On controlling invasive species:
how to tackle conservation, ethics and communication to the general public?

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Acknowledgements | Foreword

First of all, I would like to thank the Alfred Toepfer Foundation and the Europarc Federation for awarding me the Alfred Toepfer Natural Heritage Scholarship, allowing me this great opportunity, and to attend the enthralling Europarc Conference in Killarney, Ireland, 2014, and the ATS Scholar's meeting in Hamburg, 2014.

I would also like to thank all of the people who helped to make my visits so thriving: all the staff of Parque Regional del Sureste - but especially Juan Manuel Ceballos and Pedro López Nieva - who warmly welcomed and helped me, and the staff from the Consejería de Medio Ambiente - Comunidad de Madrid, Maria José Fernández Casals, Juan Carlos García Perez, Ismael Hernández Fernández, who kindly helped with the surveys.

I am always thankful to those who are dear to my heart and give me their support and constructive critics even when I am miles away, Mário, Nelson, Juliana, Rosinha, Sónia, Ubelha, Mom...

I must certainly thank the University of Aveiro, especially professor Carlos Fonseca and the Wildlife Research Unit, for always being supportive to my projects.

Four years ago I finished my PhD, which was focused on assessing the impacts of agriculture and forestry intensification on biodiversity. The first sentence of my thesis was "No man is an island", by John Donne. As a researcher, I understood no-one was going to read my thesis or my papers, and there was so much to learn to and with people! We can't do anything all by ourselves… So I decided to pursue a post-doc on communication. I think Nature has too much value to be lying in academic drawers. In a very practical way, I am also working in a Portuguese Life project which aims at controlling invasive plant species through community engagement. I think we all agree on the issue invasive species are posing to conservation, and the importance of educating people on the subject. But during work I started to question myself: instead of plants, how would we feel if we were killing animals? How would we explain to people we have to eliminate those innocent beings? So the Alfred Toepfer Scholarship allowed me to go to the Parque Regional del Sureste, in Spain, to learn how these ethical and controversial aspects are handled, since there is a programme to control raccoons. And how are these issues communicated to general public and decision-makers.

In conservation meetings we hear a lot about networking, communicating, and also dreaming. Dreaming of a better future, of a better nature. I am from Portugal, and in the current context it sometimes seems we are not allowed to dream big. Many people would perceive this award only as a scholarship, but for me, it's a major opportunity. I cannot thank everyone enough for all I've learned and will be learning. It's not about what I individually take with me, it's about what I will be able to pass on to all those I want to communicate with, those who didn't get this opportunity. Thanks for allowing me to add a tiny little brick to the huge edifice of nature conservation. This little brick, to me, means to dream big. I am personally committed to do all I can to inspire others to dream as big as they can too. Thank you.

@Parque Regional de Sureste, with Park staff.

1. Summary

Alien invasive species are a worldwide leading cause of biodiversity decline, ranking second only to habitat loss. The seriousness of this issue led the European Commission to entitle a whole target on it, within the EU Biodiversity Strategy. The negative consequences of invasive species extend beyond environment to ecosystem services, public health, economy, landscape aesthetics, etc., representing a main concern and threat to all aspects of sustainability. Once established, invasive species are extremely difficult and costly to control and eradicate, and their ecological effects are often irreversible.

Thus, producing effective invasive species management plans is a central issue in conservation, and increasing awareness and understanding of the risks and issues involved in dealing with invasive alien species is an overarching matter in conservation communication. When it comes to charismatic species, ethical questions also arise, and tackling conservation through their control is a very complex issue.

This study visit took place in Parque Regional del Sureste, Spain, where a raccoon control program is being carried out. The goal was to learn how communication in such a delicate topic is being handled. Also, surveys were distributed in Spain and Portugal in order to assess the public perception and knowledge on invasive species.

The main conclusions of the study were:

- Children/Youngsters are less concerned and aware of environmental issues than adults.
- Some occupational fields are more concerned/aware of environmental issues than others. Nature-related professionals are the more engaged people, opposing for instance to marketeers, advertisers, architects and constructors.
- The occupational field has an influence on the *knowledge* on invasive species but not on the *attitude* towards the topic.
- Information and engagement levels seem to increase on par with the regularity people go outdoors and visit natural areas.
- The control of invasive animal species raises more ethical concerns than the control of plants, but a certain "desensitization" seems to occur when people regularly contact with invasive animal species control programs.
- In general, the public understands that invasive species pose an issue to biodiversity, ecosystems and historical values, but the effects on the economy, climate change, public health and aesthetics of the landscape are not so clearly perceived.

Communication on invasive species has still a long way to go, but these results present some insights and directions to fulfil real gaps and achieve more effective communication. It also gives a positive feedback on the hard work Protected Areas and conservation practitioners have been doing.

2. Introduction

Title:
On controlling invasive species:
how to tackle conservation, ethics and communication to the general public?

Theme:
Implementation of the EU Biodiversity Strategy in the European protected areas.

Name of protected area:
Parque Regional del Sureste

Country of visit:
Spain

Purpose of the field trip:
Learn to create effective management plans addressing invasive species and how to engage in ethics and communicate the need of controlling those species to the general public.

Alien invasive species are a worldwide leading cause of biodiversity decline (Clavero and García-Berthou, 2005), ranking second, at least in islands, only to habitat loss (BISE, 2015).

The European Commission approaches alien invasive species as The seriousness of this issue led the European Commission to entitle a whole target on the subject, within the EU Biodiversity Strategy, stating "*Invasive Alien Species are animals and plants that are introduced accidently or deliberately into a natural environment where they are not normally found, with serious negative consequences for their new environment. They represent a major threat to native plants and animals in Europe, causing damage worth billions of Euros to the European economy every year.*"

In fact, the negative consequences of invasive species extend beyond environment to ecosystem services, public health (Pyšek and Richardson, 2010), economy (Pimentel et al., 2005), aesthetics, etc., representing a main concern and threat to all aspects of sustainability (Bax et al., 2003; Strayer et al., 2006). Once established, invasive species are extremely difficult and costly to control and eradicate, and their ecological effects are often irreversible (Vilà et al., 2011).

The EU Regulation 1143/2014 on invasive alien species entered into force on 1 January 2015 and represents a serious attempt *to prevent, minimise and mitigate the adverse effects of invasive alien species on biodiversity and ecosystems, as well as on human health and the economy* in Europe. The Regulation is structured in three main types of priority interventions: prevention, early detection and rapid eradication, and management. Briefly, all State Members will have to prepare action plans to address the priority pathways and to prevent the unintentional introduction and spread of invasive alien species of concern in their territory and in their marine waters, with the Commission ensuring that the EU countries involved cooperate and work together to deal with the problem.

It is then clear that invasive species are no longer just a preoccupation of academics or conservation practitioners, but a serious priority among top stakeholders and decision-makers.

It is also acknowledged that both *pre* and *post*-invasion actions are urgent, from early detection and prevention to control or restoration programs. Thus, producing effective invasive species management plans is a central issue in conservation (Wittenberg and Cock, 2001), and increasing awareness and understanding of the risks and issues involved in dealing with invasive alien species is an overarching matter in conservation communication. When it comes to charismatic species, ethical questions also arise (McNeely, 2001; Selge et al., 2011), and tackle conservation through their control is a very complex issue.

This project took place in Parque Regional del Sureste, in Madrid area, since this park is facing an invasion from a carnivore species which is considered cute and attractive, thus is highly demanded as a pet – the raccoon (*Procyon lotor*). The Park has a control program taking place since 2007, and one can imagine the challenging human dimensions associated with such a program. Therefore, the goal of this project was to learn from the Parque Regional del Sureste team's experience on how to tackle conservation and communication issues with respect to invasive species control, and combine the gathered knowledge and shared experiences in order to build a conservation framework tackling the communication on invasive species.

Fig. 1. Effective communication on invasive species – a long way to go.

3. Parque Regional Sureste

3.1. General description

Parque Regional del Sureste, which translates as "Southeast Regional Park", is a Spanish regional park located 20 km southeast of the Community of Madrid (Fig.7). The geographical location is obviously behind the park's name, which actually is "Parque Regional en torno a los ejes de los cursos bajos de los ríos Manzanares y Jarama" (*Regional Park around the axes of the lower courses of rivers Manzanares y Jarama*) in its complete form.

The Park was created in 2004 (under Law 6/1994) in order to promote the sustainable and orderly public use of the area, including education, cultural and leisure activities. A first estimate made in 2013 (PRS, 2014) indicates it is visited by roughly 700 000 people a year, mostly in Spring and Autumn, when temperatures are more pleasant. The area presents Mediterranean **climate**; the average annual temperature is around 14ºC, with summer averages from 22 to 25ºC – but easily reaching over 42ºC, and winter average temperature is close to 6ºC. The average annual rainfall lies between 440 and 490 mm

The Park is functionally built around the rivers Henares, Manzanares, Tajuña and Jarama and occupies 31 550 hectares, including territories from 16 townships, being inhabited by over 600 000 individuals, which represent about 11% of the total population of the community of Madrid (PRS, 2015). The **human pressure** is thus highly pronounced, and many environmentally impacting activities, such as intensive agriculture, mining, quarrying, and industry, take place within the Park. In fact, the Park was legally established in order to prevent the degradation generated by such activities, regulate the exploitation of natural resources, and protect the unique conservation values of the region.

A general overview to the Park's **landscape** straightforwardly reveals greatly contrasting scenarios (Fig.2), comprising from wholly industrial or residential areas to fragile cliffs or wetland ecosystems. It is actually fascinating how "heavy" artificial structures coexist with astonishing natural elements without jeopardizing the resilience or beauty of the latter. The complexity of the Park itself is worth a visit, and understandably poses a constant management challenge.

Fig. 2. Contrasting landscape features in Parque Regional de Sureste.

The Park is highly heterogeneous, and several landscape units can be delimited. The northern part is more severely marked by human activity, but in general the Park is crossed by infrastructures such as the highway A-3 (Madrid-Valencia), local and county roads, major highways (M-45, M-50, R-3 and high-speed railway line Madrid-Barcelona), electricity distribution lines of high tension (PRS, 2015), urbanizations, villages, industrial areas, quarries, etc. Notwithstanding, attending to the proximity to a major capital city, natural elements are surprisingly diverse, linger, frame the landscape and remain the most impressive features.

The complex and differentiated areas within the Park led to a concomitant management plan, which classified the territory according to its biotopes, characteristics, land use, and conservation status. As a result, the Park was divided into seven Zones (Fig.8), with different management requirements:

- Zone A: integral reserve;
- Zone B: nature reserve;
- Zone C: degraded to regenerate;
- Zone D: orderly exploitation of natural resources;
- Zone E: agricultural, forestry, recreational, educational and/ or environmental equipment and/ or special uses destination;
- Zone F: peripheral zone of protection;
- Zone G: to order by urban planning.
-

3.2. Natural values

The Park is included in the **Natura 2000** network, Site of Community Importance "Vegas, Cuestas y Páramos de Sureste de Madrid" (ES3110006), which includes two Special Protection Areas for Birds, "Carrizales y Sotos de Aranjuez" and "Cortados y Cantiles de los ríos Jarama y Manzanares". This last SPA basically coincides with Parque Regional del Sureste, and represents 62% of the Site's area (Consejería de Medio Ambiente y Ordenación del Territorio, 2005). The Site includes 19 natural habitats and 21 species listed in the Annexes I and II of the Habitats Directive 92/43/CEE.

