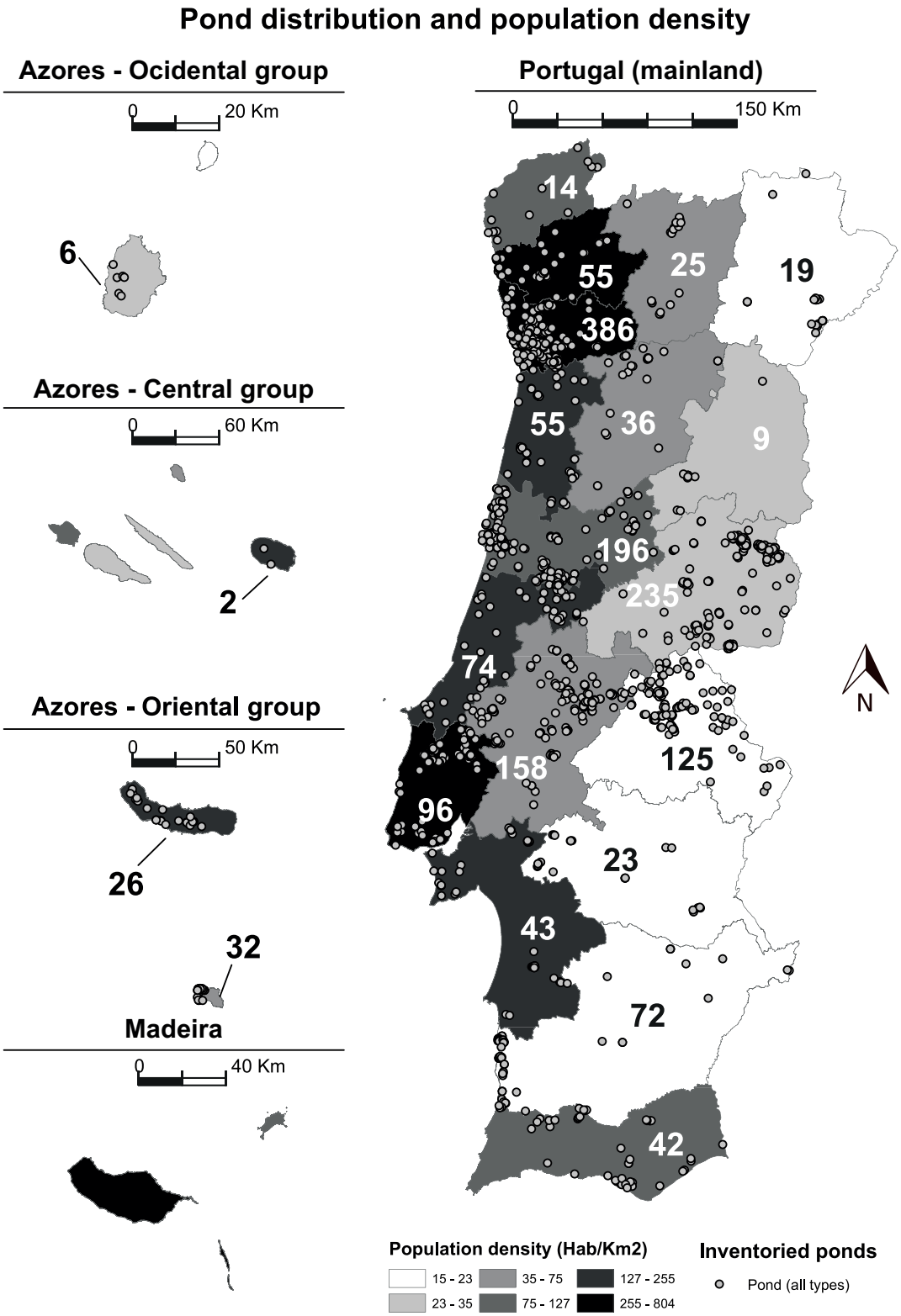

Figure 6.3 Pond Distribution of inventoried ponds and population density map.

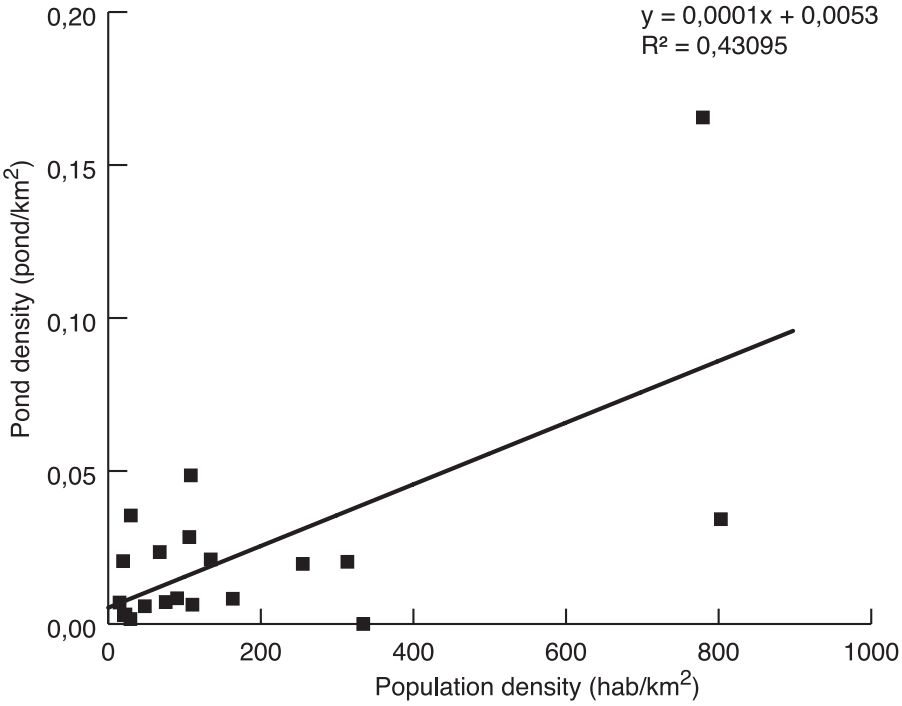

Figure 6.4 Linear regression between Population Density (hab/Km2) and Inventoried Pond Density (Pond/Km2)

6.5. DISCUSSION

Over three years the Pond Inventory web tool was able to include 1726 new entries by 152 different participants, creating the first map of pond distribution in the Portuguese territory based on volunteer's contribution and VGI methods. This study confirms that citizen science projects, if appropriately supported by data validation systems, are able to obtain valid large-scale habitat inventory data (Douglas & Rollins, 2007; Bonney et al., 2009; Devictor et al., 2010). The inventory collected data about the geographical location, type, ecological and physical characteristics of water bodies. The photo and description fields proved to be very useful in the validation process and to provide specific information about the habitats, allowing the detection of valuable ponds for monitoring, conservation or restoration plans. Previous studies also indicated the importance of photos in the validation process of citizen science projects (Worthington et al., 2011).

Although there isn't an unanimous classification of pond types in the scientific community and some authors recognize that the definition of pond isn't clearly understood by the public, our validation process proved that classification used in the present study was consistently attributed by the participants (Zacharias et al., 2007).

Only four ponds were inventoried as extinct. Despite so far there is no monitoring program to assess the decline of these habitats in Portugal at a national scale, some local studies with Mediterranean ponds confirm the general tendency observed in other countries (Zacharias &

Zamparas, 2010; Ferreira, M. & Beja, 2013). The low number of extinct pond entries in the present study suggests that the participants concentrated the efforts in finding new habitats and failed to understand the importance of monitoring the evolution of ponds status over time or mapping habitats that no longer exist. Nevertheless, the present database can now be used as important base information to monitor the evolution of these water bodies and to quantify and map pond decline in Portugal.

So far, the map obtained (Figure 3) showed a heterogeneous distribution of data throughout the territory. Given Portugal's highly diversified landscapes and climate, pond geographical spreading and, sometimes, difficult access, it could be expected some gaps in the inventory map (Soti et al., 2009). However, other interfering factors related with the nature of citizen science methods seem to play an important role (Cooper et al., 2007; Conrad & Hilchey, 2011 ; Hobbs & White, 2012). Considering geographic population distribution (Figure 3) a marked positive relation between inventoried pond distribution and the geographical dispersion of the population was found, as other authors previously suggested (Goodchild, M. F., 2007; Sullivan et al., 2009).

For example, very few ponds have been inventoried in the southern districts, although given the territory's nature (low slope and sparse tree cover) this is one of the easiest area to detect ponds (Beja & Alcazar, 2003; Ferreira, M. & Beja, 2013). Thus, the scarce results in some areas where the potential for mapping ponds is high is probably mirroring the marked asymmetry in the population distribution in Portugal and the ability of raise volunteers by the project dissemination strategies.

The project dissemination strategy may also influence the study results. The Ponds with Life project dissemination and support procedure was designed to be primarily web based. However, when required, it was provided physical face-to-face support to some participants groups, which seemed more effective in enhancing the motivation of volunteers to participate in the inventory. Unfortunately, due to human and economic restrictions the project team could not provide equal physical support throughout all territory, particularly in those districts located further from the team head office location (Oporto). In accordance, the districts where the project dissemination and support was mainly web based were the ones with fewer pond entries. A marked evidence of this is reflexed in the results from the island areas, where no data is available from Madeira Islands, where no project formation was assured during this period, while 68 ponds were inventoried in Azores archipelago, where several activities were performed by the project team (including two training sessions). Another evidence of this fact is that the higher density of inventoried ponds was by far found around the team location (Oporto district), where the project head office is located and most project activities were performed. Thus, to enhance participation, it seems vital to develop a strategy that efficiently disseminates information throughout all territory and preferably assures some face-to-face contact, training sessions, etc.

The fact that the inventory is an on-line tool can also inhibit the participation of some users with low digital literacy (Goodchild, M. F., 2007; Elwood, 2008). The interior and south regions of Portugal, besides being the less densely populated, are also the most aged and the less technologically literate areas of the territory (Instituto Nacional de Estatística, 2012), which may also contribute to reduce participation in the Pond Inventory in those areas. However, namely in rural areas, which are likely to about ponds due to their higher contact with nature, people

cannot share this information because of this digital divide effect, once they may experience difficulty to find information about the project or data.

Finally, volunteer's motivation can also restrict the Pond Inventory success and influence differently the participant categories. Traditionally, volunteers of citizen science projects are motivated by reasons such has: being truly contributing to science discovery, self-promotion and personal development or skill acquisition (Douglas & Rollins, 2007; McCallie et al., 2009; Hobbs & White, 2012). For instance, most of the contributions arrived from groups or public entities linked to biodiversity or environmental research and dissemination. On the other hand, schools, which were the main audience of the "Ponds with Life" project, usually focus their participation on other areas of the project (experimental activities) and in most cases only contribute to the inventory with the pond they work with, limiting their participation to one pond per school. The same pattern happens with NGOs and Pedagogical Farms.

Lack of motivation may also explain the low contribution of researchers. Previous studies pointed that researchers may still not be sufficiently motivated to participate in citizen science projects, due still to some negative connotation to amateurism or reluctance to share their scientific knowledge (Poliakoff & Webb, 2007).

The Pond Inventory is expected to continue in the next years. Some authors defend that the extension of projects overtime and the correspondent increase of the sample, tend to decrease bias effects due to heterogeneous distribution of population (Dickinson et al., 2010).

Our experience suggests that several mechanisms might improve the results of similar citizen science projects based in web2.0. We recommend a broad national scale effort and multidisciplinary dissemination strategy in order to engage the public, especially population clusters out of main urban areas and under digital divide effect. We consider that the inclusion of photography and detailed habitat characterization should be mandatory in this and any similar project to best ensure data quality, use and validation.

The inclusion of a registration procedure with additional sociodemographic data of the participants should also be mandatory. Although it may inhibit some participation in citizen science projects, it appears to be very useful to contextualize more accurately the results, to allow data update by the participants and to strengthen their motivation and relationship with the project.

6.6. CONCLUSIONS

This study showed that citizen engagement is an appropriate tool to inventory ponds and wetlands in general, allowing to efficiently collect crucial data from a large geographical area, otherwise highly dependent on heavy personal, time and economical resources.

The use of public participation and VGI tools assumes therefore to be of great value for the mapping of these habitats and hence to its use for biodiversity management, study and conservation demands.

7. DISCUSSION

The studies developed allowed to achieve the proposed objectives. However, it would be overwhelming to create a global analysis for the objectives of this work considering the general society, all the communication pathways and to contemplate all global biodiversity in this work. Because of this, the efforts were dedicated to specific publics, specific communication pathways and specific strategies of science communication that, supported by the pillars developed by other authors, revealed to be the most effective to demonstrate the effects of science communication towards biodiversity awareness.

"Animal preferences follow Human phylogenetic proximity" contributed to the understanding of the public perception of biodiversity focusing in teenagers preferences relating to animals.

On the other hand, concerning the importance of children books as communication pathways in childhood, the "Portray of Biodiversity in children's trade books" allowed understanding how the biodiversity is continuously exposed in several non-specific communication pathways and the relation that it could have with the public perception of biodiversity. This study also demonstrates the importance and the potential of a focused science communication through several common pathways.

The "Measuring the impacts of an environmental education project on changing attitudes towards ponds and associated biodiversity", and "Citizen Science for habitat and biodiversity conservation: a public inventory of Ponds in Portugal", enhanced the potential of environmental education and citizen science as an emerging strategies in science communication on biodiversity that break with the conventions of the most common communication pathways. Thus, the four studies are interrelated and complementary. Because of this, the results are likely to be discussed together in a holistic perspective.

7.1. ENVIRONMENTAL PROBLEMS

People care about the environmental although not consistently (Elder et al., 1998). The results about environmental conscience from the studies performed during the present work concluded that the public might have, in fact, a meaningful environmental awareness. However, the results from the "Ponds With Life" project demonstrated that the public still lack conscience about men's ability to resolve environmental problems, about the seriousness of the environmental crisis and the nature strength to deal with problems generated by industrialized countries. This is according the suggestions from previous authors that the public has little knowledge about the ecological functioning, ignoring the synergetic effects of the human impacts in nature (Kaiser et al., 1999; Alerby, 2000; Kaplan, S., 2000; European Commission, 2005; Heal, 2005; Fischer & Young, 2007).

On the other hand, the results about environmental conscience didn't show significant alterations during the environmental education project implemented during this study, which suggests that the students apparently didn't establish the indirect relation between the objectives of the "Ponds With Life" project and their own conscience of environmental problems. Apparently, they weren't able to transfer their experience during the project implementation into higher levels of

reasoning and understand the complex synergies between the project results and other environmental problems.