Thus, the natural values of the Park comprise unique geological, botanical and faunal assets. The **geological** landscape is dominated by great masses of gypsum elevated by tectonic and eroded by water courses over millennia, and marl soils.

Flora and vegetation are rich and distributed in a complex mosaic (Fig.9) of gradations and transitions that include the following compositions (adapted from Consejería de Medio Ambiente y Ordenación del Territorio, 2005):

- Broadleaf deciduous and marcescent forest.
  Deciduous vegetation mostly occurs on the banks of the Jarama river courses and tributaries. The riparian communities comprise species such as *Salix* spp., *Populus alba*, *Fraxinus angustifolia, and Ulmus minor. Quercus faginea* is the principal marcescent species, which in some places forms pure stands, but usually is accompanied by typically Mediterranean species such as *Cistus ladanifer*, *Lavandula officinalis*, *Rosa micrantha*, *Rosa puzinii*, *Rosa canina*, or *Crataegus monogyna*, among others.

- Evergreen hardwoods

  Wich includes species such as *Quercus faginea*, *Juniperus oxycedrus*, *Phillyrea angustifolia*, *Pistacia terebinthus*, *Quercus coccifera*, *Acer monspessulanum, Quercus suber, Pyrus bourgeana, Lonicera etrusca, Rubia peregrine*, among other.

- Pinewoods

  The pine forests were mostly planted in the second half of the twentieth century, and include pine forests of Aleppo pine (*Pinus halepensis*), which occupy approximately 5.4% of the area, and forests of *Pinus pinea* which occupies around 1% of the area.

- Croplands

  Occupy at least half of the area of the Park. The most common crops are maize, olive trees, vineyard and cereals, which are regularly colonized by species such as *Papaver rhoeas, Papaver somniferum, Hordeum murinum, Onopordum nervosum, Marrubium vulgare, Eruca vesicaria, Cynoglossum cheirifolium*.

- Shrubland

  Occupy approximately 23% of the area of the Park and are considerably diverse, including species such as *Rosmarinus officinalis*, *Cistus clusii*, *Thymus vulgaris*, *Teucrium polium subsp. Capitatum, Thymus masticina, Artemisia herba-alba*, *Ephedra nebrodensis* y *Ephedra distachia*, *Genista scorpius*, *Salvia lavandulifolia*, *Cistus salvifolius, Lavandula pedunculata, Cistus ladanifer, Retama sphaerocarpa, Quercus coccifera, Rosmarinus officinalis, Jasminum fruticans*), among others. It is also important to highlight *Limonium dichotomum*, *Juncus gerardii* and *Juncus acutus* which comprise the priority habitat '1510-Mediterranean salt steppes' from the Habitats Directive.

- Grassland

  Which include species such as *Stipa tenacissima, Elymus pungens, Brachypodium phoenicoides, Lygeum spartum*, *Hordeum marinum, Aeluropus littoralis, Puccinellia festuciformis*, distributed among different communities.

Fig. 3. Flora and vegetation details.

Such a diversity of flora, vegetation and habitats distributed on a mosaic of gypsum steppe, many aquatic environments of both running water and stagnant water, vertical cliffs, shrublands, croplands and woodlands naturally create numerous opportunities for wildlife. Parque Regional del Sureste is home to a diverse **fauna** from which we highlight the following species (adapted from Consejería de Medio Ambiente y Ordenación del Territorio, 2005):

- Invertebrates
  The Park is very rich in invertebrates, and includes hundreds of species of Lepidoptera (butterflies and moths), Diptera, Hymenoptera, Odonata, mantoidea, Hemiptera, Orthoptera, among others. We also underline the discovery of new species for science, such as the beetles (*Plagionotus marcorum*, *Cryptocephalus bahilloi* and *Tillus ibericus*), or the first record in the district of *Chlorophorus varius*, proving the richness of information yet to explore.

- Amphibians and reptiles
  Around ponds or moist areas several amphibian species breed. The mos characteristic species of the gypsum areas is *Pelodytes punctatus*. The reptile community includes *Timon lepidus*, *Psammodromus hispanicus*, *Natrix maura*, *Rhinechis scalaris*, *Mauremys leprosa*, *Tarentola mauritanica*, among others.

- Birds
  As in most natural or semi-natural areas, birds constitute the most diverse groups of vertebrates. The ornithological community of the Park includes steppe birds such *Otis tarda*, *Tetrax tetrax*, *Burhinus oecdinemus*, *Falco naumanni* and *Circus pygargus*. Open areas are habitat for *Galerida thecklae*, *Sylvia conspicillata*, *Galerida cristata*, *Calendar melanocorypha*, *Alauda arvensis*, *Alectoris rufa* and *Coturnix coturnix*. The cliffs' holes shelter the raptors *Falco peregrinus* and *Bubo bubo*, and also *Pyrrhocorax pyrrhocorax*, *Oenanthe leucura* and *Monticola solitarius*. In the river banks or in the riparian communities of ponds we can find *Alcedo athis*, *Ardea cinerea*, *Nycticorax nycticorax*, *Bubulcus ibis*, *Circus aeroginosus*, *Remiz pendulinus*, *Cettia cetti*. Waterfowl of the laggons include *Fulica atra*, *Gallinula chloropus*, *Anas platyrhynchos*, *Anas clypeata*, *Anas strepera*, *Aythya farina*, *Netta rufina*, *Aythya fuligula*, *Aythya nyroca*, and *Oxyura leucocephala*. Waders include *Himantopus himantopus*, *Tringa ochropus*, *Actitis hypoleuca*, *Charadrius dubius*, *Gallinago gallinago*, *Calidris* spp. More generalist species include *Asio otus*, *Hieraeetus pennatus*, *Buteo buteo*, *Accipiter gentilis*, *Erithacus rubecula*, *Fringilla coelebs*, *Parus major*, *Parus caeruleus*, *Saxicola torquata*, *Lanius senator*, *Lanius meridionalis*, *Columba palumbus*, *Columba livia*, *Columba oenas*, *Sturnus unicolor*, *Carduelis carduelis*, *Hirundo rustica*, *Delichon urbica*, *Passer monatnus*, and other passerine birds.

- Mammals
  The mammal community includes small mammals such as *Suncus etruscus*, *Apodemus sylvaticus, Mus musculus, Rattus norvegicus, Microtus spp.*; carnivores such as Vulpes vulpes, *Felis silvestris*, Genetta genetta, Martes foina; bats such as *Rhinolophus hipposideros* and *Pipistrelus pipistrelus*; rabbits *Oryctolagus cuniculus*, and the wild boar *Sus scrofa*.

Fig. 4. Fauna from the Park.

Unfortunately, the unique biotic and abiotic conditions of the Park are not only attractive to native fauna and flora, but is also allows the establishment of several exotic species, of which some end up gaining invasive behaviour, mostly due to the absence of a limiting factor (Richardson et al., 2000), such as a predator or a competitor.

WWF Spain carried out an environmental education campaign on **invasive species**, aimed at scholar communities in the Comunidad de Madrid. The didactic materials they distributed, besides a booklet with information, learning activities and exercises, also comprised a poster (available for download), which listed some examples of invasive species living in Madrid area (Fig.5), thus also occur/may occur in Parque Regional de Sureste.

Fig. 5. Poster of the WWF Spain environmental education campaign.

3.3. Environmental education

Parque Regional de Sureste comprises two environmental education centers, which are under the custody of the the Consejería de Medio Ambiente - Comunidad de Madrid:

- Environmental education centre "**El Campillo**"
  The Centre's surrounding is framed by the Campillo lagoon (result of an ancient gravel pit), the proximity to the Jarama river and the cliffs, that mark the landscape. Besides the flora and fauna typical of aquatic and riparian ecosystems, there are remarkable gypsum cliffs. The surrounding ecological, paleontological and archaeological resources testify the use of land by people since prehistoric times, which are pedagogically used to explain the changes and consequences that happened over time to define current practices and behaviours consistent with a sustainable development.

- Environmental education centre "**Caserío de Henares**"
  Caserio de Henares has an area of 194 ha and is located in the valley of the river Henares, in a suitable environment for activities based on knowledge of forest banks and the practice of agriculture – in the form of public produce gardens. In addition to the grove of the river and the abundant bird life, the remains of archaeological and paleontological and the Castle-Palace Soto de Aldovea locate near. Altogether, these places represent a natural setting within an area of intense human activity.

The two centers function as information, interpretation and education points of the Park and intend to:

- Promote interest, knowledge and understanding of the factors and environmental processes and their relation to economic and cultural systems.
- To facilitate understanding of environmental issues that affect their surroundings, relate to the rest of the planet and promote behaviours and capabilities aimed at its resolution.
- Promoting the motivation to participate actively and responsibly in environmental matters.
- To value the natural and cultural resources of South Park.
- Encourage habits and provide opportunities for use and enjoyment of the environment that are compatible with the conservation of those values.
- Encourage coordination among the local population needs, the expectations of visitors and the sustainable management of the Regional Park.
- Provide educational resources related to this protected area.

Both centers develop programs for the local population, education system and public.

In collaboration with the Ministry of Education, the Centers contribute to the training of teachers, who develop environmental education activities with their students in the field, for which they are provided with supporting documentation and a monitor.

All resources of the centers (trails, exhibitions, library, audiovisual contents, games, etc) are available to the general public. Available activities, campaigns and/or workshops are disclosed through a regular newsletter. Programs for the local population are different in each centre, as they are tailored in order to more specifically suit the characteristics and needs of their own target population, environment and resources.
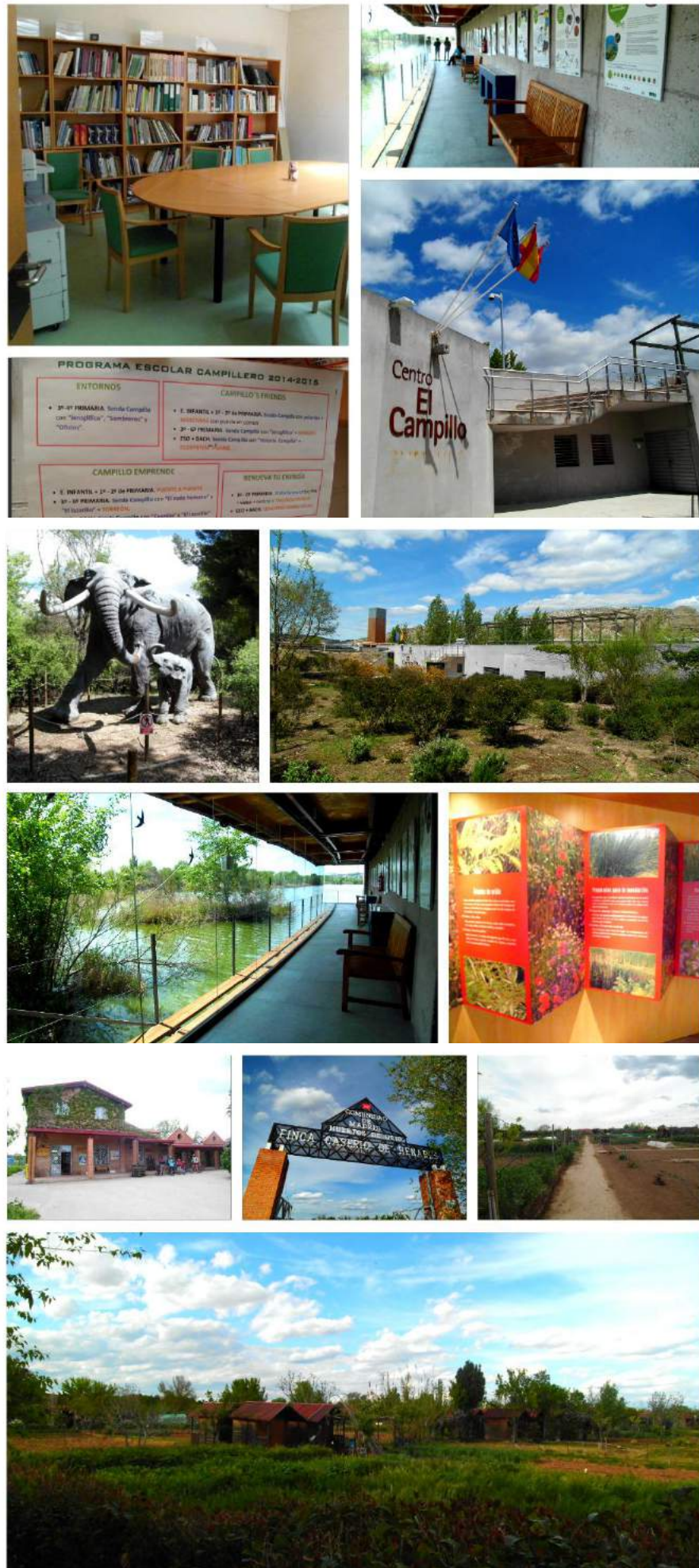
Fig. 6. Details of environmental education centres El Campillo and Caserio de Henares.
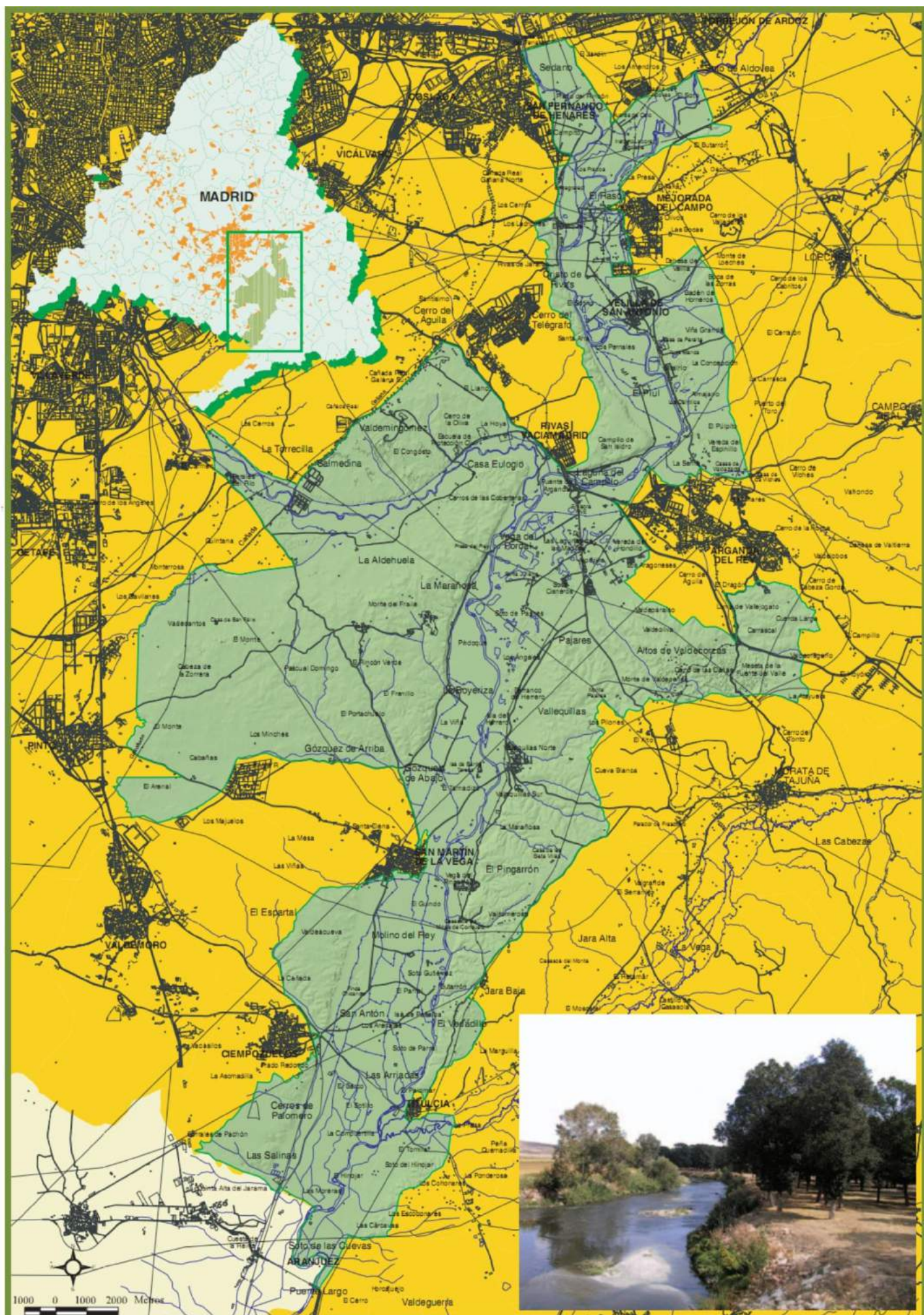
Fig. 7. Location of Parque Regional de Sureste in the Municipality of Madrid, Spain. Extracted from *Atlas Básico del Parque Regional del Sureste*. Consejería de Medio Ambiente y Ordenación del Territorio, Comunidad de Madrid. (2005)
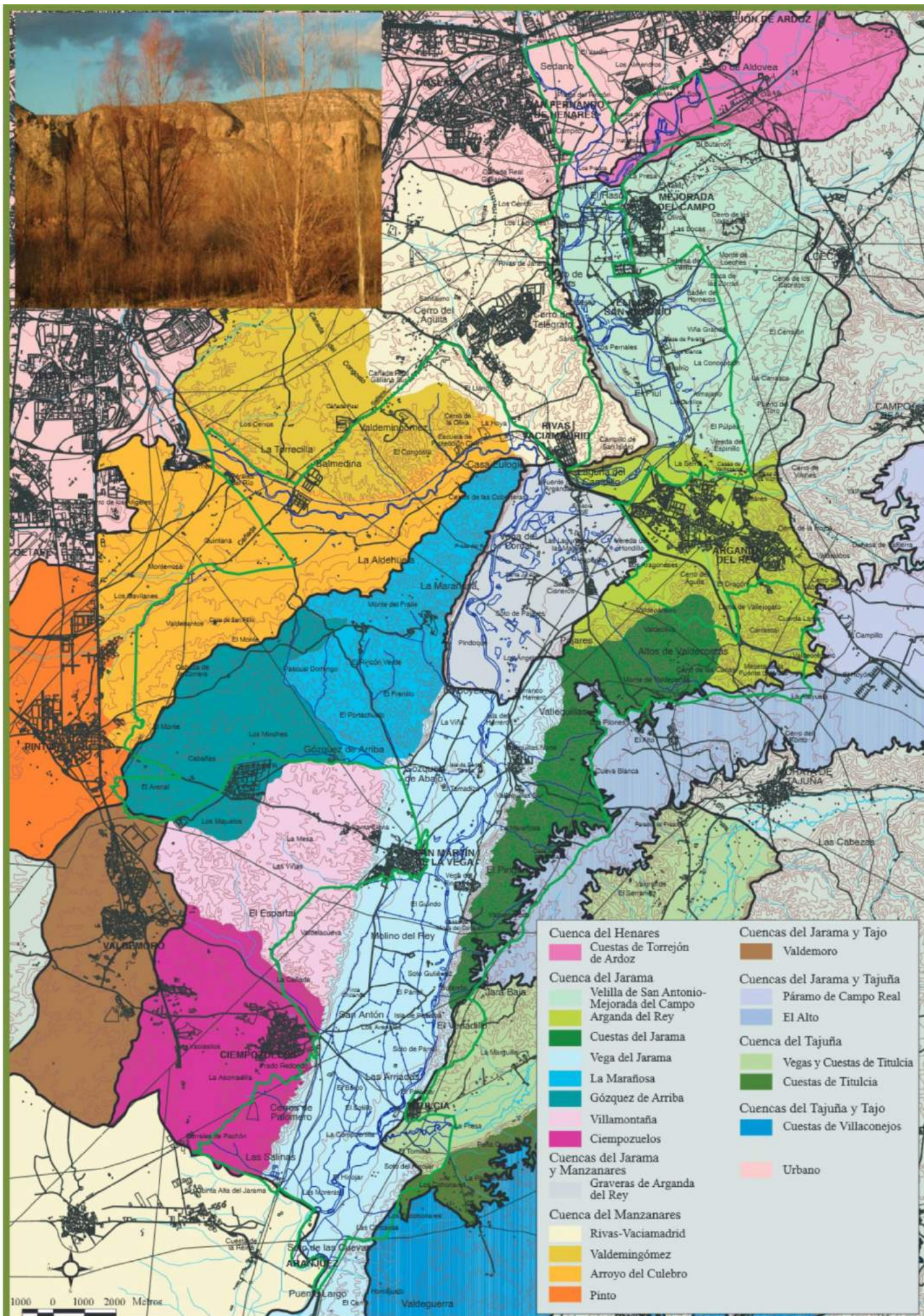
Fig. 8. Landscape units of Parque Regional de Sureste in the Municipality of Madrid, Spain. Extracted from *Atlas Básico del Parque Regional del Sureste*. Consejería de Medio Ambiente y Ordenación del Territorio, Comunidad de Madrid. (2005)
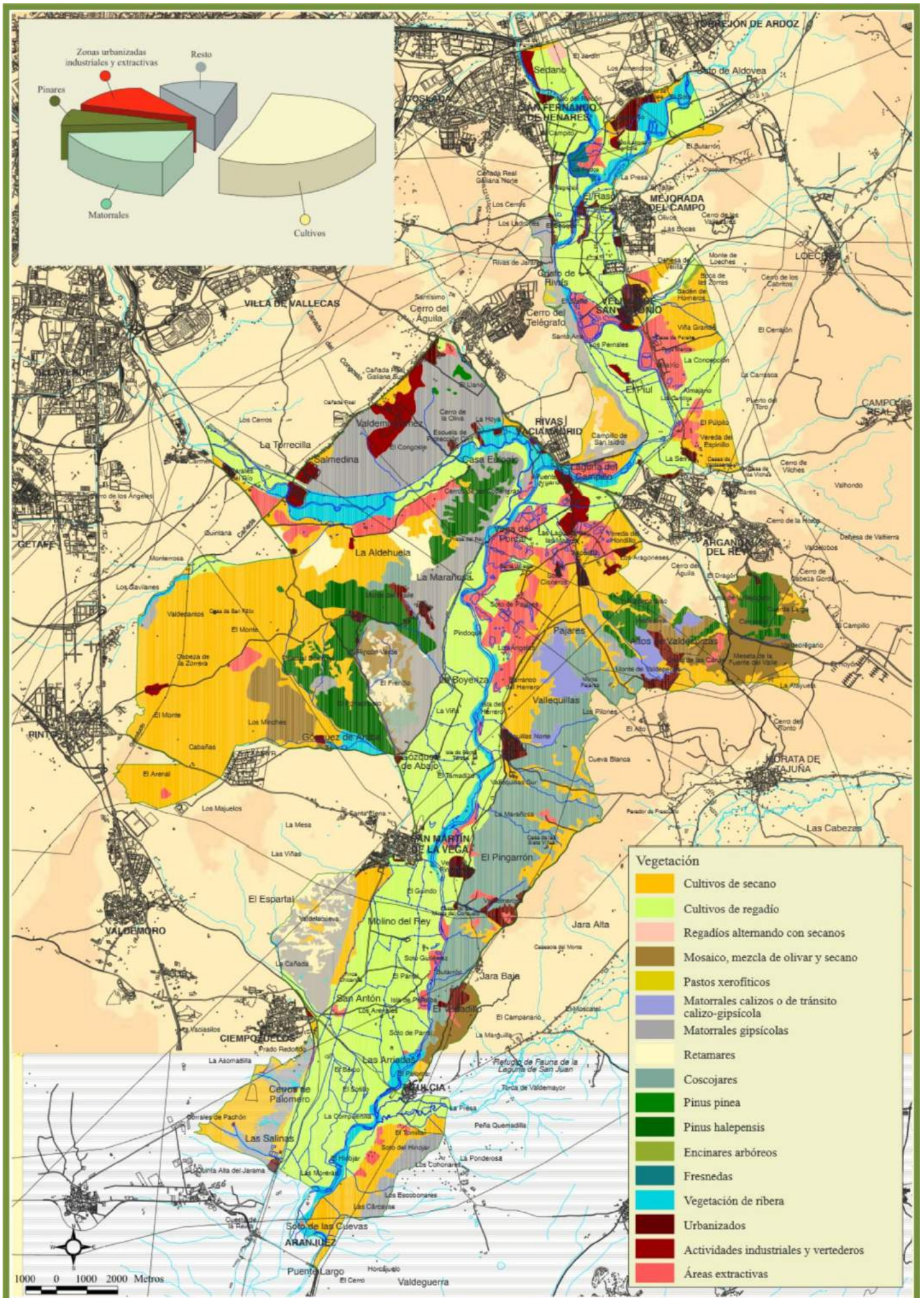
Leyenda del mapa (Vegetación):