This indicates that environment conscience principles may not directly materialize through ecological literacy in specific contexts, daily-life experiences and vice-versa unless the public is aware of them (Lindemann-Mathies, 2002). This abstract and unsupported environmental conscience detected during the present work is according other authors and confirms that the public usually see environmental problems theoretically, geographically and temporally dispersed, unrelated, not directly observable and lack perceived control about their own pro-environmental behaviours and actions (Kaiser et al., 1999; Kaplan, S., 2000; Kollmuss & Agyeman, 2002; Serpell, 2004).

Taking this into account, we believe that, despite the public retains considerable environmental conscience, they allocate the task and responsibility to resolve environmental problems to major institutions as governments, big organizations and companies, and is unaware about the individual and local role of each citizen to a global effect.

7.2. PEOPLE CONNECTION WITH BIODIVERSITY

The studies regarding human preferences for animals, the portray of biodiversity in children trade books and "Ponds With Life" project became important sources about the people connection with biodiversity by the participants.

The results are according previous authors suggestions and demonstrate that the most important sources of information about biodiversity are mainly indirect and rely on the Internet (Schroeder et al., 2009; Ballouard et al., 2011; Ganea, Patricia A. et al., 2011). This result was also consolidated through the results regarding the Ponds With Life environmental education project that showed that the previous contact with ponds, i.e. local ecosystems and biodiversity, is mainly done through Internet that was previously identified as a source of inconsistent, limited and trendy information about biodiversity based on distorted conservation messages, flagship and exotic mega fauna (Ballouard et al., 2011).

Regarding direct contact, the public shortly refer previous direct contact with nature in both studies about human preferences for animals and the "Ponds With Life" environmental education project, with the exception of some walks or trips to near by ponds. This showed that, despite the efforts for public engagement on biodiversity issues during the last decades, the direct contact with nature is scarce as suggested by previous authors (Miller, J. R., 2005).

On the other hand, even when direct experience is available, the public do not recognize these experiences as sources of direct contact with nature and biodiversity. This confirms that the public are not aware of daily contact with biodiversity even in urban context and mostly focus on nature contemplation (Peter H. Kahn, 1997; Wandersee & Schussler, 2001; Lindemann-Mathies, 2002; Fischer & Young, 2007; Lindemann-Mathies & Bose, 2008).

While Internet appears to be an important source of free choice information during youth, in younger and older individuals, the lack of competences for the use of digital devices may force to considerate other sources of information gathering (Elder et al., 1998; Ballouard et al., 2011; Ganea, Patricia A. et al., 2011; Gonen & Guler, 2011; Ganea, P. A. et al., 2014; Waxman et al., 2014). The importance of the childhood in creating attitudes and behaviours made us focus on

these important ages through the study of the portray of biodiversity in children trade books (Kellert, 1985a, 2002). As proposed by several authors, children books constitute one of the first communication pathways for young children and a very important role in information, transference, emotions and attitude development especially considering biodiversity (Pringle & Lamme, 2005; Wells & Zeece, 2007; Hug, 2010; Ganea, Patricia A. et al., 2011).
Despite the advantages of environmental education, participants devalued it as an important source of information about biodiversity. However, Environmental Education is a growing tool consistently recognized by the scientific community as a strong instrument to restore the public direct contact with nature (Armstrong & Impara, 1991; Kassas, 2002; Weelie & Wals, 2002; Chawla, Louise & Cushing, 2007). Because of this, it became the focus for the development of the "Ponds With Life" project and the pond mapping tool.

7.3. Biodiversity in Children Books

The portray of biodiversity in children books demonstrated that biodiversity and habitats are widely present in children trade books regardless its themes or message contents. Under this point of view, children books are an important source of indirect contact with nature at early ages of development and contribute to the creation of concepts and emotions about biodiversity that will determine the character of the adult attitude and behaviour (Wells & Zeece, 2007; Hug, 2010; Ganea, Patricia A. et al., 2011; Waxman et al., 2014).
However, biodiversity portray in children books from the Portuguese National Reading Plan is distorted and limited to a few number of organisms that are not representative of the global proportion of biodiversity groups on earth and are according with the biodiversity portray in other communication pathways (Ballouard et al., 2011; Williams, J. et al., 2012). While vertebrates, especially biodiversity groups phylogenetically closer to humans, are usually overrepresented, invertebrates are underrepresented (Woods, 2000; Batt, 2009; Ballouard et al., 2011). The main profile of organisms in the children books are animals, mostly mammals, especially pets or domesticated animals as well as other charismatic megafauna, commonly portrayed as main characters in the stories, showing anthropomorphization skills and inhabiting humanized or well-known habitats. Plants also showed important contributions in the books but usually constitute scenario elements, adding a green nature feeling, and are not provided with any type of characteristics which is according to previous authors suggestions (Wandersee, 1986; Wandersee & Schussler, 2001; Lindemann-Mathies, 2005; Fischer, Langers, et al., 2011; Reis et al., 2011). Reptiles and amphibians were, within vertebrates, the least represented, especially the amphibians that were also loosely mentioned by a few references of anura taxonomic group.
Regarding this, we conclude that children books representation of biodiversity limits the human-biodiversity relationship to a very limited interaction.
Considering habitats, the book sample showed that the habitats in the stories are usually partially or completely humanized, as public gardens, agriculture landscapes or even building interiors. Apart from the humanized habitats, the forest is unequivocally the most common natural habitat in the book sample, enhancing the forest symbology as an especial place for biodiversity and stories (Bettelheim, 1976).

On the other hand, the use of biodiversity and habitats is commonly used on children books as a tool to an efficient content transfer since the use of animals as substitutes for human characters and habitats as substitutes for familiar placed situations that may contribute to a better internalization of the messages by the children as well a better identification with the contents, valuing the book educative charge (Bettelheim, 1976; Varga, 2009). This shows that authors do not always use biodiversity as a way to connect children with nature but as a way to improve the transmission of other content messages. This means that, in many cases, the use of biodiversity in children books is more related with storytelling than to have a goal of inform about it. However, the messages associated with biodiversity characteristics, attributes or behaviours on the book context are also likely to be transferred by the children and might produce misconception (Ganea, Patricia A. et al., 2011; Ganea, P. A. et al., 2014).

Results from the present work also demonstrate that various strategies of anthropomorphization are used in children books and might also be one important source of misconceptions (Woods, 2000; Ganea, P. A. et al., 2014). Despite some authors argue that anthropomorphization can be important in order to develop empathy and also contribute to a better involvement of the children, it may also negatively shape biodiversity inadequate perception (Cartmill, 1993; Alberti, 2008; Batt, 2009; Varga, 2009; Ganea, P. A. et al., 2014; Waxman et al., 2014). By observing the use of these mechanisms during this work, we suggest that some are less invasive than others. We suggest that speech ability may marginally interfere with information transfer about an organism characteristics and habits and may constitute a way of enable a better children involvement and connection with animal characters since it plays a key role in message transfer between humans. Other categories as human behaviour or even the application of human characteristics on animals and plants (as hands, for instance) can contribute to erroneous understanding of biodiversity and also contribute to a generalized and homocentric view of nature.

As a consequence of the results from the portray of biodiversity in children books, it is not suggested that author's freedom and the assignment of attributes or the use of anthropomorphization in children stories including or about biodiversity should be inhibited. This would destroy the extraordinary potential of children books as a communication pathway that has been previously described as being extremely important to children development of emotions and attitudes (Rice, 2002; Pringle & Lamme, 2005; Crowson & Hopper, 2009; Schroeder et al., 2009; Hug, 2010; Ganea, Patricia A. et al., 2011; Robischon, 2014; Waxman et al., 2014). However, it is known that although 6-year-old children are able to transfer information from books to their lives they might not be able to distinguish between real and fictional information (Ganea, Patricia A. et al., 2011). In addition, this age is the most suitable to create links, relations and emotions about nature and biodiversity that will constitute the basis of the adult attitude and behaviour (Kellert, 1985a, 2002). Thus, from the moment we become aware of the negative impact that it also could have over children understanding of biodiversity, it is important that those processes are more conscientious applied in order to result in more innocuous or positive contents to biodiversity. Considering this, it is important that authors but also illustrators develop some habits of information accuracy without limiting their creative freedom. This might also constitute a high level creative challenge that, although it seems to introduce some limits, is contributing to open

new creative possibilities that increase the educational role of the children's book in several areas, particularly in biodiversity considering its strong role in children's books.

7.4. PEOPLE PERCEPTION OF BIODIVERSITY

7.4.1. PREFERENCES AND ATTITUDES

Regarding public preferences about animals, the present work was able to help understand the preferences patterns of children/young adults towards animals. The results are according to some previous studies showing that the most preferred animals are phylogenetically closer to humans, generally vertebrates, mostly mammals, and preferentially exotic, flagship animals as well as some companion animals (Woods, 2000; Stokes, 2006).

This work also achieved that mammals and birds are preferred, reptiles and invertebrates are disliked, amphibians have an undefined position between liked and disliked, rarely mentioned as preferred animals. Surprisingly, humans themselves aren't mentioned often which is according to some studies that suggest the public usually considers their own specie as an enormous out-group separated from the rest of nature context under an anthropocentric point of view (Kellert, 1985b; Batt, 2009).

In addition, evaluation of the "Ponds With Life" project, which once more showed that the participants have contrasting attitudes considering the different taxa that can be found in ponds, also presents a significant improvement between pre-project and post-project attitudes about amphibians and snakes as previously suggested by other authors (Knight, 2008; Tomazic, 2008; Prokop, Pavol et al., 2009; Tomazic, 2011b; Ceriaco, 2012; Ballouard et al., 2013). Nevertheless, this work also demonstrated better attitudes about plants and turtles even before the project implementation, suggesting that the students attribute to them aesthetic values despite other studies suggest that plants are usually considered lifeless (Wandersee, 1986; Lindemann-Mathies, 2005). This work also suggests that turtles can be considered a public favourite out-group within reptiles.

In addition, the results from human preferences about animals and the "Ponds With Life" evaluation present relevant similarities to the biodiversity portray in the children books and studies from other countries (Woods, 2000).

According to the results from the public preferences about animals, phylogeny appears to have an important role in determining the groups of species that are preferred or disliked by the general public, as already suggested by previous authors (Kellert, 1989; Woods, 2000). However, several exceptions to this trend and the significant similarities between preferences in this study and other studies from different world locations, revealed an unequivocal relation between information drifted by communication pathways and the public attitudes towards biodiversity. Therefore, the studies from this work showed that the power of conservation message trends is also conducting other communication pathways' messages that, in turn, determine the public preferences towards biodiversity. As a consequence, this also may direct the people's will to like and protect for the same exotic, far away species rather than their general local biodiversity

(Serpell, 1999; Stokes, 2006; Chawla, L. , 2006 ; Lindemann-Mathies & Bose, 2008; Snaddon et al., 2008).
As a conclusion, the present work suggests that communication and global conservation messages might be standardizing the public preferences about animals, including children book authors, all over the world in a way that are distorting the reality of biodiversity, commanding the public preferences, wish to protect, attitudes, behaviours towards a distorted understanding, attitude and relation about species, habitats and even entire ecosystems.

7.4.2. PUBLIC KNOWLEDGE

The variety of the global biodiversity is much higher than the groups addressed in the various studies. However, the information available from communication pathways, as well as the image of biodiversity retained by the public showed to be very limited to some major groups of living beings. This demonstrates that the public is not aware or connected to all other living forms and, as suggested by previous authors, have a limited and distorted perception of biodiversity(Woods, 2000; Lindemann-Mathies, 2005; Stokes, 2006).
Pond With Life evaluation study demonstrated that people retain some prior knowledge and visual concepts about habitats but usually haven't knowledge about specific species. In addition, the pond mapping demonstrated that the public retain important information about biodiversity and local habitats as well as some concepts about biodiversity although, most of the times, are not familiar with the scientific terms and processes (Cooper et al., 2007; Fischer & Young, 2007; Sullivan et al., 2009; Devictor et al., 2010; Dickinson et al., 2010; Wiersma, 2010; Fischer, Langers, et al., 2011). According to the same study and other similar works, public knowledge is also valuable for scientific research and to conservation actions application and cat be gathered through Citizen Science projects (Cooper et al., 2007; Greenwood, 2007; Conrad & Hilchey, 2011).
The results from the Pond mapping study may however not be indicative of the knowledge of the all general public since the participants profile shows that most of the participants are already interested and aware of the issues related to the projects and that are usually motivated to provide contributions to science. Likewise, others studies support that the citizen science usually rely on previously interested people in the issues addressed (Hobbs & White, 2012).

7.5. SCIENCE COMMUNICATION ROLE IN ATTITUDES TOWARDS BIODIVERSITY: PONDS AND AMPHIBIANS

Communication and education strategies demonstrated to have a very important role in creating and changing attitudes to counteract the effect of solid installed misconceptions about biodiversity (Armstrong & Impara, 1991; Elder et al., 1998; Lindemann-Mathies, 2002; Weelie & Wals, 2002; McCallie et al., 2009). Despite the present work demonstrated that young students devalued the importance of environmental education, it was able to improve awareness and the public behavior towards biodiversity and ecossystems, more specifically, about ponds and its biodiversity (as amphibians and reptiles) using environmental education.
The success of this study was obviously strategic since it aimed to detect improvements in both the pond habitat and amphibians that are commonly negative connoted by the public (Zacharias

et al., 2007; Tomazic, 2008; Zacharias & Zamparas, 2010; Ceriaco, 2012; Ferreira, M. & Beja, 2013), which was also demonstrated by the pre-project results. The development of the Ponds With Life project resulted in significant modifications in young adults attitudes to a more positive perception of amphibians and the pond habitat, in general.

The results are according previous work demonstrating that, despite amphibians are not gifted with some important factors that determine our preference by them, it is possible to modify the negative perceptions towards them through environmental education activities, especially through initiatives that promote direct contact, active learning and that introduce an integrated understanding of their habitat and associated living beings (Tomazic, 2008).

Moreover, the ponds demonstrated to be a very important tool having an important role in the success of the project implementation and results regarding attitudes toward biodiversity. The fact that ponds can be found and successfully constructed near most of the urban areas and school gardens, its high levels of biodiversity, easy observation of different species and fauna and for a groups and small size allowed this little ecosystem to be used as a base to direct contact with nature and as a living laboratory that rapidly responds to environmental alterations. In addition, the success about this project in this specific habitat is also related with the fact that, by reducing dimensions of the ecosystem ecologic functioning, it can be more efficiently comprehended and can promote a sense of empowerment in the public by instilling in the participants an active role on creating, monitor, protect and revitalize this habitat and associated local biodiversity (Armstrong & Impara, 1991; Weelie & Wals, 2002; Tomazic, 2008; Hug, 2010).

Despite the main significant improvements during the Ponds With Life project were about amphibians, the biodiversity group that deserved our greatest investments during the project implementation, it was visible a general improvement of the attitudes of the participants across all biodiversity groups and towards ponds. Under this point of view, the use of local habitats in environmental education activities may work as an umbrella, by raising the public awareness for a number of different species and issues in only one project(Andelman & Fagan, 2000; Kassas, 2002; Weelie & Wals, 2002).