- Cultivos de secano
- Cultivos de regadío
- Regadíos alternando con secanos
- Mosaico, mezcla de olivar y secano
- Pastos xerofíticos
- Matorrales calizos o de tránsito calizo-gipsícola
- Matorrales gipsícolas
- Retamares
- Coscojares
- Pinus pinea
- Pinus halepensis
- Encinares arbóreos
- Fresnedas
- Vegetación de ribera
- Urbanizados
- Actividades industriales y vertederos
- Áreas extractivas

Leyenda del gráfico circular:

- Zonas urbanizadas industriales y extractivas
- Resto
- Pinares
- Matorrales
- Cultivos

Fig. 9. Vegetation map of Parque Regional de Sureste in the Municipality of Madrid, Spain. Extracted from *Atlas Básico del Parque Regional del Sureste*. Consejería de Medio Ambiente y Ordenación del Territorio, Comunidad de Madrid. (2005)

4. The Study Visit

The study visit was divided in two parts. The first took place between the 18th April and the 1st May, and the second part between the 4th and the 11th October 2015.

The first days of the visit were dedicated to meet the Park staff, ask questions (so many questions!), and explore the environmental education centers, namely to know their working system, materials available, communication strategies and other elements that would help me get a comprehensive understanding of the functioning and dynamics of the Park. I was particularly interested in learning the communication universe around the invasive species theme. I was not disappointed, as the Park's own materials on invasive species and the WWF campaign were immediately noticeable. Under an attentive look, information on invasive species was widespread in flyers, poster and information panels (Fig.10). Besides, the centres' staff clearly answered whatever doubts visitors presented on the subject. I also found out that invasive species were the theme for regular workshops for scholars or general public. I could observe Parque Regional de Sureste is genuinely committed in generating awareness and disclosing valuable evidence-based information in order to promote good practice and prevention in what regards the introduction of exotic species.

After getting acquainted with the centres, the following days were spent with the staff, both in the offices and visiting the Park itself, learning on its heterogeneity, natural values, human pressure and resulting intricacies. The support of the staff members was outstanding every step of the way. As the Park is quite large, it took us several field trips/days to see all sections and habitats.

Some interesting facts:
- Some years ago, vehicles related to quarrying/mining activities accounted for 34% of the Park's traffic, at least in the southern part.
- The Park encompasses 87km of water courses.
- Roads or pathways allow the access to practically all areas of the Park, even the more sensitive ones.
- The vast majority (80%) of the Park is private owned.

It is easy to understand that human pressure and the management of water-related issues are two major challenges posed to the Park administration, and effective communication with the Park residents is key for achieving a healthy balance and human-nature coexistence. I was able to discuss the Park's communication actions with the staff, and as in the majority of protected areas throughout Europe, they recognize there is a need to improve the dialogue between the Park administration and stakeholders, residents, general public, visitors, etc, in order to achieve a more sound, sustainable and participated management.

Within communication-related aspects, I was particularly interested in understanding how the Park managers dealt with explaining the public the delicate issue of controlling a vertebrate species, and how the public responded.

Mass media (Fig.11) played an important role in disclosing messages the Park administrators carefully oriented, as it is indeed a difficult subject, which could easily be misinterpreted or negatively regarded in the public opinion.

The Park has also prepared several scientific reports in order to register and analyse their interventions, aid/support their decision-making, and share information with a more informed public and colleagues.

My quest for understanding the public perception of invasive species and assess their position on control programs proceeded with a **meeting** with representatives of the Consejería de Medio Ambiente y Ordenación del Territorio, the Ministry of Environment and Spatial Planning.

I had planned to address the public perception of the general public on the invasive species issue more in-depth, through surveys. A draft of the questionnaires was discussed and improved during the meeting, in which I was offered full support of the Ministry for delivering the surveys, for instance using the environmental education centres.

The staying at the Park resumed with the preparation of the final versions of the questionnaires, and with a thorough elucidation on the practicalities and conservation issues related to the raccoon control programme, which included accompanying an unsuccessful trapping campaign.

When finished, surveys were delivered to the Park staff for distribution in the centers. The next step was to also make surveys available online, in order to reach a potentially wider audience.

The first part of the visit ended with all surveys made available.

The second part of the visit was dedicated to gather the questionnaires that were filled during the previous months, transcribe the results of paper surveys into a digital database, and start organizing the data for statistical treatment and interpretation.

The division of field work/visits in such way granted a more adjusted time span for carrying out the surveys and allowed a more comprehensive desk research and preparation of materials.

Fig. 10. Examples of informative means in Parque Regional del Sureste.

Fig. 11. Examples of news on raccoon control by Parque Regional del Sureste.

Fig. 12. Pictures related to raccoon control in Parque Regional del Sureste.

5. Surveys

Questionnaires are one of the most commonly used methods in social sciences to collect data (Bachman and Schutt, 2014). This method allows asking several questions exactly the same way to different subjects, as if it were a standardized interview (Brace, 2008). The information collected is often quantitative and structured and, therefore, requires a simple and direct analysis (Cohen et al., 2010). In order to the information be credible, the survey must fulfil several requirements: (i) be clear in its overall goals and what one needs to ask to fulfil its purpose; (ii) thoroughly cover all topics to be included; (iii) use the most appropriate kind of questions; (iv) ask the questions in order to get the kind of information that is needed to answer the research problem; (v) request empirical data.

The surveys prepared for this project aimed at evaluating:
- The visitors' level of knowledge about alien invasive species;
- Their personal awareness and commitment towards nature conservation;
- Their understanding about conservation measures that are taking place in the Park;
- Their sensitivity towards ethical questions in the controlling of invasive species;
- Their willingness to receive more information about the Park's conservation and education actions.

The language and depth of the surveys were adjusted to the age of participants, thus two set of questionnaires were prepared: one for children (10-15 years old) and another for adults (16 years old or over).

The questionnaires were organized in four main sections:
- I. Respondents profile.
- II. Relationship with nature and outdoors.
- III. Awareness/concerns with nature conservation.
- IV. Perception of invasive species.
- V. Attitude towards invasive species control.

In order to reach a wider audience, questionnaires were made available in paper format and distributed to visitors in the environmental education centres of the Park; but were also published online, in three different languages: English, Portuguese, and Spanish. A dedicated website was built for the effect (Fig.13):

http://milenematos.wix.com/invasoras

A QR Code (Fig. 14) containing the link was also posted at the reception desk of the Centres, allowing swift online access. The link to the site was published on the Centre's social media, and also in my own channels. The objective was to reach a diversified audience from Spain and Portugal, ideally representative of the general public of the Iberian Peninsula. Questionnaires were available for five months.

Hopefully, results will diagnose what is and what isn't working in nature conservation communication, allowing to draw communication guidelines that better suit the public interests and needs and to help park managers to better engage their visitors with their daily work. Finally, results should also let perceiving what the public knows about invasive species and how they face the need of their control of charismatic, in order to provide guidance to the best ways to inform the public on those matters.

Fig. 13. Questionnaires available online.

Fig. 14. QR Code linking to the questionnaires available online and pictures of the species mentioned in the questionnaire.

5.1. Survey for children

Percepción pública
sobre las especies invasoras

SP Escolares

- -
Tu perfil

1. Edad *(Señala con una x en el recuadro correspondiente)*
☐ 10 – 11 años (Tercer ciclo de E. Primaria)
☐ 12 – 15 años (E.S.O.)