7.6. Citizen Science

Within the entire work, the study regarding the Pond Mapping through VGI strategies was the less dedicated to the public's perception of biodiversity and focused on the possibilities and benefits of public engagement in conservation. This project was able to create the first map of ponds and other small water bodies in the Portuguese territory. In addition, it contributed to confirm that, when ensuring an efficient data collection methodology and a wide communication and formation strategy, it is possible and highly profitable to inventory ponds and wetlands through VGI methods, otherwise highly dependent on heavy personal, time and economical resources (Douglas & Rollins, 2007; Cohn, 2008; Elwood, 2008; Dickinson et al., 2010; Conrad & Hilchey, 2011). The use of public participation and VGI tools assumes therefore to be of great value for the mapping of these habitats and hence to its use for biodiversity management, study and conservation demands(Wood et al., 2003; Goodchild, M., 2007; Goodchild, M. F., 2007; Schmeller et al., 2009; Devictor et al., 2010).

Results from pond mapping also contributed to confirm that active citizens are appropriate tools for data collection, showing how the public knowledge can be endowed with great scientific meaning as previously suggested by other authors (Brossard et al., 2005; Cohn, 2008; Delaney et al., 2008; Conrad & Hilchey, 2011). However, efficient methods and data validation procedures are a crucial part of citizen science implementation that allows decreasing bias associated this type of projects and creating more accurate and quality data. In addition, this study enhanced the importance of public empowerment through citizen science initiatives creating a platform between the public and the scientific community with important repercussions to the public scientific literacy, the science development and to high level science communication strategies(Silvertown, 2009; Devictor et al., 2010; Dickinson et al., 2010; Jordan et al., 2011; Toerpe, 2013).

Furthermore, the volunteers profile in citizen science programs appears to be much linked with people that are somehow previously aware and interested on biodiversity issues or is individually or professionally active on conservation rather than a general, diverse public (Hobbs & White, 2012). This conclusion demonstrates the importance of the efforts for environmental education to create a more informed, active and assertive public.

On the other hand, an important percentage of general public contribution during the pond mapping demonstrated that the public have much more to offer to science than it might be expected. Therefore, depending of an active motivation and dissemination initiatives and the extension of projects over time, it is possible to educate the public and captivate their attention and interest to become active citizen scientists increasing the public impact in science outputs and the future of nature conservation.

7.7. Data Analysis and Evaluation Methodologies

The present work dealt with the innovative, but also under developed area of knowledge of science communication, which still suffers from obvious the lack of own strategies and methodologies in science communication, especially when projects implementation impact analysis was taken into account (Elder et al., 1998; Lindemann-Mathies, 2002; McCallie et al., 2009; Norton & Nohara, 2009; Rodari, 2009; Science for All Expert Group, 2010; Bultitude, 2011). The present work tried to absorb the knowledge, methodologies and habits from science communication biggest supporter areas namely: education, communication, conservation, biodiversity, ethnography and sociology.

In order to reach an objective interpretation of the public perception, inquiries and questionnaires were implemented using as fewer open questions as possible to reduce subjectivity in data analysis and interpretation. The data were registered in the form of matrices and the responses were codified in order to analyse data quantitatively whenever possible.

Data analysis included various approaches including basic descriptive statistics, frequency analysis, hypotheses testing and complex innovative multivariable analysis, bringing to this work the advantages of quantitative interpretation of multiple variables. However, given the characteristics of the data, their interpretation cannot exclude some subjectivity due to the variety of factors that can influence it, which cannot be overcome by the analytical methodologies.

Emphasising the evaluation of impact of the implementation of Ponds With Life project, the present work was also innovative not only by motivating a more regular monitoring of environmental education actions in order to increase their effectiveness and sustainability but also by proposing examples of an efficient methodology for an objective evaluation.

Through this combination of strategies and methodologies of data collection, transformation, analysis and interpretation, the present work was able to reach its main objectives and, at the same time, proposing methodologies for research in the field of science communication.

8. CONCLUSION

The work developed during this PhD period allowed to achieve the proposed objectives of contributing to understand public perception of biodiversity in Portugal, find causes for public perception in the communication pathways, and promote strategies to modify stereotypes, creating a more aware and active public towards biodiversity issues.

The understanding of the limited and distorted public preferences about animals as well as the possible sources of this type of information in common communications pathways as children books, enables the planning and implementations of efficient environmental education strategies that are able to change attitudes towards biodiversity and create more active citizens in conservation projects.

From this work, important conclusions can be taken. First of all, it was able to demonstrated that despite the efforts in the last decades invested in conservation messages, the young adults in Portugal have limited and standardized preferences about animals mostly directed to mammals and birds and manifesting on the contrary negative attitudes towards amphibians, some reptiles and invertebrates.

The similarity of the results from this work with other studies from other countries suggests that the skewed conservation messages might be normalizing the public preferences about biodiversity all over the world and that communication can be a much more important factor influencing the people's preferences than it was previously suggested.

The present work demonstrated that some of the patterns about public preferences are transversal to a key communication pathway of information about biodiversity to young children: the children trade books. This is directing the information available to children during a decisive age period to the development of positive attitudes towards biodiversity. On the other hand, the investment in vicarious experience with direct contact with biodiversity to the public seems the best strategy to reverse this pattern.

Regarding this, this work also focused in the implementation of environmental education strategies that rely on young adults direct contact with everyday local habitats and biodiversity, enhancing the importance of small wetlands and the ecology and biology of amphibians. The evaluation of the impact of these strategy demonstrated that direct contact could have determinant influence in changing attitudes about biodiversity and habitats, especially regarding amphibians.

Finally, the implementation of an additional citizen science methodology based in volunteer geographical information about ponds allowed the construction of the first map of the location of ponds in Portugal with the contributions of hundreds of aware volunteers that actively contributed with massive habitat data collection all over the country and to the future development of conservation actions.

In conclusion, this work demonstrated that, in order to be effective, biodiversity education and communication should be a committed effort from all the pathways and sources of public communication in a multidisciplinary perspective that enhances the direct contact with nature

and the public engagement and empowerment in conservation actions. Future work should be done regarding this target by exploring and innovating the old and new communication pathways and creating objective methods, techniques and objectives for science communication of biodiversity.

9. REFERENCES

Ajzen, I. (1985). *From intentions to actions: a theory of planned behaviour*. Berlin, Germany: J. Kuhl & Beckmann.

Alberti, S. J. M. M. (2008). Constructing nature behind glass. *Museum and Society, 6*(2), 73-97.

Alerby, E. (2000). A Way of Visualising Children's and Young People's Thoughts about the Environment: a study of drawings. *Environmental Education Research, 6*(3), 205-222.

Alves, R. R. N., Vieira, W. L. S., & Santana, G. G. (2008). Reptiles used in tradicional folk medicine: conservation implications. *Biodiversity Conservation, 17*, 2037-2049.

Andelman, S. J., & Fagan, W. F. (2000). Umbrellas and flagships: Efficient conservation surrogates or expensive mistakes? *PNAS, 97*(11), 5954–5959.

Armstrong, J. B., & Impara, J. C. (1991). The impact of an environmental education program on knowledge and attitude. *The Journal of Environmental Education, 22*, 36-40.

Askew, C., Cakir, K., Poldsam, L., & Reynolds, G. (2014). The Effect of Disgust and Fear Modeling on Children's Disgust and Fear for Animals. *Journal of abnormal psychology, 123*(3), 566-577.

Bagella, S., & Caria, M. C. (2012). Diversity and ecological characteristics o vascular flora in Mediterranean. *Comptes Rendus Biologies, 335*, 69-76.

Baillie, J. E. M., Hilton-Taylor, C., & Stuart, S. N. (2004). 2004 IUCN Red List of Threatened Species™. A Global Species Assessment. Gland, Switzerland and Cambridge, UK.: IUCN.

Ballouard, J.-M., Ajtic, R., Balint, H., Brito, J. C., Crnobrnja-Isailović, J., Elmouden, E. L., Erdogan, M., Feriche, M., Pleguezuelos, J. M., Prokop, P., Sanchez, A., Santos, X., Slimani, T., Sterijovski, B., Tomović, L., Usak, M., Zuffi, M., & Bonnet, X. (2013). Schoolchildren and One of the Most Unpopular Animals: Are They Ready to Protect Snakes? *Anthrozoos, 26*(1), 93-109.

Ballouard, J.-M., Brischoux, F., & Bonnet, X. (2011). Children Prioritize Virtual Exotic Biodiversity over Local Biodiversity. *PLos ONE, 6*(8), e23152.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* . Englewood Cliffs, N.J.: Prentice-Hall.

Batt, S. (2009). Human attitudes towards animals in relation to species similarity to humans: a multivariate approach. *Bioscience Horizons, 2*(2), 180-190.

Beatson, R. M., & Halloran, M. J. (2007). Humans rule! The effects of creatureliness reminders, mortality salience and self-esteem on attitudes towards animals. *British Journal of Social Psychology, 46*, 619-632.

Bednar-Friedi, B., Buijs, A., Dobrovodská, M., Dumortier, M., Eberhard, K., Fischer, A., Geamana, N., Grünberger, S., Langers, F., Mauz, I., Musceleanu, O., Tátrai, I., & Young, J. (2004). A Long-Term Biodiversity, Ecosystem and Awareness Research Network. Public perceptions of biodiversity change - results from a (pilot) survey in 8 European countries. *Network Excellence: Global Change and Ecosystems.*: ALTER-Net.

Beja, P., & Alcazar, R. (2003). Conservation of Mediterranean temporary ponds under agricultural intensification: an evaluation using amphibians. *Biological Conservation, 114*, 317-326.

Bell, B. F. (1981). When is an animal, not an animal? *Journal of Biological Education, 15*(3), 213-218.

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (2009). *Learning science in informal environments: People, places and pursuits*. Washington D.C.: The National Academies Press.

Bettelheim, B. (1976). *The Uses of Enchantment The Meaning and Importance of Fairy Tales*. London: Thames & Hudson.

Biodiversity Project. (1996). Human Values and Nature Future: Americans' Attitudes on Biological Diversity: An Analysis of Findings from a National Survey, conducted by Beldon, Russonello and Stuart. In C. C. a. M. C. (CCMC) (Ed.). Washington, DC: Author.

Bonney, R., Cooper, C. B., Dickinson, J., Rosenberg, K. V., & Shirk, J. (2009). Citizen Science: A developing Tool for Expanding Science Knowledge and Scientific Literacy. *BioScience, 59*(11).

Bord, R. J., O'connor, R. E., & Fisher, A. (2000). In what sense does the public need to understand global climate change? . *Public Understanding of Science. , 9*, 205–218.

Brewer, C. (2002). Conservation Education Partnerships in Schoolyard Laboratories: A Call Back To Action. *Conservation Biology, 16*, 577-579.

Brossard, D., Lewenstein, B., & Bonney, R. (2005). Scientific Knowledge and attitude change: The impact of a citizen science project. *International Journal of Science Education, 27*(9), 1099-1121.

Bultitude, K. (2011). The Why and How of Science Communication. In P. Rosulek (Ed.), *Science Communication*. Pilsen: European Commission.

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S., & Naeem, S. (2012). Biodiversity loss and its impact on humanity. *Nature 486*, 59–67.

Carrada, G. (2006). Communicating Science "A Scientist's Survival Kit". Luxembourg: European Communities.

Cartmill, M. (1993). The Bambi syndrome. *Natural History, 102*(6), 6.

Céréghino, R., Biggs, J., Oertli, B., & Declerck, S. (2008). The ecology of European ponds: defining the characteristics of a neglected freshwater habitat. *Hydrobiologia, 597*, 1-6.

Ceriaco, L. M. P. (2012). Human attitudes towards herpetofauna: The influence of folklore and negative values on the conservation of amphibians and reptiles in Portugal. *Journal of Ethnobiology and Ethnomedicine, 8*, 8.

Ceríaco, L. M. P., Marques, M. P., Madeira, N. C., Vila-Viçosa, C. M., & Mendes, P. (2011). Folklore and traditional ecological knowledge of geckos in Southern Portugal: implications for conservation and science. *Journal of Ethbobiology and Ethnomedicine, 7*, 26.

Chagas, I. (1999). *Literacia Científica. O Grande Desafio para a Escola.* Paper presented at the 1º Encontro Nacional de Investigação e Formação, Globalização e Desenvolvimento Profissional do Professor, Escola Superior de Educação de Lisboa.

Chanson, J., Hoffmann, M., Cox, N., & Stuart, S. (2008). The State of the World's Amphibians *Threatened Amphibians of the World* (pp. 33-52). Barcelona/Gland/Arlington: Lynx Edicions/IUCN/Conservation International.

Chawla, L. (2006). Learning to love the natural world enough to protect it. . *Barn, 2*, 57–78.

Chawla, L., & Cushing, D. F. (2007). Education for strategic environmental behavior. *Environmental Education Research, 13*(4), 437-452.

Chipeniuk, R. (1995). Childhood Foraging as a Means of Acquiring Competent Human Cognition about Biodiversity. *Environment and Behaviors, 27*(4), 90-512.

Christie, M., Hanley, N., Warren, J., Murphy, K., Wright, R., & Hyde, T. (2006). Valuing the diversity of biodiversity. *Ecological Economics, 58*, 304-317.

Cincotta, R. P., Wisnewski, J., & Engelman, R. (2000). Human population in the biodiversity hotspots. *Nature, 404*, 990-992.

Clarke, K. R., & Gorley, R. N. (2006). PRIMER v6: User Manual/Tutorial. Plymouth: PRIMER-E.

Clarke, K. R., Gorley, R. N., Somerfield, P. J., & Warwick, R. M. (2014). *Change in marine communities: an approach to statistical analysis and interpretation. 3rd edition*. Plymouth, UK.: PRIMER-E. .