2. Zona de residencia
Pueblo/región   País

3. Relación con la naturaleza y al aire libre *Puntúa de 1 (nada) a 5 (mucho)*

	1	2	3	4	5
¿Con qué frecuencia sales al campo para jugar, caminar, etc.?	☐	☐	☐	☐	☐
¿Con qué frecuencia visitas parques naturales?	☐	☐	☐	☐	☐
¿Cómo calificarías tu preocupación por la conservación de la naturaleza?	☐	☐	☐	☐	☐

- -
Valores naturales y su conservación

4. ¿Puedes nombrar algunas PLANTAS que son típicas en la zona donde vives? _____

5. ¿Puedes nombrar algunos ANIMALES que son típicos en la zona donde vives? _____

6. ¿Hay algún animal o planta IMPORTANTE (de especial valor) en la zona donde vives? Sí ☐ No ☐
¿Por qué es importante? _____

7. ¿Hay algún animal o planta que NO TE GUSTA en la zona donde vives? Sí ☐ No ☐
¿Por qué no te gusta? _____

8. ¿Puedes señalar algunos problemas de la naturaleza en la zona donde vives?

9. ¿Sabes qué es una especie invasora? *(Explícalo)* _____

_____

_____

10. ¿Has oído hablar de especies invasoras? Sí ☐ No ☐

¿Dónde has oído hablar de ellas? *(Señala con x)*
☐ TV / Radio
☐ Periódicos / Revistas
☐ Redes sociales (Facebook, Twitter ...)
☐ Internet (sítios web, blogs ...)
☐ Entre amigos o familiares
☐ Paneles informativos o folletos
☐ Colegio / Instituto
☐ Otros _____

11. ¿Sabes alguna forma de introducir especies exóticas en el medio ambiente?

_____

_____

12. ¿Puedes identificar alguna especie invasora en la siguiente lista?

FLORA
☐ Jara
☐ Mimosa
☐ Caña común
☐ Álamo blanco
☐ Hierba de la Pampa
☐ Ailanto o árbol del cielo

FAUNA
☐ Gineta
☐ Garza real
☐ Mapache
☐ Martín-pescador
☐ Galápago de Florida
☐ Cotorra argentina

13. ¿Cómo calificarías los siguientes efectos de las especies invasoras?

(Puntúa de -5 a 5: -5 efectos muy negativos; 0 neutro; 5 efectos muy positivos)

	Negativos				Neutros					Positivos
	-5	-4	-3	-2	-1	0	1	2	3	4	5
Sobre la naturaleza (animales y plantas)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sobre el medio ambiente (agua, suelo, clima...)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sobre la agricultura	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sobre la vida cotidiana de las personas	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Control de especies invasoras

14. ¿Crees que la naturaleza necesita la ayuda humana con respecto a las especies invasoras?

Pontúa de 1 (no) a 5 (sí, mucho)   1   2   3   4   5
☐ ☐ ☐ ☐ ☐

15. ¿Conoces algún programa de control de especies invasoras que tenga lugar en la zona donde vives?

Sí ☐ No ☐ **¿Puedes nombrarlo o describirlo?** _____

_____

16. ¿Te gustaría participar en un programa de protección de la naturaleza?

Pontúa de 1 (no) a 5 (sí, mucho)   1   2   3   4   5
☐ ☐ ☐ ☐ ☐

Tu opinión es muy importante para nosotros.
¡Gracias por contestar esta encuesta!

Percepción pública sobre las especies invasoras

SP Adultos

Ayúdanos a entender cómo podemos mejorar nuestra comunicación sobre conservación de la naturaleza y las especies invasoras.

Tu opinión es muy importante para nosotros!

- -

Tu perfil

Edad
- ☐ 16 – 20 años
- ☐ 21 – 30 años
- ☐ 31 – 45 años
- ☐ 45 – 60 años
- ☐ > 61 años

Educación
- ☐ Educación primaria
- ☐ Educación secundaria (graduado o formación profesional)
- ☐ Bachillerato
- ☐ Diplomado (grado)
- ☐ Licenciado (máster)
- ☐ Doctorado o más

Profesión o área de formación

_____

Zona de residencia
Pueblo/región   País

_____

Has visitado el Parque Regional del Sureste (Madrid)?
- ☐ Si
- ☐ No   En caso afirmativo, ¿cuántas veces?

- ☐ 1 – 5
- ☐ 6 – 10
- ☐ > 10

- -

Relación con la naturaleza y al aire libre

Califica de 1 (nada) a 5 (mucho)

	1	2	3	4	5
¿Con qué frecuencia vas al aire libre para caminar, senderismo, visitas turísticas, etc.?	☐	☐	☐	☐	☐
¿Con qué frecuencia visitas áreas protegidas o parques naturales?	☐	☐	☐	☐	☐
¿Cómo calificarias tu compromiso con la conservación de la naturaleza?	☐	☐	☐	☐	☐
¿Cómo calificarias tu conciencia sobre los problemas de conservación de la naturaleza?	☐	☐	☐	☐	☐

- -

Valores naturales y su conservación

¿Puedes nombrar algunas PLANTAS silvestres que son típicas en tu zona de residencia?

_____

_____

¿Puedes nombrar algunos ANIMALES silvestres que son típicos en tu zona de residencia?

_____

_____

¿Hay un animal o una planta IMPORTANTE en tu área de residencia? Si☐ No☐
En caso afirmativo, por qué es importante? _____
_____

¿Hay alguna especie que no te gusta en tu área de residencia? Si☐ No☐
En caso afirmativo, por qué no te gusta? _____
_____

¿Puedes señalar algunas amenazas para la conservación de la naturaleza en tu área de residencia?
_____
_____

¿Si has visitado el Parque Regional del Sureste, puedes señalar algunas amenazas a sus valores naturales? _____
_____

- -
Especies invasoras

¿Puedes explicar la diferencia entre una especie nativa y una especie exótica?
_____
_____

¿Has oído hablar de especies invasoras? Si☐ No☐
En caso afirmativo, dónde has oído hablar de ellas? ☐ TV / Radio
☐ Periódicos / Revistas
☐ Redes sociales (Facebook, Twitter ...)
☐ Internet (sitios web, blogs ...)
☐ Entre colegas, amigos o familiares
☐ Paneles informativos o folletos
☐ Evento público
☐ Otros_____

¿Puedes nombrar alguna forma de introducir especies exóticas en el medio ambiente?
_____
_____

¿Puedes identificar alguna especie invasora en la siguiente lista?

FLORA

Coscoja (*Quercus coccifera*) ☐	Jara (*Cistus* spp.) ☐	Acacia, mimosa (*Acacia* spp.) ☐	Caña (*Arundo donax*) ☐
Álamo blanco (*Populus alba*) ☐	Hierba de la Pampa (*Cortaderia selloana*) ☐	Ailanto (*Ailanthus altissima*) ☐	Pino silvestre (*Pinus sylvestris*) ☐

FAUNA

Perca sol (*Lepomis gibbosus*) ☐	Gineta (*Genetta genetta*) ☐	Garza real (*Ardea cinerea*) ☐	Mapache (*Procyon lotor*) ☐
Martín-pescador (*Alcedo atthis*) ☐	Culebra de collar (*Natrix natrix*) ☐	Galápago de Florida (*Trachemys scripta*) ☐	Cotorra argentina (*Myiopsitta monachus*) ☐

¿Cómo calificarías los siguientes efectos de las especies invasoras?
-5 efectos altamente negativos; 0 neutro; 5 efectos altamente positivos

	Negativo				Neutro				Positivo	
	-5	-4	-3	-2	-1	0	1	2	3	4	5
Biodiversidad (especies y hábitats)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Servicios de los ecosistemas (agua limpia, suelo fértil, control de la erosión, etc.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cambio climático	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Agricultura, forestal y pesca	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Estética del paisaje / usos ornamentales	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Economía	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Salud pública	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Valores históricos o culturales	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

¿A cuánto crees que ascienden las pérdidas económicas que ocasionan las especies invasoras en Europa, por año?

120 000 € ☐
12 000 000 € ☐
12 000 000 000 € ☐

4
Control de especies invasoras

¿Crees que la naturaleza necesita la intervención humana con respecto a las especies invasoras?

Califica de 1 (no) a 5 (sí, mucho)   1 2 3 4 5
☐ ☐ ☐ ☐ ☐

¿Estás de acuerdo con la aplicación de programas de control de especies invasoras por las entidades locales / regionales / nacionales competentes?

Califica de 1 (no) a 5 (sí, mucho)   1 2 3 4 5
☐ ☐ ☐ ☐ ☐

¿Conoces algún programa de control de especies invasoras que tiene lugar en tu área de residencia?

Sí☐ No☐ En caso afirmativo, puedes nombrar o describirlo? _____

_____

¿Te parece bien que se eliminen las PLANTAS invasoras?

Sí☐ No☐ Por qué? _____

_____

¿Te parece bien que se eliminen los ANIMALES invasores?

Sí☐ No☐ Por qué? _____

_____

Te gustaría sugerir alternativas para el control de los animales invasores por eliminación?

_____

_____

¿Te gustaría recibir las conclusiones de este estudio? Sí☐ No☐

¿Te gustaría recibir más información de las especies invasoras? Sí☐ No☐

¿Te gustaría recibir actualizaciones sobre las actividades de conservación y educación en el Parque Regional del Sureste? Sí☐ No☐

En caso afirmativo, indique su dirección de correo electrónico. _____

Milene Matos – Universidade de Aveiro, Portugal
Parque Regional del Sureste, España
EUROPARC Federation
Alfred Toepfer Foundation

Tu opinión es muy importante para nosotros.
Gracias por contestar esta encuesta!

6. Results

6.1. Respondents' profile

We obtained a total of 409 responses to the surveys (Table 1), the majority (77%) from Spain and in paper format (70%), meaning most surveys were filled in the Environmental Education Centers from the Park.

Table 1. Distribution of the responses to the survey according to country of respondent, age category and survey format type.

Country	Category	Nr. Surveys	Country	Type	Nr. Surveys
SP	Adults	198	SP	Online	22
	Children	112		Paper	288
PT	Adults	95	PT	Online	99
	Children	4		Paper	0
	Total	**409**		**Total**	**409**

Most respondents were children 12 to 15 years old (26%; n=105) and adults 31 to 45 years old (25%; n=104) (Fig.15).
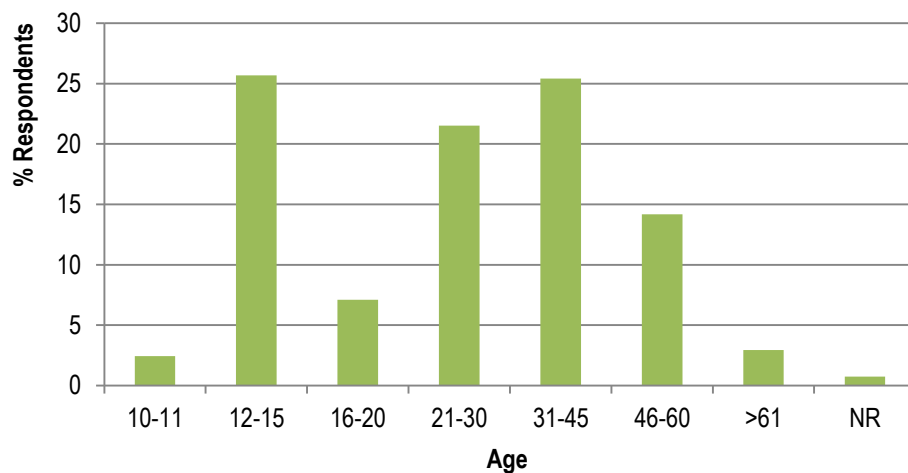
Fig. 15. Ages of survey respondents.

Most adult respondents were highly educated, with a master degree (36%, n=106). Over 95% of the adult respondents had at least received secondary education (Fig. 16). The educational level of the adult respondents did not differ between nationalities (F=0.066; P=0.789).
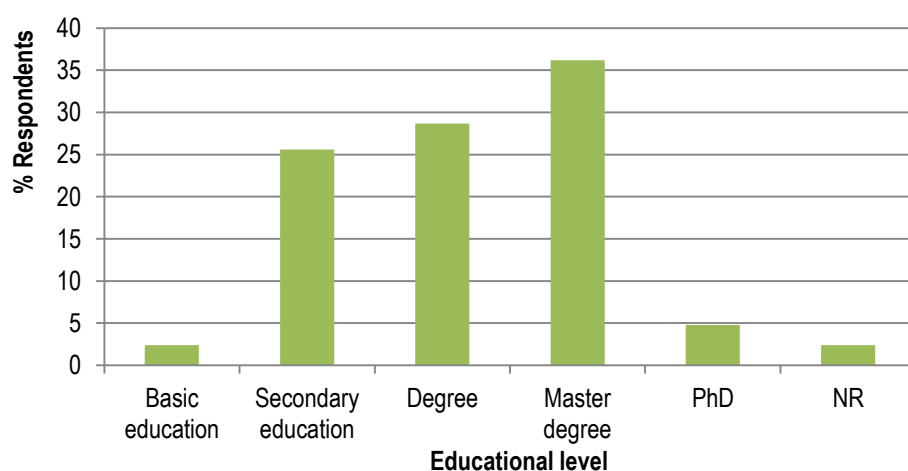
Fig. 16. Education level of the adult survey respondents.

Training or occupational fields of the adult respondents were very diverse, but most respondents were trained in life or environmental sciences (19%, n=56) and education (12%, n=34) (Fig. 17). Each country's set of respondents did not equally distribute among occupational fields (χ^2 = 41.772, p = 0.000).
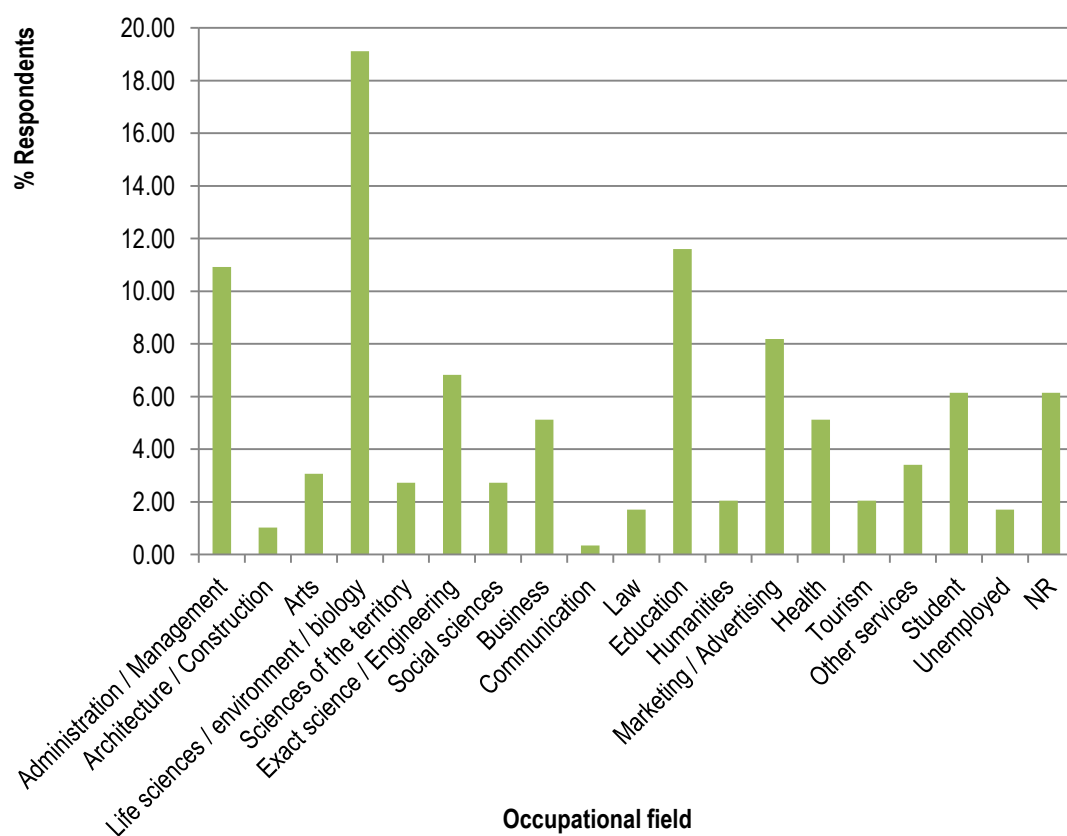
Fig. 17. Occupational field/Occupation of the adult respondents.

Approximately half of the adult respondents (n=146) answered they had not visited the Park yet. 177 Spanish respondents took the survey in paper format, thus, in the Environmental Education Centres of the Park. However, 47 of these respondents (26%) claimed they had not visited the Park yet, demonstrating they did not know they were in the Park when filling out the survey.

Among the respondents that answered they had visited the Park, 60% (n=87) had been there between 1 and 5 times; 10% (n=15) visited between 6 and 10 times; and 30% (n=44) visited over 10 times.

On average, adults showed a significantly greater (F=120.073; P=0.000) engagement towards nature, significantly doing more outdoors activities, visiting more protected areas or natural parks, and considering themselves more concerned with environmental issues than children (Fig. 18).
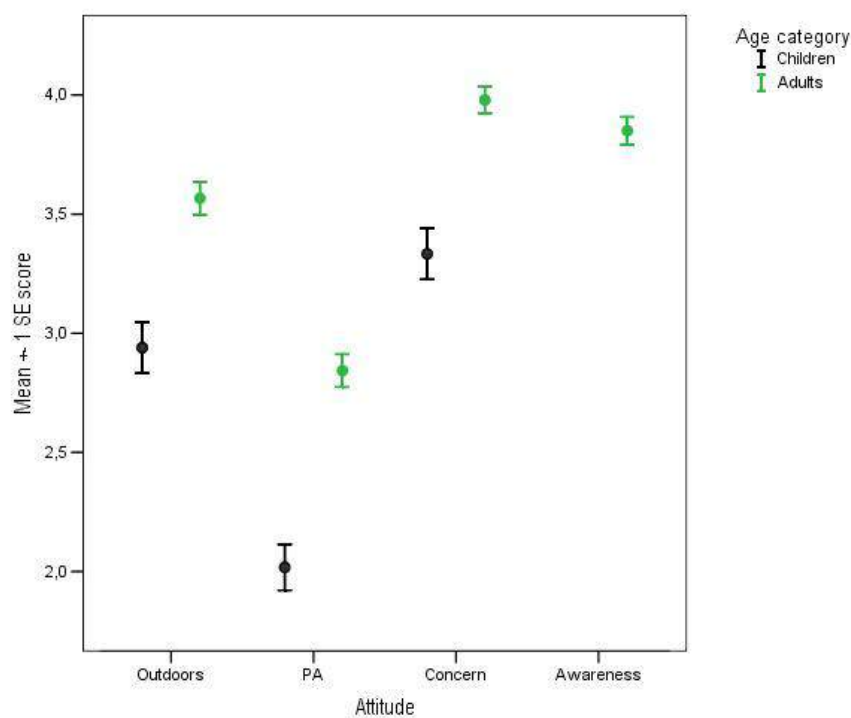
Fig. 18. Mean and standard error of the attitudes/behaviours of adult respondents: outdoors activities practice (Outdoors), visits to protected areas and natural parks (PA), concern with environmental issues (Concern), and awareness towards environmental problems (Awareness). Scores were attributed in a scale from 1 to 5.

6.2. Practice of outdoor activities

The majority of respondents – both adults and children - answered they practiced outdoor activities such as trekking on a regular basis or very frequently. In a scale from 1 to 5, most adults answered 3, 4 or 5, and most children 3 or 4 (Fig. 19). Among adults, the practice of outdoor activities presented significant differences according to the **occupational field** (F=5.162; P=0.000). The groups that less frequently seek the outdoors were architects/constructors, marketeers/advertisers. Tukey post–hoc tests proved there were significant differences between pairwise comparisons, namely between professionals working on life or environmental sciences and professionals working on architecture/construction or marketeers/advertisers, with the former going more outdoors. Also, and for instance, education professionals seek the outdoors significantly more than marketeers/advertisers. In fact, the groups that less frequently seek the outdoors were architects/constructors, and marketeers/advertisers. Landscape/territory professionals such as geographers or land planners were the group that most frequently seek the outdoors, followed by unemployed and health professionals.

The practice of outdoor activities also presented significant differences according to the adult respondents' **nationality** (F=20.986; P=0.000), with Portuguese respondents (4.01±1.05) practicing outdoor activities more frequently than Spanish respondents (3.35±1.19)
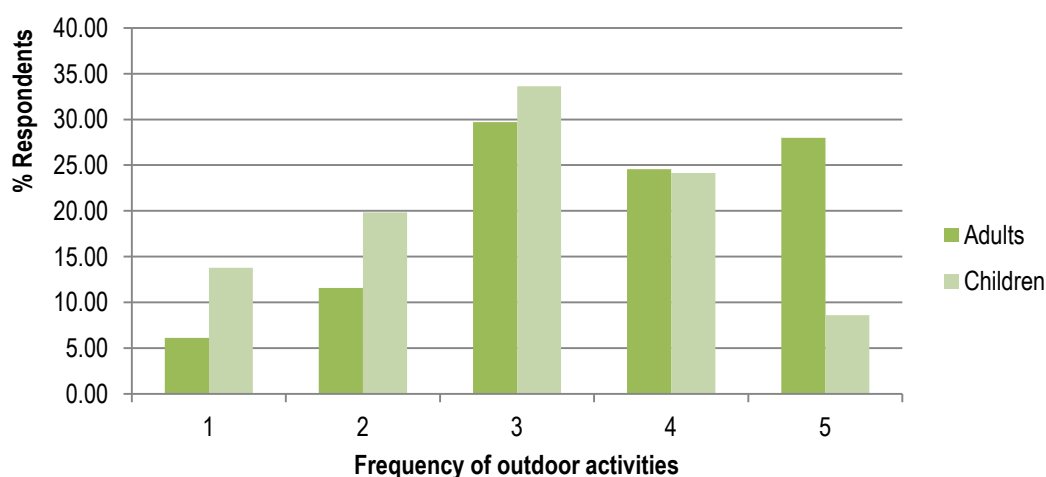
Fig. 19. Self-evaluation of the frequency of practicing outdoor activities, by age category.