Clayton, S., & Brook, A. (2005). Can Psychology Help Save the World? A Model for Conservation Psychology. *Analyses of Social Issues and Public Policy, 5*(1), 87-102.
Cohn, J. P. (2008). Citizen Science: Can Volunteers Do Real Research? *BioScience, 58*(3), 192-197.
Conrad, C. C., & Hilchey, K. G. (2011). A review of citizen science and community-based environmental monitoring: issues and opportunities. *Environ Monit Assess, 176*, 273–291.
Cooper, C. B., Dickinson, J., Phillips, T., & Bonney, R. (2007). Citizen Science as a Tool for Conservation in Residential Ecosystems. *Ecology and Society, 12*(2), 11.
Costa, A. F. D., Pegado, E., Ávila, P., & Coelho, A. R. (2011). Avaliação do Plano Nacional de Leitura: os primeiros cinco anos. *Avaliação Externa do Plano Nacional de Leitura*: CIES – Centro de Investigação e Estudos de Sociologia e ISCTE – Instituto Universitário de Lisboa.
Costa, J. C., Aguiar, C., Capelo, J. H., Lousã, M., & Neto, C. (1998). Biogeografia de Portugal Continental *Quercetea* (pp. 5-56).
Crowson, A. F., & Hopper, P. F. (2009). The use of Trade Books in Science Classrooms. *National Forum of Teacher Education Journal 19*(3), 1-5.
Czech, B., Krausman, P. R., & Borkhataria, R. (1998). Social Construction, Political Power, and the Allocation of Benefits to Endangered Species. *Conservation Biology, 12*, 1103-1112.
Daily, G. C. (1997). *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington, D.C.: Island Press.
Davey, G. C. L., Macdonald, A. S., Hirisave, U., Prabhu, G. G., Iwawaki, S., Jim, C. I., Merckelbach, H., John, P. J., Lejny, L. W. P., & Reimann, L. (1998). A cross-national study of animal fears. *Behaviour Research and Therapy, 36*(7-8), 735-750.
Davies, S. R. (2008). Constructing Communication: Talking to Scientists About Talking to the Public. *Science Communication, 29*(4), 413-434.
Deboer, G. (2000). Scientific Literacy: Another Look at Its Historical and Contemporary Meanings and Its Relationship to Science Education Reform. *Journal of Research in Science Teaching, 37*(6), 582-601.
Delaney, D. G., Sperling, C. D., Adams, C. S., & Leung, B. (2008). Marine invasive species: validation of citizen science and implications for national monitoring networks. *Biological Invasions*(10), 117-128.
Department of Trade and Industry. (2000). Excellence and Opportunity. A science and innovation policy for the 21st century. Executive summary. United Kingdom: Author.
Devictor, V., Whittaker, R., & Beltrame, C. (2010). Beyond scarcity: citizen science programmes as useful tools for conservation biogeography. *Diversity and Distributions, 16*, 354-362.
Dias, M., Araújo, S., & Godinho, A. (2003). Comunicar Ciência um guia prático para investigadores: Associação Viver a Ciência.
DíAz, S., Fargione, J., Iii, F. S. C., & Tilman, D. (2006). Biodiversity Loss Threatens Human Well-Being. *PLoS Biology, 4*(8), e277.
Dickinson, J. L., Zuckerberg, B., & Bonter, D. N. (2010). Citizen Science as an Ecological Research Tool: Challanges and Benefits. *Annu. Rev. Ecol. Evol. Systems, 41*, 149-172.
Direcção-Geral Do Território. (2012). Carta Administrativa Oficial de Portugal (CAOP). Available from Direção-Geral do Território Carta Administrativa Oficial de Portugal (CAOP) Retrieved 01 Oct0ber 2013 http://www.igeo.pt/produtos/cadastro/caop/versao20121.htm
Douglas, C., & Rollins, R. (2007). Motivations, Training and Supervision of Volunteers in Conservation. *Environments Journal, 35*(1), 79-89.
Driscoll, J. W. (1995). Attitudes toward Animals: Species Ratings. *Society and Animals, 3*(2), 139-150.
Dunlap, R. E. (2008). The New Environmental Paradigm Scale: From Marginality to Worldwide Use. *The Journal of Environmental Education, 40*, 1.

Dunlap, R. E., Liere, K. D. V., Mertig, A. G., & Jones, R. E. (2000). Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. *Journal of Social Issues, 56*(3), 425-442.
Elder, J., Coffin, C., & Farrior, M. (1998). Engaging the Public on Biodiversity. A Road Map for Education and Communication Strategies. (pp. 118). Madison, Winsconsin: The Biodiversity Project.
Elwood, S. (2008). Volunteered geographic information: key questions, concepts and methods to guide emerging research and practice. *GeoJournal, 72*, 133-135.
Epcn. (2008). The Pond Manifest. Oxford: European Pond Conservation Network.
European Commission. (2005). Attitudes of European citizens towards the Environment (Vol. 217): Author.
European Commission. (2008). Public Engagement in Science. Report of the Science in Society Session. Luxembourg: Author.
European Commission. (2011). From Challenges to Opportunities: Towards a Common Strategic Framework for EU Research and Innovation funding. *Green Paper* (Vol. COM: 48). Brussels: Author.
Falk, J. H. (1983). Field trips: A look at environmental effects on learning. . *Journal of Biological Education, 17*, 137–142.
Falk, J. H., & Dierking, L. D. (1998). Free-choice learning: an alternative term to informal learning? *Informal Learning Environmets Research Newsletter, 2*(1), 2.
Falk, J. H., & Storksdieck, M. (2005). Learning Science from Museums. *História, Ciências, Saúde - Manguinhos, 12 (supplement)*, 117-143.
Falk, J. H., Storksdieck, M., & Dierking, L. D. (2007). Investigating public science interest and understanding: Evidence for the importance of free-choice learning. *Public Understanding of Science, 16*(4), 455-469.
Ferreira, A. (2000). "Caracterização de Portugal Continental", Dados Geoquímicos de Base de Sedimentos Fluviais de Amostragem de Baixa Densidade de Portugal Continental: Estudo de Factores de Variação Regional. Retrieved from e-Geo – Sistema Nacional de Informação Geocientífica/LNEG website: http://egeo.ineti.pt/edicoes_online/teses/antonio_ferreira/volume1/
Ferreira, M., & Beja, P. (2013). Mediterranean amphibians and the loss of temporary ponds: Are there alternative breeding habitats? *Biological Conservation, 165*, 179-186.
Fischer, A., Bednar-Friedl, B., Langers, F., Dobrovodská, M., Geamana, N., Skogen, K., & Dumortier, M. (2011). Universal criteria for species conservation priorities? Findings from a survey of public views across Europe. *Biological Conservation, 144*, 998-1007.
Fischer, A., Langers, F., Bednar-Friedl, B., Geamana, N., & Skogen, K. (2011). Mental representations of animal and plant species in their social contexts: Results from a survey across Europe. *Journal of Environmental Psycology, 31*, 118-128.
Fischer, A., & Young, J. C. (2007). Understanding mental constructs of biodiversity: Implications for biodiversity management and conservation. *Biological Conservation, 136*, 271-282.
Ford, D. J. (2006). Representations of Science Within Children's Trade Books. *Journal of Research in Science Teaching, 43*(2), 214-235.
Frey, B. S., & Foppa, K. (1986). Human behaviour: possibilities explain action. *Journal of Sconomic Psychology, 7*, 137-160.
Fulton, D. C., Manfredo, M. J., & Lipscomb, J. (1996). Wildlife value and orientations: A conceptual and measurement approach. *Human Dimensions of Wildlife, 1*(2), 24-47.
Gallant, A. L., Klaver, R. W., Casper, G. S., & Lannoo, M. J. (2007). Global Rates of Habitat Loss and Implications for Amphibian Conservation. *Copeia, 2007*(4), 967-979.

Ganea, P. A., Canfield, C. F., Simons-Ghafari, K., & Chou, T. (2014). Do cavies talk? The effect of anthropomorphic picture books on children's knowledge about animals. *Frontiers in Psychology, 5*, 1-9.
Ganea, P. A., Deloache, J. S., & Ma, L. (2011). Young Children's Learning and Transfer of Biological Information From Picture Books to Real Animals. *Child Development, 82*(5), 1421-1433.
Gonen, M., & Guler, T. (2011). The Environment and Its Place in Children's Picture Story Books. *Procedia Social and Behavioral Sciences, 15*, 3633-3639.
Goodchild, M. (2007). Citizens as Voluntary Sensors: Spatial Data Infrstructure in the World of Web 2.0. *International Journal of Spatial Data Infrastructures Research, 2*, 24-32.
Goodchild, M. F. (2007). Citizens as Sensors. *GeoJournal, 69*, 211-221.
Gore, A. (2006). *Uma Verdade Inconveniente: A Emergência Planetária do Aquecimento Global e o que Podemos Fazer em Relação a Isso*. Lisboa: Esfera do Caos.
Greenwood, J. J. D. (2007). Citizens, science and bird conservation. *Journal of Ornithology, 148* (Suppl 1), S77_S124.
Gura, T. (2013). Amateur experts. *Nature, 496*, 259.
Hawksworth, D. L. (1996). *Biodiversity: measurment and estimation*: The Royal Society.
Heal, G. M. E. A. (2005). *Valuing Ecosystem Services: Toward Better Environmental Decision-Making*: The National Academies Press.
Hermsworth, P. H. (2003). Human-animal interactions in livestock production. *Applied Animal Behaviour Science, 81*, 184-198.
Hobbs, S. J., & White, P. C. L. (2012). Motivations and Barriers in relation to community participation in biodiversity recording. *Journal for Nature Conservation, 20*, 364-273.
Hof, C., Araújo, M. B., Jetz, W., & Rahbek, C. (2011). Additive threats from pathogens, climate and land-use change for global amphibian diversity. *Nature, 480*, 516–519.
Hooper-Greenhill, E., & Moussouri, T. (2001). *Researching Learning in Museums and Galleries 1990-1999: A Bibliographic Review*. University of Leicester: Research Centre for Museums and Galleries.
Hug, J. W. (2010). Exploring instructional strategies to develop prospective elementary teacher's children's literature book evaluation skills for science, ecology and environmental education. *Environmental Education Research, 16*(3-4), 267-382.
Hull, A. (1997). *The pond life project : a model for conservation sustainability.* Paper presented at the UK Conference of the Pond Life Project, Pond Life Project Liverpool.
Hunter, L. M., & Brehm, J. (2003). Qualitative Insight Into Public Knowledge of, and Concern With, Biodiversity. *Human Ecology, 31*(2), 309-320.
Instituto De Conservação Da Natureza E Das Florestas. (2013a). AP_NOV_2013. Retrieved 18 November 2013, from Instituto de Conservação da Natureza e das Florestas http://www.icnf.pt/portal/naturaclas/cart/ap-rn-ramsar-pt
Instituto De Conservação Da Natureza E Das Florestas. (2013b). RAMSAR_CONTINENTE18. Retrieved 18 November 2013, from Instituto de Conservação da Natureza e das Florestas http://www.icnf.pt/portal/naturaclas/cart/ap-rn-ramsar-pt
Instituto De Conservação Da Natureza E Das Florestas. (2013c). SIC_DEZ_2012. Retrieved 18 November 2013, from Instituto de Conservação da Natureza e das Florestas http://www.icnf.pt/portal/naturaclas/cart/ap-rn-ramsar-pt
Instituto De Conservação Da Natureza E Das Florestas. (2013d). ZPE_Dez_2012. Retrieved 18 November 2013, from Instituto de Conservação da Natureza e das Florestas http://www.icnf.pt/portal/naturaclas/cart/ap-rn-ramsar-pt
Instituto Nacional De Estatística. (2011). População residente (N.º) por Local de residência. Recenseamento da População e Habitação. Retrieved 22 November 2013, from Author

http://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0003182&selTab=tab0
Instituto Nacional De Estatística. (2012). Censos 2011 Resultados Definitivos - Portugal. In I. P. Instituto Nacional de Estatística (Ed.). Lisboa-Portugal: Author.
Internacional Business Machines. (Released 2011). IBM SPSS Statistics for Mac (Version 20.0.0). Armonk, NY: IBM Corp.
International Union for Conservation of Nature. (2014). The IUCN Red List of Threatened Species. Version 2014.3. . Retrieved 28 April 2015., from Author http://www.iucnredlist.org
Johansson, M., & Heningsson, M. (2011). Social-Psychological Factors in Public Support for Local Biodiversity Conservation. *Society and Natural Resources, 24*, 717-733.
Johnson, K. R. (1996). The Ambiguous Terrain of Petkeeping in Children's Realistic Animal Stories. *Society & Animals, 4*(1), 1-17.
Jordan, R. C., Gray, S. A., Howe, D. V., Brooks, W. R., & Ehrenfeld, J. G. (2011). Knowledge Gain and Behavioral Change in Citizen-Science Programs. *Conservation Biology, 25*(6), 1148-1154.
Kaiser, F. G., Wölfing, S., & Fuhrer, U. (1999). Environmental Attitude and Ecological Behaviour. *Journal of Environmental Psychology, 19*, 1-19.
Kaplan, R., & Kaplan, S. (1989). *The experience of Nature. A Psychological Perspective.* Cambridge: University Press.
Kaplan, S. (2000). Human Nature and Environmentally Responsible Behaviour. *Journal of Social Issues, 46*, 491-508.
Kassas, M. (2002). Environmental education: biodiversity. *The Environmentalist, 22*, 345-351.
Kelemen, E., Balázs, K., Choisis, J. P., Gomiero, T., Kovács, E., Nguyen, G., Paoletti, M. G., Podmanczky, L., Ryschawy, J., & Sarthou, J. P. (2011). *Competing perceptions on biodiversity and its benefits: Theorical and methodological implications of a focus group study*. Paper presented at the 9th International Conference of the European Society for Ecological Economics, Istanbul.
Kellert, S. R. (1985a). Attitudes toward Animals: Age-Related Development among Children. *The Journal of Environmental Education, 16*, 29-39.
Kellert, S. R. (1985b). Public Perceptions of Predators, Particularly the Wolf and Coyote. *Biological Conservation, 31*, 167-189.
Kellert, S. R. (1989). Perceptions of animals in America *Perceptions of animals in American Culture*. Washington DC: Smithsonian Press.
Kellert, S. R. (1993). Values and Perceptions of Invertebrates. *Conservation Biology, 7*(4), 845-855.
Kellert, S. R. (1996). *The value of life: biological diversity and human society*. Washington: Island Press.
Kellert, S. R. (2002). Experiencing Nature: Affective, Cognitive, and Evaluative Development in Children *Children and Nature: Psychological, Sociological, and Evolutionary Investigations*. Cambridge: MA: The MIT Press.
Knight, A. J. (2008). ‘‘Bats, snakes and spiders, Oh my!’’ How aesthetic and negativistic attitudes, and other concepts predict support for species protection. *Journal of Environmental Psychology, 28*, 94–103.
Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behaviour? *Environmental Education Research, 8*(3), 239-260.
Kouper, I. (2010). Science blogs and public engagement with science: practices, challenges, and opportunities. *Journal of Science Communication, 9*(1), 1-10.
Letunic, I., & Bork, P. (2006). Interactive Tree Of Life (iTOL): an online tool for phylogenetic tree display and annotation. *Bioinformatics, 23*(1), 128-128.

Letunic, I., & Bork, P. (2011). Interactive Tree Of Life v2: online annotation and display of phylogenetic trees made easy. *Nucleic Acids Research, 39*(Web Server issue), W475–W478.

Lewenstein, B. V. (2007). Why should we care about science books? *Journal of Science Communication, 6*(11), 1-7.

Lindemann-Mathies, P. (2002). The Influence of an Educational Program on Children's Perception of Biodiversity. *The Journal of Environmental Education, 33*(2), 22-31.

Lindemann-Mathies, P. (2005). "Loveable" mammals and "lifeless" plants: how children's interest in common local organisms can be enhanced through observation of nature. *International Journal of Science Education, 27*(6), 655-677.