6.3. Visits to Protected Areas or Natural Parks

Adults and children showed different patterns in what concerns visiting protected areas or natural parks. In general, in a scale of 1 to 5, most adults visit protected areas with a frequency of 1 or 2; and most children visit protected areas with a much lower frequency (38.79% answered score 1) (Fig. 20). Among adults, visits to protect areas or parks presented significant differences according to their **occupational field** (F=5.188; P=0.000). Again, the groups that less frequently visit protected areas were architects/constructors, and marketeers/advertisers. Landscape/territory (e.g. geographers, land planners) and life sciences (e.g. biologists or environmental engineers) professionals were the groups that most frequently visit protected areas. Tukey post–hoc tests proved there were significant differences between pairwise comparisons, namely between professionals working on life or environmental sciences and professionals working on business, administration, management, marketing or advertising. Also, and again, education professionals visit protected areas significantly more often than marketeers/advertisers.

The pattern of visits to protected areas also presented significant differences according to the adult respondents' **nationality** (F=16.021; P=0.000), with Portuguese respondents (2.66±1.21) visiting protected areas more frequently than Spanish respondents (3.23±1.03).
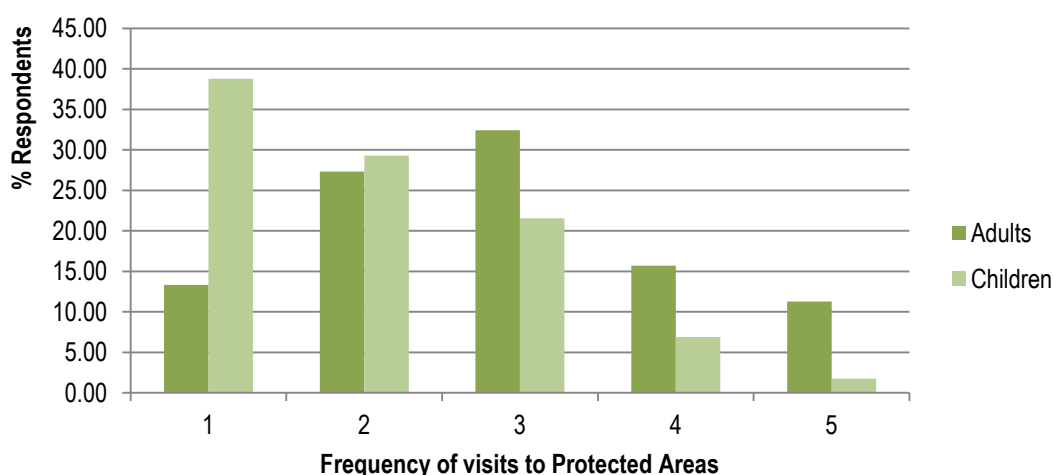
Fig. 20. Self-evaluation of the frequency of visits to protected areas, by age category.

6.4. Concern with environmental issues

Both adult and children respondents showed a considerable concern with environmental issues, with most adult responding 4 or 5, in a scale from 1 to 5 (Fig.21). Among adults, concern with environmental issues presented significant differences according to their **occupational field** (F=5.209; P=0.000). The professional groups that present greater concerns with the environment are life sciences professionals, artists, and educators. The group with the lowest concern level was architects/constructors. Tukey post–hoc tests proved there were significant differences between pairwise comparisons, namely between professionals working on life or environmental sciences and administrators/managers, architects/constructors, business people, students and marketeers/advertisers. Also, for instance, education professionals presented a significantly higher level of concern towards environmental issues than architects/constructors and marketeers/advertisers.

The concern with environmental issues also presented significant differences according to the adult respondents' **nationality** (F=14.334; P=0.000), with Portuguese respondents (4.28±0.75) showing higher levels of concern than Spanish respondents (3.84±0.99).

Fig. 21. Self-evaluation of the level of concern with environmental issues, by age category.

6.5. Commitment towards nature protection

Regarding the respondents' commitment towards nature protection, most adults (37.20%) attributed a score of 4, in a scale from 1 to 5 (Fig. 22). These concerns presented significant differences according to the **occupational field** of the respondents (F=4.315; P=0.000). The groups that presented greater commitment towards nature protection were professionals of territory sciences such as geographers and land planners, and artists, opposing to architects/constructors and marketeers/advertisers, who presented the lowest levels of commitment.

Tukey post–hoc tests proved there were significant differences between pairwise comparisons, namely between professionals working on life or environmental sciences and students. Also, for instance, education professionals presented a significantly higher level of commitment towards nature conservation than marketeers/advertisers.

The concern with environmental issues also presented significant differences according to the adult respondents' **nationality** (F=14.334; P=0.000), with Portuguese respondents (4.28±0.75) showing higher levels of concern than Spanish respondents (3.84±0.99).

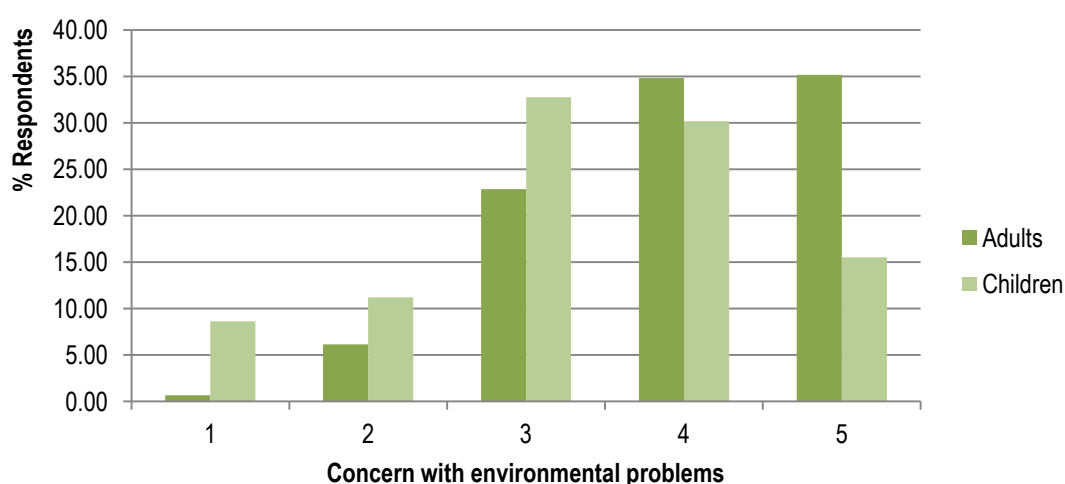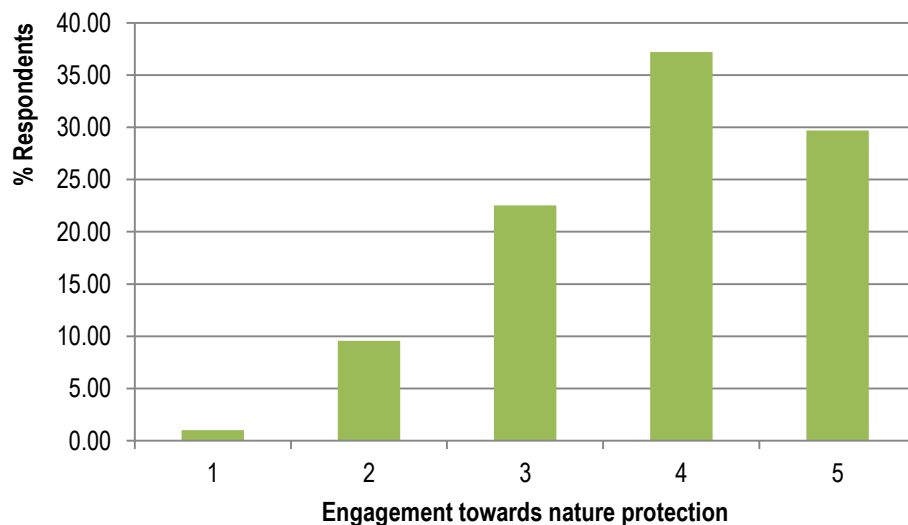**Fig. 22.** Adult respondents' self-evaluation on the level of commitment towards nature protection.

6.6. Perception of natural values

When asked if they could name some wild species typical in their area of residence, most respondents actually provided correct answers, despite a considerable number of domestic species (e.g. fruit trees, vegetables, cats and dogs) being mentioned. Table 2 displays the 15 most frequently mentioned plant and animal species by adults and children. Curiously, both for plants and animals, 10 top-mentioned species were the same for adults and children respondents (highlighted in bold in the table).

Table 2. Most frequently mentioned "typical wild plant and animal species". Bold formatting indicates species that were most commonly mentioned both by adults and children.

PLANTS				ANIMALS			
Adults		**Children**		**Adults**		**Children**	
Species	**%Respondents**	**Species**	**%Respondents**	**Species**	**%Respondents**	**Species**	**%Respondents**
Pine trees	23.21	**Pine trees**	54.31	**Rabbit**	32.08	**Pigeon**	37.07
Thyme	11.60	Olive tree	36.21	**Fox**	19.45	**Rabbit**	31.03
Oak trees	10.92	Rose	19.83	**Stork**	15.02	Dog	26.72
Holly oak	10.58	**Rosemary**	18.10	**Sparrow**	12.63	**Squirrel**	25.00
Gum rockrose	10.58	**Lavender**	12.07	**Pigeon**	10.92	**Cat**	24.14
Poplar	10.24	**Holly oak**	11.21	**Magpie**	8.87	Bird	18.97
Rosemary	9.22	**Cardoon**	9.48	**Hare**	8.53	Bull	11.21
Poppy	8.87	Wild blackberry	7.76	Wild boar	8.53	**Stork**	10.34
Broom	7.85	**Daisy**	7.76	Goshawk	7.51	**Lizard**	10.34
Cardoon	7.85	Plane-tree	7.76	Duck	7.17	**Fox**	9.48
Elm	6.14	**Thyme**	6.90	Blackbird	6.83	**Sparrow**	9.48
Lavender	5.12	**Oak trees**	6.03	**Cat**	6.14	Ants	8.62
Strawberry tree	5.12	Almond	6.03	Mouse	6.14	**Hare**	7.76
Daisy	4.78	**Poppy**	5.17	**Lizard**	5.80	**Magpie**	7.76
Thorn trees	4.10	**Thorn trees**	5.17	**Squirrel**	4.78	Snake	7.76

In the same question, a considerable number of respondents indicated exotic or even invasive species (e.g. *Acacia*) as being "typical" in their region (Table 3). In general, this trend was more evident in adults than children.