Lindemann-Mathies, P., & Bose, E. (2008). How many species are there? Public understanding and awareness of biodiversity in Switzerland. *Human Ecology, 36*, 731-742.

Lovejoy, T. E., & Hannah, L. J. (2005). *Climate change and biodiversity*: Yale University Press.

Manfredo, M. T., T.; Bright, A. (2003). Why are Public Values Toward Wildlife Changing? *Human Dimensions of Wildlife, 8*, 287-306.

Manoli, C. C., Johnson, B., & Dunlap, R. E. (2007). Assessing Children's Environmental Worldviews: Modifying and Validating the New Ecological Paradigm Scale for Use With Children. *The Journal of Environmental Education, 38*(4), 1-12.

Mccallie, E., Bell, L., Lohwater, T., Falk, J. H., Lehr, J. L., Lewenstein, B. V., Needham, C., & Wiehe, B. (2009). Many Experts, Many Audiences: Public Engagement with Science and Informal Science Education. Washington: Center for Advancement of Informal Science Education (CAISE).

Microsoft. (Released 2011). Microsoft Excel for Mac (Version 14.3.2). Redmond, Washington: Microsoft Corporation.

Millenium Ecosystem Assessment. (2005a). Ecosystems and Human Well-being: Biodiversity Synthesis. Washington, DC World Resources Institute.

Millenium Ecosystem Assessment. (2005b). Ecosystems and Human Well-being. Synthesis. Washington, DC: World Resources Institute.

Miller, J. D. (2006). *Civic Scientific Literacy in Europe and the United States*. Paper presented at the Annual meeting of the World Association for Public Opinion Research, Montreal, Canada.

Miller, J. R. (2005). Biodiversity conservation and the extintion of experience. *TRENDS in Ecology and Evolution, 20*(8), 430-434.

Mora, C., Tittensor, B. P., Adl, S., Simpson, A. G. B., & Worm, B. (2011). How Many Species Are There on Earth and in the Ocean? *PLOS Biology, 9*(8), e1001127.

More, T. A. (1977). *An Analysis of Wildlife in Children's Stories.* Paper presented at the Children, Nature, and the Urban Environment: Proceedings of a Symposium-Fair; Gen. Tech. Rep. NE-30. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.

More, T. A. (1979). Wildlife Preferences and Children's Books. *Wildlife Society Bulletin, 7*(4), 274-278.

Morris, D. (1961). An analysis of animal popularity. *International Zoo Yearbook, 2*, 60-61.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Fonseca, G. a. B. D., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature, 403*, 853-858.

Nepote, J. (2008). The other books - A journey through science books. *Journal of Science Communication, 7*(2), 1-6.

Norton, M., & Nohara, K. (2009). Science cafés. Cross-cultural adaptation and educational applications. *Journal of Science Communication, 8*(4), 1-11.

Novacek, M. J. (2008). Engaging the public in biodiversity issues. *PNAS, 105*(suppl. 1), 11571-11578.

Nunes, P. a. L. D., & Bergh, J. C. J. M. V. D. (2001). Economic valuation of biodiversity: sense or non-sense? *Ecological Economics, 39*, 203-222.
Pergam, O. R. W., & Zaradic, P. A. (2006). Is love of nature in the US becoming love of electronic media? 16-year downtrend in national park visits explained by watching movies, playing video games, internet use, and oil prices. *Journal of Environmental Managemen, 80*, 387-393.
Peter H. Kahn, J. (1997). Developmental Psychology and the Biophilia Hypothesis: Children's Affiliation with Nature. *Developmental Review, 17*, 1-61.
Pinto-Cruz, C., Barbosa, A. M., Molina, J. A., & Espírito-Santo, M. D. (2011). Biotic and abiotic parameters that distinguish types of temporary ponds in a Portuguese Mediterranean ecosystem. *Ecological Indicators, 11*, 1658-1663.
Plous, S. (1993). Psychological Mechanisms in the Human Use of Animals. *Journal of Social Issues, 49*, 11-52.
Poliakoff, E., & Webb, T. L. (2007). What Factors Predict Scientists' Intentions to Participate in Public Engagement of Science Activities? *Science Communication, 29*(2), 242-263.
Primack, R. B. (2010). *Essentials of Conservation Biology* (5th ed.): Sinauer Associates.
Pringle, R. M., & Lamme, L. L. (2005). Using Picture Storybooks to Support Young Children's Science Learning. *Reading Horizons, 46*(1), 1-15.
Prokop, P., & Fancovicová, J. (2013). Does colour matter? The influence of animal warning coloration on human emotions and willingness to protect them. *Animal Conservation, 16*, 458–466.
Prokop, P., Özel, M., & Uşak, M. (2009). Cross-Cultural Comparison of Student Attitudes toward Snakes. *Society and Animals, 17*, 224-240.
Prokop, P., & Tunniclife, S. D. (2010). Effects of Having Pets at Home on Children's Attitudes toward Polpular and Unpopular Animals. *Anthrozoos, 23*(1), 21-35.
Prokop, P., & Tunnicliffe, S. D. (2008). "Disgunting" Animals: Primary School Children's Attitudes and Myths of Bats and Spiders. *Eurasia Journal of Mathematics, Science & Tecnhnology Education, 4*(2), 87-97.
Prokop, P., Usak, M., & Erdogan, M. (2011). Good Predators in Bad Stories: cross-cultural comparision of Children's Attitudes Towards Wolves. *Journal of Baltic Science Education, 10*(4), 229-242.
Randler, C., Ilg, A., & Kern, J. (2005). Cognitive and Emotional Evaluation of Amphibian Conservation Program for Elementary School Students. *The Journal of Environmental Education, 37*(1), 43-52.
Reis, C. S., Marchante, H., Freitas, H., & Marchante, E. (2011). Public Perception of Invasive Plant Species: Assessing the impact of workshop activities to promote young students awareness. *International Journal of Science Education*, 1-23.
Rice, D. C. (2002). Using trade books in teaching elementary science: Facts and fallacies. *The Reading Teacher, 55*(6), 552-565.
Robischon, M. (2014). Hugh's book and Krogh's animals: biodiversity and textbook examples in teaching. *Advances in Physiology Education, 38*(3), 195-198.
Rodari, P. (2009). Learning science in informal environments: people, places and pursuits. A review by the US National Science Council. *Journal of Science Communication, 8*(3).
Sasaki, K., Sasaki, Y., & Fox, S. F. (2008). Endangered tradicional beliefs in Japan: influences on snake conservation. *Hepertological Conservation and Biology, Biodiversity and Conservation*(17), 2037-2049.
Schmeller, D. S., Henry, P.-Y., Julliard, R., Gruber, B., Clobert, J., Dziock, F., Lengyel, S., Nowicki, P., D´Eri, E., Budrys, E., Kull, T., Tali, K., Bauch, B., Settele, J., Swaay, C. V., Kobler, A., Babij, V.,

Papastergiadou, E., & Henle, K. (2009). Advantages of Volunteer-Based Biodiversity Monitoring in Europe. *Conservation Biology, 23*, 307–316.

Schmidt, L. (2008). Comunicar a Ciência: o papel dos media e os problemas científico-ambientais. *Ciência e Cidadania - Homenagem a Bento de Jesus Caraça* (pp. 85-112). Lisboa: Imprensa de Ciências Sociais.

Schroeder, M., Mackeough, A., & Graham, S. (2009). The Contribution of Trade Books to Early Science Literacy: In and Out of School. *Research in Science Education, 39*, 231-250.

Science for All Expert Group. (2010). Science for All. Report and action plan from the Science for All Expert Group, . United Kingdom: Author.

Secretariat of the Convention on Biological Diversity. (1992). Convention on Biological Diversity Retrieved January 7th, 2015, from http://www.cbd.int/convention/articles/default.shtml?a=cbd-02

Serpell, J. (1999). Animals in Children's Lives. [Guest Editor's Introduction]. *Society & Animals, 7*(2), 87-94.

Serpell, J. (2004). Factors influencing human attitudes to animals and their welfare. *Animal Welfare, 13*, S145-151.

Shirk, J. L., Ballard, H. L., Wilderman, C. C., Phillips, T., Wiggins, A., Jordan, R., Mccallie, E., Minarchek, M., Lewenstein, B. V., Krasny, M. E., & Bonney., R. (2012). Public participation in scientific research: a framework for deliberate design. *Ecology and Society, 17*(2), 29.

Silvertown, J. (2009). A new dawn for citizen science. *TRENDS in Ecology and Evolution, 24*(9), 467-470.

Snaddon, J. L., Tunner, E. C., & Foster, W. A. (2008). Children's Perceptions of Rainforest Biodiversity; Which Animals Have the Lion's Share of Environmental Awareness? *PLoS ONE, 3*(7), e2579.

Society, R. (1985). The Public Understanding of Science. London: The Royal Society.

Sodhi, N. S., Bickford, D., Diesmos, A. C., Lee, T. M., Koh, L. P., Brook, B. W., Sekercioglu, C. H., & Bradshaw, C. J. A. (2008). Measuring the Meltdown: Drivers of Global Amphibian Extinction and Decline. . *PLoS ONE, 3*(2), e1636. .

Soti, V., Tran, A., Bailly, J.-S., Puech, C., Seen, D. L., & Bégué, A. (2009). Assessing optical earth observation systems for mapping and monitoring temporrary ponds in arid areas. *International Journal of Applied Erath Observation and Geoinformation, 11*, 344-351.

Stern, P. (2000). Towards a coherent theory of environmentally significant behaviour. *Journal of Social Issues, 56*(3), 407-424.

Stewart, K., & Cole, M. (2009). The Conceptual Separation of Food and Animals in Childhood. *Food,Culture & Society, 12*(4), 458-476.

Stokes, D. L. (2006). Things We Like: Human Preferences among Similar Organisms and Implications for Conservation. *Human Ecology, 35*, 361-369.

Sullivan, B. L., Wood, C. L., Iliff, M. J., Bonney, R., Fink, D., & Kelling, S. (2009). eBird: A citizen-science bird observation network in the biological sciences. *Biological Conservation, 142*, 2282-2292.

Tanner, C. (1999). Constrains on Environmental Behaviour. *Journal of Environmental Psychology, 19*, 145-157.

The Galup Organization. (2010). Attitudes of Europeans towards the issue of biodiversity wave 2 (Vol. 290): European Commission.

Toerpe, K. (2013). The Rize of Citizen Science. *The Futurist, July-August*, 25-30.

Tomazic, I. (2008). The influence of direct experience on students' attitudes to, and knwoledge about amphibians. *Acta Biologica Slovenica, 51*(1), 39-49.

Tomazic, I. (2011a). Pre-service biology teachers' attitude, fear and disgust toward animals and direct experience of live animals. *The Online Journal Of New Horizons In Education, 1*(1), 32-39.

Tomazic, I. (2011b). Pre-Service Biology Teachers' and Primary School Students' Attitudes Toward and Knowledge about Snakes. *Eurasia Journal of Mathematics, Science & Technology Education, 7*(3), 161-171.

Tomazic, I. (2011c). Reported Experiences Enhance Favourable Attitudes Toward Toads. *Eurasia Journal of Mathematics, Science & Tecnhnology Education, 7*(4), 253-262.

Trumbull, D. J., Bonney, R., Bascom, D., & Cabral, A. (2000). Thinking Scientifically during Participation in a Citizen-Science Project. *John Wiley & Sons, Inc. Sci Ed., 84*, 265-275.

United Nations Educational, S. a. C. O. (1971). Convention on Wetlands of International Importance especially as Waterfowl Habitat. *UN Treaty Series, No. 14583. As amended by the Paris Protocol, 3 December 1982, and Regina Amendments, 28 May 1987*.

Varga, D. (2009). Babes in the Woods: Wilderness Aesthetics in Children's Stories and Toys, 1830-1915. *Society & Animals, 17*, 187-205.

Veríssimo, D., Macmillan, D. C., & Smith, R. J. (2011). Marketing diversity: a response to Joseph and colleagues. . *Conservation Letters, 4*, 326–327.

Vié, J.-C., Hilton-Taylor, C., & (Eds), S. N. S. (2009). Wildlife in a Changing World - An Analysis of the 2008 IUCN Red List of Threatened Species (pp. 180 pp). Gland, Switzerland: IUCN.

Vieira, N. (2007). Literacia Científica e Educação de Ciência. Doius objectivos para a mesma aula. *Revista Lusófona de Educação, 10*, 97-108.

Wagler, R. (2011). The Impact of Vicarious Experiences and Field Experience Classroom Characteristics on Preservice Elementary Science Teaching Efficacy. *Electronic Journal of Science Education, 15*(2), 1-28.

Wagler, R., & Wagler, A. (2012). External insect morphology: A negative factor in attitudes toward insects and likelihood of incorporation in future science education settings. *International Journal of Environmental & Science Education, 7*(2), 313-325.

Wandersee, J. H. (1986). Plants or animals—which do junior high school students prefer to study? *Journal of Research in Science Teaching, 23*, 415–426.

Wandersee, J. H., & Schussler, E. E. (2001). Toward a Theory of Plant Blindness. *Plant Science Bulletin, 47*, 2-9.

Watermeyer, R. (2010). Social Network science: pedagogy, dialogue, deliberation. *Journal of Science Communication, 9*(1), 1-9.

Waxman, S. R., Hermann, P., Woodring, J., & Medin, D. L. (2014). Humans (really) are animals: picture-book reading influences 5-year-old urban children's construal of the relation between humans and non-human animals. *Frontiers in Psychology, 5*, 1-8.

Waylen, K. A., Fischer, A., Mcgowan, P. J. K., Thirgood, S. J., & Milner-Gulland, J. (2010). Effect of Local Cultural Context on the Success of Community-Based Conservation Interventions. *Conservation Biology, 24*(4), 1119-1129.

Weelie, D. V., & Wals, A. (2002). Making biodiversity meaningful through environmental education. *International Journal of Science Education, 24*(11), 1143-1156.

Wells, R., & Zeece, P. C. (2007). My Place in My World: Literature for Place-Based Environmental Education. *Early Childhood Education Journal, 35*(3), 285-291.

White, R. (2006). Young Children's Relationship with Nature: Its importance to Children's Development & the Earth's Future. . *Taproot, 16*(2), 1-9.

Wiersma, Y. F. (2010). Birding 2.0: Citizen Science and Effective Monitoring in the Web 2.0 World. *Avian Conservation and Ecology, 5*(2), 13.

Williams, J., Podesschi, C., Palmer, N., Schwadel, P., & Meyler, D. (2012). The Human-Environment Dialog in Award-winning Children's Picture Books. *Sociological Inquiry, 82*(1), 145-159.

Williams, P., Whitfield, M., Biggs, J., Bray, S., Fox, G., Nicolet, P., & Sear, D. (2004). Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. *Biological Conservation, 115*, 329–341.

Wilson, E. O. (1984). *Biophilia*. Cambridge, Massachusetts, USA: Harvard University Press.

Wilson, E. O., & Peter, F. M. (1988). *Biodiversity*. Washington DC: National Academy of Sciences.

Wilson, J., & Willis, R. (2004). The task is to make visible the invisible, to expose to public scrutiny the assumptions, values and visions that drive science. London: Demos.

Wood, P. J., Greenwood, M. T., & Agnew, M. D. (2003). Pond biodiversity and habitat loss in the UK. *Area, 35*, 206–216.

Woods, B. (2000). Beauty and the Beast: Preferences for animals in Australia. *The Journal of Tourism Studies, 11*(2), 25-35.

Worthington, J. P., Silvertown, J., Cook, L., Cameron, R., Dodd, M., Greenwood, R. M., Mcconway, K., & Skelton, P. (2011). Evolution MegaLab: a case study in citizen science methods. *Methods in Ecology and Evolution, 3*, 303-309.

Yen, C.-F., Yao, T.-W., & Mintzes, J. J. (2007). Taiwanese Students' Alternative Conceptions of Animal Biodiversity. *International Journal of Science Education, 29*(4), 535-553.

Zacharias, I., Dimitriou, E., Dekker, A., & Dorsman, E. (2007). Overview of temporary ponds in the Mediterranean region: Threats, management and conservation issues. *Journal of Environmental Biology, 28*(1), 1-9.

Zacharias, I., & Zamparas, M. (2010). Mediterranean temporary ponds. A disapearing ecosystem. *Biodiversity Conservation, 19*, 3827-3834.

Zar, J. H. (1984). *Biostatistical Analysis* (Second Edition ed.). Englewood Cliffs, New Jersey: Prenntice Hall International Editions. 2nd edition.

Zhang, W. Z., Goodale, E., & Chen, J. (2014). How contact with nature affects children's biophilia, biophobia and conservation attitude in China. *Biological Conservation, 177*, 109-116.

10. ANNEXES

Annex 1: Questionnaire made to the visitors to the Biodiversity stand at the UP Fair in 2012 and 2013.

CIBIO
Centro de Investigação em Biodiversidade e Recursos Genéticos

Começa já a colaborar com o CIBIO em estudos sobre a "Biodiversidade e Sociedade" respondendo a este inquérito sobre os teus **animais favoritos**.

No espaço abaixo lista os 5 animais de que **mais gostas**:

No espaço abaixo lista os 5 animais de que **menos gostas**:

Da lista abaixo seleciona as 3 principais fontes de informação sobre a biodiversidade que mais utilizas:

☐ Televisão
☐ Internet
☐ Livros
☐ Jornais ou revistas
☐ Aulas da escola
☐ Workshops de educação ambiental
☐ Museus, centros de ciência ou exposições
☐ Documentários em filme
☐ Família e amigos
☐ Professores ou cientistas
☐ Outra, qual? _____

Dá-nos algumas informações sobre ti:

Sexo: ☐ F ☐ M

Idade: _____ anos.

Concelho onde vives: _____

Obrigada pela colaboração! A tua opinião também é essencial para o nosso trabalho.

Annex 2: List of animals mentioned by the students as being their most favourite and least favourite animals. The terms in the table are the ones used by the students to mention the animals.

Favourite animals		**Least favourite animals**	
Name	**Frequency**	**Name**	**Frequency**
Cão	130	Aranha	85
Gato	92	Cobra	70
Golfinho	74	Rato	41
Cavalo	67	Mosca	36
Leão	36	Barata	32
Tartaruga	24	Lagarto	30
Coelho	22	Tubarão	30
Tigre	21	Abelha	28
Peixes	18	Crocodilo	27
Macaco	15	Mosquito	25
Pinguim	15	Gato	24
Girafa	14	Sapo	23
Papagaio	13	Centopeia	22
Pássaro	13	Formiga	15
Urso	13	Minhoca	15
Chita	12	Galinha	12
Leopardo	12	Cão	11
Panda	12	Melga	10
Baleias	11	Ratazana	10
Tubarão	11	Vaca	9
Borboleta	10	Cabra	8
Lince	10	Leão	8
Lobo	10	Porco	8
Elefante	9	Escorpião	7
Sapo	9	Alforrecas	6
Zebra	9	Insectos	6
Cobra	8	Rã	6
Koala	8	Vespa	6
Pantera	8	Elefante	5
Focas	7	Lampreia	5
Canguru	6	Macaco	5
Águia	5	Piranha	5
Aranha	5	Caracóis	4
Hamster	5	Gaivotas	4
Puma	5	Girafa	4
Rato	5	Lesma	4
Vaca	5	Pomba	4
Camaleões	4	Serpente	4
Esquilo	4	Carraca	3
Orca	4	Enguia	3
Abelha	3	Escaravelho	3
Andorinhas	3	Larva	3
Burro	3	Libelinhas	3
Chinchila	3	Morcego	3
Escorpião	3	Ovelhas	3
Joaninha	3	Pássaro	3
Lagarto	3	Peixes	3
Lémur	3	Peixes dourados	3
Polvo	3	Piolho	3
Rã	3	Répteis	3
Suricata	3	Sanguessuga	3

Urso Polar	3	Sardanisca	3
Veado	3	Urso	3
Araras	2	Anfíbios	2
Aves	2	Babuino	2
Cabra	2	Baleias	2
Cágado	2	Burro	2
Canário	2	Camelo	2
Chimpanzé	2	Gafanhoto	2
Lontra	2	Hipopótamo	2
Minhoca	2	Javali	2
Morcego	2	Leopardo	2
Pato	2	Orca	2
Pavão	2	Ouriço-do-mar	2
Peixe-lua	2	Peixe-espada	2
Raposa	2	Pessoas	2
Alforrecas	1	Polvo	2
Anémonas	1	Preguiça	2
Ave do Paríso	1	Pulga	2
Beluga	1	Tarântula	2
Camelo	1	Tartaruga	2
Caracóis	1	Tritões	2
Caranguejo	1	Ácaros	1
Cavalo-marinho	1	Águia	1
Cobaia	1	Andorinhas	1
Colibri	1	Anguila	1
Coruja	1	Aracnídeos	1
Crocodilo	1	Aves	1
Dragão de Komodo	1	Avestruz	1
Estrela-do-mar	1	Bisonte	1
Flamingo	1	Bode	1
Formiga	1	Borboleta	1
Furão	1	Cágado	1
Galinha	1	Cascavel	1
Galo	1	Cavalo	1
Garça	1	Coruja	1
Gorila	1	Corvo	1
Grilo	1	Cucaracha	1
Iguana	1	Esquilo	1
Insectos	1	Focas	1
Leopardo das Neves	1	Ganso	1
Louva-a-deus	1	Gibóia	1
Marta	1	Hienas	1
Ornitorrinco	1	Iguana	1
Palanca-negra	1	Koala	1
Peixe-palhaço	1	Lagartixa	1
Peixe-tigre	1	Lapa	1
Pessoas	1	Lobo	1
Periquito	1	Lombriga	1
Pisco de peito ruivo	1	Louva-a-deus	1
Porco	1	Macaco-narigudo	1
Porco da Índia	1	Mula	1
Porco Vietnamita	1	Pantera	1
Raia	1	Papa-formigas	1
Rela	1	Parasita	1
Salamandra de pintas amarelas	1	Pavão	1
Salamandras	1	Peixe-aranha	1
Tatu	1	Peixe-balão	1
Tigre Branco	1	Peru	1
Tubarão-baleia	1	Pinguim	1

Tubarão-martelo	1	Periquito	1
Tucano	1	Puma	1
		Raposa	1
		Rinoceronte	1
		Tainha	1
		Tartaruga Marinha	1
		Tigre	1
		Tigre Branco	1
		Toupeira	1
		Touro	1
		Tucano	1
		Vaca-loura	1
		Vespão gigante	1
		Zebra	1

Annex 3: List of the 164 analysed books from the National Reading Plan of the Portuguese government (PNL – Plano National de Leitura) for six-eight years old children.

Title	Authors
A bruxa Mimi vai à praia	Paul, Korky et al.
A girafa que comia estrelas	Agualusa, José Eduardo
EFGH... alguma bicharada até ao Z	Correia, Octaviano
O quadro que não quer acabar	Maia, Celeste
A árvore da vida. Um livro que descreve a vida de	Sis, Peter
A menina que detestava livros	Pawagi, Manjusha
Branca de Neve e os sete anões	Baker, Liza(adapt.)
Era uma vez um sonho	Windsor, Grace
O concurso da escola	Katschke, Judy et al.
O dia da amizade	Parent, Nancy
O gato do chapéu	Terra, Goncalo(trad.) (Dr Seuss)
Os tigres não gostam de perder	Gaines, Isabel
O elefante que não era elefante	Ferner, Marta Rivera
Pimpão e os leões	Oliveira, Domingos
Espelho	Lee, Suzy
Pablo, o pintor	Kitamura, Satoshi
A Arca de Noé	Janisch, Heinz(adapt.)
O médico do mar	Timmers, Leo
A pequena sereia	Andersen, Hans Christian
Contas-me uma história?	Gliori, Debi
O gato das botas	Hamilton, Judy(adapt.)
O homem de pão de erva-doce	Hamilton, Judy
A mãe vai sair esta noite	Leiz, Juliet Pomés
Avós	Heras, Chema
Chocolata	Núñez, Marisa et al.
Jogos de todo o mundo	Ripoll, Oriol
O patinho feio	Eizaguirre Alvear, Belén et al.
O pequeno dragão d'água	Cordelle, Geneviève et al.
O sonho do ursinho rosa	Aliaga, Roberto
Onze damas atrevidas	González, Xosé M.
Por que somos de cores diferentes?	Gil, Carmen
A lebre e a tartaruga	La Fontaine, Jean de(adapt. de Ed. Susaeta)
As aventuras da comadre raposa	Simon, Romain
Jogos com pés e cabeça	Martin, Lise
Leónia devora os livros	Herbert, Laurence
Monstros lá de casa	Marijanovic, Stanislav
O rapaz que tinha medo	Stein, Mathilde
O sapo apaixonado	Velthuijs, Max
O sapo e o tesouro	Velthuijs, Max
A lebre e a tartaruga	Ward, Helen
A surpresa de Handa	Browne, Eileen
As casas dos animais	Hannaford, Priscilla
Aventuras em casa do avô	Kincaid, Eric et al.
É tão injusto!	Thomson, Pat
Era uma vez um dia normal de escola	McNaughton, Colin
Eu e tu	Browne, Anthony
Eu quero um amigo	Ross, Tony
João e o feijoeiro mágico	Walker, Richard
Lavar, escovar, esfregar!	Manning, Mick
Mozart	Rachlin, Ann et al.
O aniversário do Bob	Redmond, Diane
O boneco de neve	Briggs, Raymond
O gato adormecido	Allen, Judy
O livro dos porquinhos	Browne, Anthony

O mistério do balão fugitivo	Blyton, Enid
O pequeno carro vermelho	Baxter, Nicola
Rosa, a coelhinha curiosa	Rawlinson, Julia
Surpresa! Surpresa!	Foreman, Michael
O pato camponês	Waddell, Martin
A princesa baixinha	Masini, Beatrice
O meu tetravô... era um guerreiro!	Francaviglia, Riccardo
Um lobo pela trela	Visconti, Guido(adapt.)
Novas histórias ao telefone	Rodari, Gianni
A bruxa esbrenhuxa	Castel-Branco, Margarida
A caixa das ferramentas	Letria, José Jorge
A casa de férias	Tavares, Gonçalo M.
À esquina da rima, buzina	Torrado, António
A estrela perdida	Fernandes, Francisco
A Flor vai pescar num bote	Redol, Alves
A manta. Uma história aos quadradinhos de	Martins, Isabel Minhós
A Mosquito	Oliveira, Inês de
A panela mágica	Soares, Maria Isabel de Mendonça (trad.)
A princesa da chuva	Soares, Luísa Ducla
A princesinha corajosa	Contumélias, Mário
A raposa azul	Magalhães, Ana Maria et al.
A valentia da Ritinha	Antunes, Isabel
A vassoura voadora 1	Moutinho, José Viale (selec.)
A vassoura voadora 2	Moutinho, José Viale (selec.)
ABC das flores e dos frutos em rima infantil	Faria, Rosa Lobato de
Adivinhas coloridas	Salgueiro, Tiago
Anedotas de animais ilustradas	Salgueiro, Tiago(compil.)
Animais nossos amigos	Vieira, Afonso Lopes
Arco, barco, berço, verso	Vasconcelos, José Carlos de
As cancõezinhas da Tila	Araújo, Matilde Rosa
As caretas da Lua	Andrade, Carmo et al.
As fadas verdes	Araújo, Matilde Rosa
As três touguinhas brancas	Parafita, Alexandre
Aventura do cavaleiro da linda figura	Gil, Renata
Bernardino	Bacelar, Manuela
Branca de Neve e os sete anões	Costa, Sara(trad. e adapt.)
Branca Flor, o príncipe e o demónio	Parafita, Alexandre
Cá em casa somos...	Martins, Isabel Minhós
Canta o galo gordo	Pupo, Inês et al.
Cantigas e cantigos	Fanha, José
Ciclo do mel	Quental, Cristina et al
Como quem diz	Torrado, António
Conto estrelas em ti Poemas	Gomes, José António(coord.)
Contos de Perrault	Menéres, Maria Alberta (trad.)
Contos tradicionais	Mota, António(adapt.)
Conversas com versos	Menéres, Maria Alberta
De um a dez da cabeça aos pés	Letria, José Jorge
Dom Leão e dona Catatua	Micaelo, Manuela
Era uma vez... ciência e poesia no reino da	Gouveia, Regina
Eu bem vi nascer o Sol	Vieira, Alice(org.)
Fala bicho	Figueiredo, Violeta
Hipólito, o filantropo	Many, Eric
História das cinco vogais	Soares, Luísa Ducla
Histórias a rimar para ler e brincar	Parafita, Alexandre
Histórias de tempo vai tempo vem	Menéres, Maria Alberta
Histórias para meninos «não quero»	Gonçalves, Vanda
Histórias pequenas de bichos pequenos	Magalhães, Álvaro
Hoje há palhaços	Torrado, António et al.
Humi e a grande viagem de iceberg	Sousa, Rui

João e o pé de feijão	Ferreira, Belmira et al.
João grão de milho Rato do campo e rato da	Vieira, Alice
Livro com cheiro a chocolate	Vieira, Alice
O caldo de pedra	Silva, Maria Teresa dos Santos
O Castelo do Queijo	Soares, Maria Isabel de Mendonca
O circo das palavras voadoras	Magalhães, Álvaro
O crocodilo e o passarinho	Gomes, Madalena
O dono de tudo	Strecht-Ribeiro, Orlando et al.
O filho do demónio: A adivinha do rei	Vieira, Alice
O gato das botas	Soares, Maria Isabel de Mendonca et al. (trad.)
O gato Gatão poeta de profissão	Breia, Graca
O H perdeu uma perna	Vicente, Ana
O leão e o canguru	Magalhães, Ana Maria et al.
O livro da Tila	Araújo, Matilde Rosa
O livro das 4 estações	Correia, Ana Cristina
O livro dos dias	Letria, José Jorge
O lobo «mau» Xau-Xau	Neto, Franclim
O meu livro	Reisinho, Pedro
O piquenique do Tomás	Simas, Helena
O pirata das ilhas da Bruma	Bradford, Mariana et al.
O que é que se passa aqui?	Micaelo, Manuela
O que se vê no ABC	Rocha, Daphne
O rapaz de pedra	Moutinho, José Viale
O rapaz que vivia na televisão e outras histórias	Soares, Luísa Ducla
O rouxinol e a sua namorada	Muralha, Sidónio
O segredo do sol e da lua	Breia, Graca et al.
O sonho de Mariana	Mota, António
O urso e a formiga	Soares, Luísa Ducla
O velho, o rapaz e o burro	Silva, Maria Teresa dos Santos(adapt.)
Onde tudo aconteceu	Mota, António
Os amigos de Lia	Oliveira, Inês de
Os ovos misteriosos	Soares, Luísa Ducla
Os sete cabritinhos	Ferreira, Belmira et al.
Os três porquinhos	Soares, Maria Isabel(trad.)
Palavras pequeninas	Nabais, Maria Antonieta
Panda e a lua mentirosa	Zambujal, Isabel
Porta-te bem!	Letria, José Jorge
Quando eu nasci	Martins, Isabel Minhós
Se tu visses o que eu vi	Mota, António
Sílvio, domador de caracóis	Mangas, Francisco Duarte
Tenho em casa um cãozinho	Letria, José Jorge
Todos no sofá	Soares, Luísa Ducla
Trava-línguas	Gomes, Luísa Costa
Trocadilhar	Letria, José Jorge
Um pé de vento	Breia, Graca
Uma corrida de vassouras	Alvim, Nicha
Uns óculos para a Rita	Soares, Luísa Ducla
Versos com todas as letras	Letria, José Jorge
O flautista de Hamelin	Santos, Isabel Simões dos(trad.)
A guardadora de patos; Os cisnes selvagens	Herreros, F. et al.
O pássaro azul; A rainha das neves	Busquets, Carlos et al.

Annex 4: List of the biodiversity elements and respective number of total occurrences (TO) in the analysed book sample.

Biodiversity element	**TO**				
Undefined tree	1470	Rose	100	Grasshopper	43
Undefined flower	1293	Cabbage	98	Water lily	42
Undefined bird	1154	Mushroom	96	Goose	42
Cat	1095	Tiger	93	Corn	42
Rabbit	957	Crow	86	Glory bush	40
Undefined plant	774	Palm tree	85	Whale	39
Dog	605	Spider	84	Swan	39
Undefined fish	490	Mosquito	80	Starfish	39
Gallinaceous	481	Snail	75	Mole	39
Mouse	475	Kangaroo	74	Eel	39
Wolf	444	Seaweed	72	Dinosaur	38
Fox	421	Sparrow	71	Wheat	37
Horse	356	Marigold	71	Owl[d]	37
Sheep	338	Cricket	70	Deer	37
Pig	320	Scarab[b]	69	Zebra	36
Crocodile	319	Ox	68	Penguin	36
Bear	292	Safu	67	Octopus	36
Butterfly	278	Undefined arthropod	65	Herbaceous plants	36
Bee	268	Cherry	64	Flea	36
Lion	259	Seagull	62	Ostrich	34
Duck	258	Chick	61	Nightingale	34
Egg	253	Grape	59	Lizard	33
Ant	239	Fig	58	Sunflower	32
Donkey	233	Banana	56	Scarab[e]	32
Elephant	211	Sparrow	54	Damselfly	32
Hippo	189	Orange	54	Cockatoo	32
Toad	176	Rat	53	Anteater	32
Fly	170	Crab	52	Lark	31
Monkey	158	Lemon	50	Tomato	31
Apple	155	Tulip	49	Viola	31
Cow	146	Pear	49	Bean plant	30
Dove	145	Carrot	48	Lamprey	30
Swallow	135	Bat	48	Potato	29
Squirrel	134	Mopheads	47	Sea-horse	29
Lamb	134	Bulrush	47	Blackberry	28
Giraffe	134	Ladybug	46	Centipede	28
Panda Bear	127	Turnip	44	Boar	28
Goat	122	Shark	44	Peach	28
Bean	122	Pine	44	Badger	28
Turtle[a]	120	Fruit	44	Cotton	27
Frog	117	Camel	44	Earthworm	27
Snake	112	Owl[c]	43	Hedgehog	27

Biodiversity element	TO				
Hyena	26	Otter	14	Weeping willow	8
Lizardfish	26	Poppy	14	Quail	8
Jasmine	25	Peacock	14	Cormorant	8
Pineapple	24	Vulture	13	Peas	8
Condor	24	Oak	13	Sea-urchin	8
Helmeted Guineafowl	24	Beaver	13	Tapeworm	8
Caterpillar	24	Legume	13	Rufous-collared Sparrow	8
Pomegranate	24	Walnut	13	Codfish	7
Moth	24	Bee-eater	12	Cheetah	7
Pumpkin	23	Antelope	12	Cyclamen	7
Passion fruit	22	Birch	12	Cicala	7
Blackbird	22	Silkworm	12	Egret	7
Bell pepper	22	Falcon	12	Apple tree	7
Wood louse	21	Hawk	12	Louse	7
Barnacle	21	Olive tree	12	Reindeer	7
Pelican	21	Snapper	12	Mulberry tree	7
Avocado	20	Vine	12	Plaice	7
Cactus	20	Blue tit	11	Hummingbird	7
Thistle	20	Cuckoo	11	Pear tree	7
Coconut	20	Melon	11	Lettuce	6
Partridge	20	Orchids	11	Medusa	6
Orange tree	19	Cucumber	11	Beetle	6
Armadillo	19	Trout	11	Coyote	6
Finch	19	Zinnia	11	Shoveler	6
Rooster	19	Buffalo	10	Roe deer	6
Seal	18	Shrimp	10	Dromedary	6
Dolphin	18	Chestnut	10	Rhea	6
Daisy	18	Chestnut-tree	10	Pheasant	6
Strawberry	18	Gillyflower	10	Kingfishers	6
Turkey	18	Jackdaw	10	Rosewood	6
Flamingo	17	Ivy	10	Sea otter	6
Polar bear	17	Leopard	10	Zebra Finch	6
Acorn	16	Watermelon	10	Mussel	6
Chameleon	16	Moss	10	Killer whale	6
Coconut tree	16	Turtledove	10	Pine Cone	6
Guava	16	Sardine	10	Bull	6
Mango	16	Nettle	10	Clover	6
Fireflies	16	Mulberry	9	Canary	5
Tangerine	16	Anemone	9	Mackerel	5
Gorilla	15	Chimpanzee	9	Gazelle	5
Rhino	15	Bullfinch	9	Ipecacuanha	5
Stork	14	Pout	9	Alligator	5
Dahlia	14	Python	9	Wolfish	5
Fig tree	14	Goldfinch	9	Walrus	5
Iguana	14	Cockroach	8	Parakeet	5

Biodiversity element	TO				
Pine nut	5	Grouper	3	Laurel	2
Hoopoe	5	Duckbill	3	Microbes	2
Rosebush	5	Pinworms	3	Mouflon	2
Topped lavender	5	Bug (Heteroptera)	3	Shrew	2
Acacia	4	Pepper	3	Okapi	2
Rosemary	4	Bream	3	Orangutan	2
Hazelnut	4	Weaver	3	Panoolin	2
Olive	4	Termite	3	Swordfish	2
Onion	4	Eagle	2	Clownfish	2
Cherry-tree	4	Albatross	2	Sawfish	2
Koala	4	Garlic	2	Hake	2
Scorpion	4	Almond	2	Oxpecker	2
Fern	4	Clams	2	Warthog	2
Jay	4	Heartsease	2	Plane tree	2
Sour cherry	4	Rice	2	Cougar	2
Gnu	4	Tuna	2	Rays	2
Gooseberry	4	Oatmeal	2	Rubber tree	2
Arum	4	Banana tree	2	Serval	2
Nit	4	Beluga	2	Cork oak	2
Slug	4	Sea bream	2	Heron	2
Linen	4	Bongo	2	Mullet	2
Ichneumon	4	Stag beetle	2	Furze	2
Mule	4	Turtle[f]	2	Germs	2
Magpie	4	Giant Cane	2	Vicuña	2
Piranha	4	Reed	2	Watercress	1
Robin	4	Rattlesnake	2	Lavender	1
Sloth	4	Chinchilla	2	Leek	1
Cricket	4	Cauliflower	2	Herring	1
Salamander	4	Greater Roadrunner	2	Holmoak	1
Parsley	4	Komodo dragon	2	Baboon	1
Ocellated Lizard	4	Cistus	2	Barbel	1
Monkfish	4	Tern	2	Cockle	1
Linden tree	4	Fallow deer	2	Eggplant	1
Toucan	4	Blue-footed Booby	2	Bonsai	1
Lily	3	Gerbera	2	Broccoli	1
Plum	3	Brooms	2	Burrié	1
Dormouse	3	Grain	2	Camellia	1
Bacillus	3	Racoon	2	Bluebell	1
Rye	3	Stick-insect	2	Deer	1
Weasel	3	Limpet	2	Jackal	1
Weed	3	Homarus	2	Lemon balm	1
Sweet pea	3	Liana	2	Cypress	1
Sponges	3	Lime	2	Coriander	1
Flying squirrel	3	Lemon tree	2	Conger	1
Beech	3	Loris	2	Verbena	1

Biodiversity element	TO				
Ear	1	Squid	1	Loquat	1
Eucalyptus	1	Honeysuckle	1	Walnut tree	1
Broad bean	1	Magnolia	1	Oyster	1
Fennel	1	Chilli	1	Peach tree	1
Genet	1	Basil	1	Sand hopper	1
Chickpea	1	Greek basil	1	Sea bass	1
Rapini	1	Shellfish	1	Willow	1
Guanaco	1	Quince	1	Salmon	1
Mentha	1	Marmot	1	Tench	1
Jaguar	1	Kite	1	Thrush	1
Rushes	1	Mimosa	1	Warbler	1
Common Yellow	1	Moray eels	1	Heather	1
Lilac	1	Turnip greens	1	Vegetable	1
Linx	1	Narcissus	1	Wasp	1
Lichen	1	Narwhal	1	Skunk	1

Note: Names are according text references or the most achievable identification by images. Some translation details are showed by superscripts:

[a] and [f] shows that the term "turtle" appears twice in the list since Portuguese has two different terms for turtle: "tartaruga"[a] and "cágado"[f]. The word "cágado" is exclusively used to designate the two species of native aquatic turtles: *Emys orbicularis* and *Mauremys leprosa*.

[b] and [e] shows that the term "scarab" also appears twice in the list since Portuguese has more than one word for scarab. In this case, the Portuguese terms are "escaravelho"[b] and "carocha"[e] that refer exactly to the same animal but usually have different connotations: "carocha" is associated with a black scarab like the *Blaps lusitanica*.

[c] and [d] shows the same for the term "Owl" that also appears twice in this list since the Portuguese has two different terms for owl: "mocho"[c] and "coruja"[d]. Besides the two terms refer to different animals they aren't associated with different taxonomic groups since "mocho" and "coruja" all belong to the Strigiformes order and Strigidae family.

Annex 5: Pre- and Post-project evaluation questionnaires made to the students that attend to the "Ponds With Life" project during the scholar year of 2013-2014.

QUESTIONÁRIO 1

Este questionário faz parte de um estudo integrado num projeto de doutoramento e visa compreender os efeitos do programa "Charcos com Vida". Isto não é um teste nem pretende avaliar os conhecimentos dos participantes mas sim as potencialidades do projeto. Por favor, lê com atenção as questões e responde honestamente a cada uma delas.

INFORMAÇÃO GERAL

A tua idade em anos: ____ O teu sexo: ☐ Feminino ☐ Masculino

OS CHARCOS....

"Os charcos são massas de água parada ou de corrente muito reduzida, geralmente de tamanho superior a uma poça e inferior a um lago. O tamanho, a duração e a estrutura dos charcos pode ser muito variável consoante o clima e a geologia do local."

Observa as imagens nos diapositivos para veres a variedade de charcos que existem.

1 **Já conhecias os Charcos antes de te serem apresentados hoje?** (Assinala apenas uma resposta)

☐ Sim. ☐ Não.

2 **De que forma já contactaste anteriormente com o habitat charco?** (Assinala uma ou várias respostas)

☐ Nunca estive num charco.
☐ Estudei o habitat charco nas aulas da escola
☐ Já vi charcos em livros, jornais ou revistas
☐ Estive num charco que existe na minha escola
☐ Estive num charco que existe na minha casa
☐ Ouvi frases populares que usam a palavra "charco"
Por exemplo:_____
_____
☐ Estive num charco de um jardim público
☐ Estive num charco durante um passeio pela natureza
☐ Vi charcos na Televisão
☐ Vi charcos na Internet
☐ Contactei com charcos de outra forma
Qual?_____
_____
_____

3 **Na escala seguinte, assinala com uma cruz a tua opinião sobre as seguintes afirmações:**

	Discordo totalmente	Discordo	É indiferente	Concordo	Concordo totalmente
Estamos a aproximar-nos do limite máximo do número de pessoas que o nosso planeta pode suportar.	☐	☐	☐	☐	☐
O ser humano tem o direito de modificar o ambiente natural de forma a satisfazer as suas necessidades.	☐	☐	☐	☐	☐
Quando o Homem interfere com a natureza, muitas vezes provoca consequências desastrosas.	☐	☐	☐	☐	☐
A inteligência humana vai assegurar que não tornamos a terra inabitável.	☐	☐	☐	☐	☐
O homem está a abusar seriamente do meio ambiente.	☐	☐	☐	☐	☐
A Terra tem recursos naturais em abundância se nós formos capazes de aprender a desenvolvê-los.	☐	☐	☐	☐	☐
Plantas e animais têm tanto direito a existir como os humanos.	☐	☐	☐	☐	☐
O equilíbrio da natureza é suficientemente forte para lidar com os impactos das nações industrializadas modernas.	☐	☐	☐	☐	☐

Apesar das suas capacidades, os humanos estão sujeitos às leis da natureza.	☐	☐	☐	☐	☐
A chamada "crise ecológica" que a humanidade enfrenta tem sido muito exagerada.	☐	☐	☐	☐	☐
A Terra é como uma nave espacial com espaço e recursos muito limitados.	☐	☐	☐	☐	☐
Os seres humanos foram feitos para governar sobre o resto da natureza.	☐	☐	☐	☐	☐
O equilíbrio natural é muito delicado e facilmente perturbado.	☐	☐	☐	☐	☐
Os humanos acabarão por aprender o suficiente sobre como a natureza funciona para serem capazes de a controlar.	☐	☐	☐	☐	☐
Se as coisas continuarem no seu curso atual, nós iremos viver muito brevemente uma grande catástrofe ecológica.	☐	☐	☐	☐	☐

4 **Classifica as seguintes afirmações como verdadeiras ou falsas <u>assinalando respetivamente com um V (verdadeira) ou um F (falsa)</u>:**

	V/F
Nos charcos é possível a ocorrência de plantas em toda a sua área.	☐
Muitos seres vivos adaptaram-se às condições de sobrevivência dos charcos e são dependentes deste habitat.	☐
Os charcos são ecossistemas robustos e estáveis pois resistem facilmente a pequenas alterações do meio graças às suas reduzidas dimensões e volume de água.	☐
Os charcos apresentam níveis de biodiversidade muito baixos em comparação com lagos e lagoas.	☐
Os charcos, por terem pequenas dimensões, não são capazes de dinamizar os ciclos dos nutrientes.	☐
Uma importante ameaça aos charcos é a ocupação por plantas autóctones.	☐
Um charco não perturbado possui peixes em abundância.	☐
As aves aquáticas têm um papel importante na colonização de novos charcos.	☐
Os alfaiates têm patas hidrofílicas e por isso mergulham frequentemente em charcos.	☐
As libélulas quando pousam fecham as asas junto ao corpo.	☐
As larvas de salamandras e tritões têm brânquias externas.	☐
Os tritões preferem charcos com vegetação submersa que utilizam para colocar os ovos.	☐
A Carpa é um peixe exótico que contribui para a degradação dos charcos.	☐
O jacinto-de-água é uma planta importante para a conservação dos charcos pois possui tolerância elevada à presença de metais pesados.	☐

5 **Observa os grupos apresentados nos diapositivos**. <u>Assinala com uma cruz</u> a tua opinião sobre os seres vivos dos diferentes grupos:

	Não gosto nada	Não gosto	Nem gosto nem desgosto	Gosto	Gosto muito
Grupo 1	☐	☐	☐	☐	☐
Grupo 2	☐	☐	☐	☐	☐
Grupo 3	☐	☐	☐	☐	☐
Grupo 4	☐	☐	☐	☐	☐
Grupo 5	☐	☐	☐	☐	☐
Grupo 6	☐	☐	☐	☐	☐
Grupo 7	☐	☐	☐	☐	☐

6 **Em geral gostas ou não de charcos?** Assinala com uma cruz a tua opinião.

Não gosto nada	Não gosto	Nem gosto nem desgosto	Gosto	Gosto muito
☐	☐	☐	☐	☐

7 **Na escala seguinte, assinala com uma cruz a tua opinião sobre as seguintes afirmações:**

	Discordo totalmente	Discordo	Indiferente	Concordo	Concordo totalmente
Acho que os anfíbios são seres vivos muito atraentes.	☐	☐	☐	☐	☐
Costumo passar o meu tempo livre a explorar locais onde existem anfíbios como charcos ou ribeiros.	☐	☐	☐	☐	☐
Devemos viver em harmonia com os anfíbios porque eles são importantes para o equilíbrio na natureza.	☐	☐	☐	☐	☐
Estou interessado em conhecer as relações entre os anfíbios e o seu meio ambiente e com as espécies com que estes se relacionam.	☐	☐	☐	☐	☐
Gosto muito de anfíbios.	☐	☐	☐	☐	☐
Estou interessado em conhecer as características físicas dos anfíbios, que tipo de anfíbios existem e como funciona o seu organismo.	☐	☐	☐	☐	☐
Acho importante usar os anfíbios nos campos de cultivo para se alimentarem dos insectos nocivos às culturas.	☐	☐	☐	☐	☐
Estou interessado em anfíbios para saber como posso ajudar a que não sejam maltratados pelas pessoas.	☐	☐	☐	☐	☐
Não tenho interesse nenhum por anfíbios porque nunca os achei nada de especial.	☐	☐	☐	☐	☐
Um charco torna a paisagem menos bonita.	☐	☐	☐	☐	☐
Os charcos são desagradáveis porque têm mosquitos que transmitem doenças humanas.	☐	☐	☐	☐	☐
Estar num charco é importante pois aprendem-se coisas sobre a natureza que não vêm nos livros.	☐	☐	☐	☐	☐
O charco é importante para acumular água para as regas da agricultura.	☐	☐	☐	☐	☐
O charco tem um papel essencial no ciclo da água do planeta.	☐	☐	☐	☐	☐
O charco é um habitat natural e por isso não deve ser perturbado por nada nem ninguém.	☐	☐	☐	☐	☐
O charco é indispensável pois é um habitat natural onde vivem muitas espécies.	☐	☐	☐	☐	☐
Os charcos devem ser escoados de forma a estabilizar os terrenos quando se pretende fazer construções ou agricultura.	☐	☐	☐	☐	☐
Gosto mais de um lago com um chafariz e nenúfares do que de um charco natural.	☐	☐	☐	☐	☐

Obrigada! A tua colaboração é essencial para o nosso estudo.
Esperamos que aprecies a campanha "Charcos com Vida".

QUESTIONÁRIO 2

Este questionário faz parte de um estudo integrado num projeto de doutoramento e visa compreender os efeitos do programa "Charcos com Vida". Isto não é um teste nem pretende avaliar os conhecimentos dos participantes mas sim as potencialidades do projeto. Por favor, lê com atenção as questões e responde honestamente a cada uma delas.

INFORMAÇÃO GERAL

A tua idade em anos: ____ O teu sexo: ☐ Feminino ☐ Masculino

OS CHARCOS....

"Os charcos são massas de água parada ou de corrente muito reduzida, geralmente de tamanho superior a uma poça e inferior a um lago. O tamanho, a duração e a estrutura dos charcos pode ser muito variável consoante o clima e a geologia do local."

1 **Participaste no projeto Escolher Ciência "Charcos com Vida"?**

☐ Sim
☐ Não

Se respondeste sim, continua para a pergunta 2. Se respondeste não passa diretamente para a pergunta 3.

2

2.1 **<u>Assinala com uma cruz</u> apenas as atividades em que estiveste presente:**

☐ Apresentação da campanha e dos charcos.
☐ Questionário inicial de avaliação do projeto.
☐ Palestra: Conservação de anfíbios e répteis em Portugal.
☐ Palestra: Investigação em genética, evolução e conservação da biodiversidade.
☐ Sessão de apoio à escolha ou construção do charco.
☐ Sessão de apoio à gestão do charco.
☐ Sessão de atividades de campo.
☐ Sessão de atividades de sala.
☐ Montagem da exposição sobre anfíbios: "Uma pata na água outra a terra".
☐ Exposição sobre anfíbios: "Uma pata na água outra a terra".

2.2 **<u>Assinala com uma cruz</u> a tua opinião sobre estas atividades:**

	Não gostei nada	Não gostei	Indiferente	Gostei	Gostei muito
Apresentação da campanha e dos charcos.	☐	☐	☐	☐	☐
Palestra: Conservação de anfíbios e répteis em Portugal.	☐	☐	☐	☐	☐
Palestra: Investigação em genética, evolução e conservação da biodiversidade.	☐	☐	☐	☐	☐
Sessão de apoio à escolha ou construção do charco.	☐	☐	☐	☐	☐
Sessão de apoio à gestão do charco.	☐	☐	☐	☐	☐
Sessão de atividades de campo.	☐	☐	☐	☐	☐
Sessão de atividades de sala.	☐	☐	☐	☐	☐
Montagem da exposição sobre anfíbios: "Uma pata na água outra a terra".	☐	☐	☐	☐	☐
Exposição sobre anfíbios: "Uma pata na água outra a terra".	☐	☐	☐	☐	☐

2.3 **Na tua opinião, qual das atividades foi a melhor? _____**

2.4 **Na tua opinião, qual das atividades foi a pior? _____**

3 **Na escala seguinte, assinala com uma cruz a tua opinião sobre as seguintes afirmações:**

	Discordo totalmente	Discordo	É indiferente	Concordo	Concordo totalmente
Estamos a aproximar-nos do limite máximo do número de pessoas que o nosso planeta pode suportar.	☐	☐	☐	☐	☐
O ser humano tem o direito de modificar o ambiente natural de forma a satisfazer as suas necessidades.	☐	☐	☐	☐	☐
Quando o Homem interfere com a natureza, muitas vezes provoca consequências desastrosas.	☐	☐	☐	☐	☐
A inteligência humana vai assegurar que não tornamos a terra inabitável.	☐	☐	☐	☐	☐
O homem está a abusar seriamente do meio ambiente.	☐	☐	☐	☐	☐
A Terra tem recursos naturais em abundância se nós formos capazes de aprender a desenvolvê-los.	☐	☐	☐	☐	☐
Plantas e animais têm tanto direito a existir como os humanos.	☐	☐	☐	☐	☐
O equilíbrio da natureza é suficientemente forte para lidar com os impactos das nações industrializadas modernas.	☐	☐	☐	☐	☐
Apesar das suas capacidades, os humanos estão sujeitos às leis da natureza.	☐	☐	☐	☐	☐
A chamada "crise ecológica" que a humanidade enfrenta tem sido muito exagerada.	☐	☐	☐	☐	☐
A Terra é como uma nave espacial com espaço e recursos muito limitados.	☐	☐	☐	☐	☐
Os seres humanos foram feitos para governar sobre o resto da natureza.	☐	☐	☐	☐	☐
O equilíbrio natural é muito delicado e facilmente perturbado.	☐	☐	☐	☐	☐
Os humanos acabarão por aprender o suficiente sobre como a natureza funciona para serem capazes de a controlar.	☐	☐	☐	☐	☐
Se as coisas continuarem no seu curso atual, nós iremos viver muito brevemente uma grande catástrofe ecológica.	☐	☐	☐	☐	☐

4 **Classifica as seguintes afirmações como verdadeiras ou falsas assinalando respetivamente com um V (verdadeira) ou um F (falsa):**

	V/F
Nos charcos é possível a ocorrência de plantas em toda a sua área.	☐
Muitos seres vivos adaptaram-se às condições de sobrevivência dos charcos e são dependentes deste habitat.	☐
Os charcos são ecossistemas robustos e estáveis pois resistem facilmente a pequenas alterações do meio graças às suas reduzidas dimensões e volume de água.	☐
Os charcos apresentam níveis de biodiversidade muito baixos em comparação com lagos e lagoas.	☐
Os charcos, por terem pequenas dimensões, não são capazes de dinamizar os ciclos dos nutrientes.	☐
Uma importante ameaça aos charcos é a ocupação por plantas autóctones.	☐
Um charco não perturbado possui peixes em abundância.	☐
As aves aquáticas têm um papel importante na colonização de novos charcos.	☐

Os alfaiates têm patas hidrofílicas e por isso mergulham frequentemente em charcos. ☐

As libélulas quando pousam fecham as asas junto ao corpo. ☐

As larvas de salamandras e tritões têm brânquias externas. ☐

Os tritões preferem charcos com vegetação submersa que utilizam para colocar os ovos. ☐

A Carpa é um peixe exótico que contribui para a degradação dos charcos. ☐

O jacinto-de-água é uma planta importante para a conservação dos charcos pois possui tolerância elevada à presença de metais pesados. ☐

5 **Observa os grupos apresentados nos diapositivos**. Assinala com uma cruz a tua opinião sobre os seres vivos dos diferentes grupos:

	Não gosto nada	Não gosto	Nem gosto nem desgosto	Gosto	Gosto muito
Grupo 1	☐	☐	☐	☐	☐
Grupo 2	☐	☐	☐	☐	☐
Grupo 3	☐	☐	☐	☐	☐
Grupo 4	☐	☐	☐	☐	☐
Grupo 5	☐	☐	☐	☐	☐
Grupo 6	☐	☐	☐	☐	☐
Grupo 7	☐	☐	☐	☐	☐

6 **Em geral gostas ou não de charcos?** Assinala com uma cruz a tua opinião.

Não gosto nada	Não gosto	Nem gosto nem desgosto	Gosto	Gosto muito
☐	☐	☐	☐	☐

7 **Na escala seguinte, assinala com uma cruz a tua opinião sobre as seguintes afirmações:**

	Discordo totalmente	Discordo	Indiferente	Concordo	Concordo totalmente
Acho que os anfíbios são seres vivos muito atraentes.	☐	☐	☐	☐	☐
Costumo passar o meu tempo livre a explorar locais onde existem anfíbios como charcos ou ribeiros.	☐	☐	☐	☐	☐
Devemos viver em harmonia com os anfíbios porque eles são importantes para o equilíbrio na natureza.	☐	☐	☐	☐	☐
Estou interessado em conhecer as relações entre os anfíbios e o seu meio ambiente e com as espécies com que estes se relacionam.	☐	☐	☐	☐	☐
Gosto muito de anfíbios.	☐	☐	☐	☐	☐
Estou interessado em conhecer as características físicas dos anfíbios, que tipo de anfíbios existem e como funciona o seu organismo.	☐	☐	☐	☐	☐
Acho importante usar os anfíbios nos campos de cultivo para se alimentarem dos insectos nocivos às culturas.	☐	☐	☐	☐	☐
Estou interessado em anfíbios para saber como posso ajudar a que não sejam maltratados pelas pessoas.	☐	☐	☐	☐	☐

Não tenho interesse nenhum por anfíbios porque nunca os achei nada de especial.	☐	☐	☐	☐	☐
Um charco torna a paisagem menos bonita.	☐	☐	☐	☐	☐
Os charcos são desagradáveis porque têm mosquitos que transmitem doenças humanas.	☐	☐	☐	☐	☐
Estar num charco é importante pois aprendem-se coisas sobre a natureza que não vêm nos livros.	☐	☐	☐	☐	☐
O charco é importante para acumular água para as regas da agricultura.	☐	☐	☐	☐	☐
O charco tem um papel essencial no ciclo da água do planeta.	☐	☐	☐	☐	☐
O charco é um habitat natural e por isso não deve ser perturbado por nada nem ninguém.	☐	☐	☐	☐	☐
O charco é indispensável pois é um habitat natural onde vivem muitas espécies.	☐	☐	☐	☐	☐
Os charcos devem ser escoados de forma a estabilizar os terrenos quando se pretende fazer construções ou agricultura.	☐	☐	☐	☐	☐
Gosto mais de um lago com um chafariz e nenúfares do que de um charco natural.	☐	☐	☐	☐	☐

Obrigada! A tua colaboração é essencial para o nosso estudo.
Esperamos que tenhas apreciado a campanha "Charcos com Vida".

Annex 6: On-line Pond Inventory Website and form.