Table 3. Percentage of respondents who mentioned exotic or invasive species as being typical in their region.

		% Respondents	
		Adults	**Children**
Typical plants	*Acacia* sp.	4.44	6.03
	Eucalyptus sp.	3.75	0.86
	"Invasive"	0.34	0.00
Typical animals	Monk parakeet	3.07	1.72
	Raccoon	0.68	0.00

When asked if they knew any important species in their region, approximately half (52.22%; n=153) of the adults and about 70% (n=81) of the children responded there were none or they did not know any important species in their region. On the other hand, 5.80% (n=17) of the adults and 3.45% (n=4) of the children responded "all species are important for the environment".

The most common species considered "important" were amphibians, by adults, and birds of prey, both by adults and children (Table 4). A small proportion of adult respondents also mentioned exotic or highly invasive species (e.g. *Acacia* sp. and the monk parakeet) as important (the mention was in a positive way). The risk of extinction and the conservation status were the main criteria for considering a species important, both for adults and children (Table 4).

Table 4. Important species considered by the respondents and respective criteria for the importance. Values highlighted in bold indicate the most common answers.

		% Respondents	
		Adults	**Children**
Important species	Amphibians	**4.44**	0.00
	Birds of prey	**4.10**	**2.59**
	White stork	2.39	0.00
	Pine trees	1.71	0.00
	Holly oak	1.37	0.86
	Otter	1.37	0.00
Invasive or exotic species	Eucalyptus	**1.02**	0.00
	Acacia sp.	0.68	0.00
	"Invasive species"	0.68	0.00
	Monk parakeet	0.52	0.00
Criteria for importance	Extinction/ Risk/ Conservation	**5.12**	**8.62**
	Protected/ Rare/ Special	3.75	1.72
	Endemism	2.73	0.00
	Ecosystem balance	1.37	0.00
	Bioindicator	1.02	0.00

When asked if there was any species they did not like in their home area, about half of the respondents answered there was none (49.49%, n=145 adults; 56.03%, n=65 children). The most frequently mentioned species or concepts are presented in Table 5. For adults, "invasive species" were the most disliked species (12.29%; n=36). Adding the general concept of invasive species with specific species mentioned (*Acacia* sp., parakeets, raccoon, ailanthus and hottentot-fig), the invasive behaviour of a species was negatively acknowledged by 38.57% (n=113) adult respondents. For children, the most disliked species are related with dirtiness (e.g. pigeons), bites (e.g. insects, wasps, mosquitoes), and allergies.

Table 5. Most frequently mentioned species or concepts when replying to "is there a species you do not like?". Bold formatting indicates species or concepts that were most commonly mentioned both by adults and children.

ADULTS		CHILDREN	
Word	**%Respondents**	**Word**	**%Respondents**
Invasive	12.29	**Pigeon**	6.03
Acacia	9.90	Bites	6.03
Pigeon	8.53	Allergies	5.17
Parakeet	7.85	Insects	5.17
Eucalyptus	4.78	Wasps	4.31
Dirtiness	3.75	**Parakeet**	2.59
Raccoon	3.41	Cardoon	2.59
Ailanthus	2.73	Noise	2.59
Hottentot-fig	2.39	**Dirtiness**	2.59
Mosquitoes	1.71	Mosquitoes	2.59

6.7. Awareness about environmental threats

The survey asked if respondents could name any environmental threats taking place in their home area. A considerable proportion of respondents (n=57, 19.45% of adults; n=30, 25.86% of children) answered there were no threats in their home areas, or they did not know any. Nevertheless, the majority of respondents pointed out one or more threats. The most frequently mentioned threats (Table 6), both by adults and children, include pollution, garbage/waste, urbanisation/construction, traffic/roads and invasive species. Alien invasive species were mentioned as a general concept, but also as respondents named specific species. When pooling the general concept and the individual species altogether, invasive species become the second most common threat considered by adults and the fourth considered by children. A list of the individual invasive species mentioned by the respondents is presented in Table 7.

Table 6. Most frequently mentioned environmental threats. Bold formatting indicates threats that were most commonly mentioned both by adults and children.

ADULTS	
Threats	% Respondents
1 **Pollution**	26.96
2 **Invasive species** (total)	25.26
"Invasive species" - general concept	10.58
Specific invasive species	14.68
3 **Urbanisation / Construction**	16.04
4 **Garbage / Waste**	8.87
5 **Man**	7.17
6 **Traffic / Roads**	6.14
7 **Noise**	5.80
8 Industry / Factories	5.80
9 Deforestation	4.10
10 Eucalyptus	3.75
11 Agriculture	3.75
12 Poaching	2.73
13 **Forest fires**	2.05
14 Tourism	1.71
15 Landfills	1.37

CHILDREN	
Threats	% Respondents
1 **Pollution**	31.03
2 **Garbage / Waste**	24.14
3 **Man**	7.76
4 **Invasive species** (total)	3.45
"Invasive species" - general concept	2.59
Specific invasive species	0.86
5 **Traffic / Roads**	3.45
6 **Urbanisation / Construction**	2.59
7 Pollen	2.59
8 Drought	2.59
9 **Noise**	1.72
10 **Forest fires**	0.86

Table 7. Alien invasive species specifically mentioned by the respondents when listing environmental threats.

Common name	Latin name	% Respondents Adults	% Respondents Children
Thorn trees	*Acacia* sp.	8.81	0.00
Monk parakeet	*Myiopsitta monachus*	3.63	0.86
Raccoon	*Procyon lotor*	2.59	0.00
Red-eared slider	*Trachemys scripta elegans*	2.59	0.00
Ailanthus	*Ailanthus altissima*	1.04	0.00
Hottentot-fig	*Carpobrotus edulis*	1.04	0.00
Pampas grass	*Cortaderia selloana*	0.52	0.00
Asian hornet	*Vespa velutina*	0.52	0.00
Needlebush	*Hakea sericea*	0.52	0.00
Water hyacinth	*Eichhornia crassipes*	0.52	0.00
Small-leaf spiderwort	*Tradescantia fluminensis*	0.52	0.00

Adult respondents were also asked to name the major environmental threats they could identify inside the Parque Regional del Sureste. Results are presented in Table 8. Among the 146 adults respondents that have visited the park, invasive species are the most frequently mentioned threat - when pooling results for the general mention of invasive species and the identification of individual invasive species. The species specifically mentioned by respondents were the monk parakeet (*Myiopsitta monachus*), the raccoon (*Procyon lotor*), the red-eared slider (*Trachemys scripta elegans*), and thorn trees (*Acacia* sp.).

Table 8. Most frequently mentioned environmental threats inside the Parque Regional de Sureste.

	Threats	% Respondents
1	Invasive species (total)	20.55
2	"Invasive species" - general concept	10.27
3	Specific invasive species	10.27
4	Pollution	17.12
5	Traffic / Roads / Transportations	15.07
6	Garbage / Waste	13.01
7	Man	12.33
8	Urbanisation / Construction	10.96
9	Noise	6.16
10	Industry / Factories	4.11
11	Agriculture	3.42
12	Forest fires	2.74
13	Poaching	1.37
14	Tourism	1.37
15	Landfills	1.37

6.8. Perception of the diversity of invasive species

The vast majority of the respondents have heard about invasive species before. Even so, adults (92.67%, n=273) are more aware than children (74.14%, n=86) on that matter. Notwithstanding, a considerable proportion of the adults (14.67%, n=43) and of the children (26.72%, n=31) could not explain the difference between an exotic and a native species, when asked.

Both adults and children mostly learn about invasive species on TV/Radio, but the internet and friends/family/peers also play an important role for adults, and schools, for children (Fig. 23).
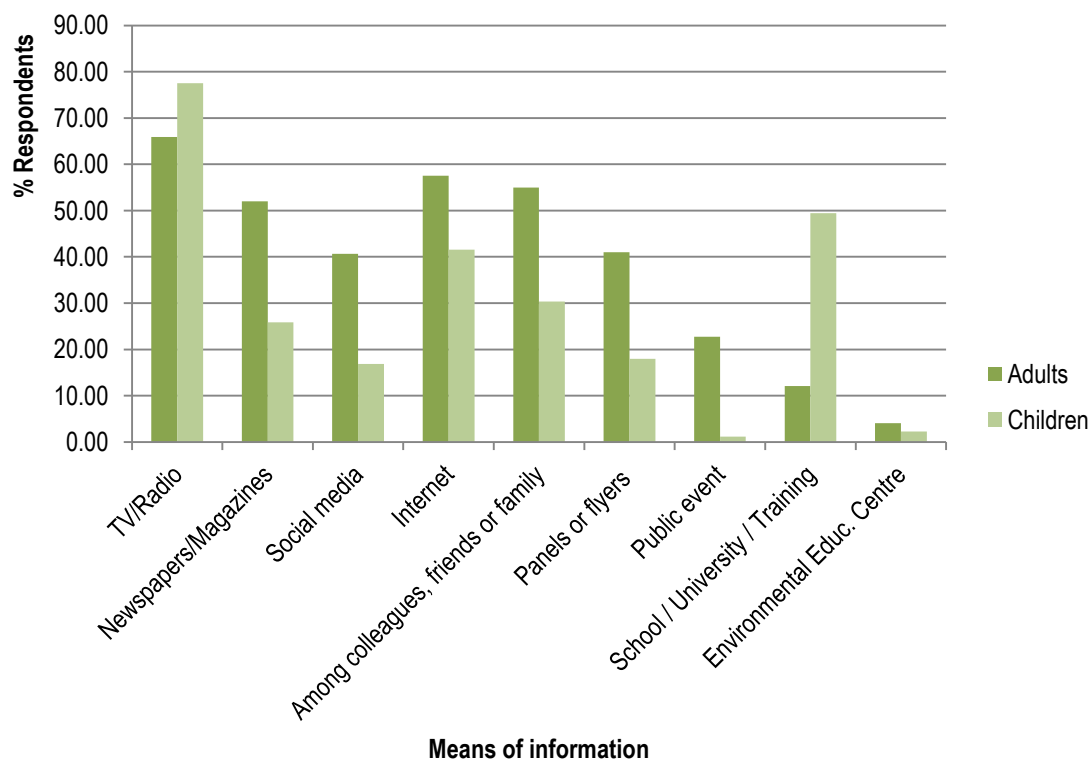
Fig. 23. Main means providing information on invasive species, by age category of respondents.

A significant proportion of the respondents (n=70, 23.89% of the adults; n=74, 63.79% of children) did not name any means of introduction of invasive species (Fig. 24). But among those who did, the majority considered the release of exotic animals or pets as the main mean of introduction of invasive species into a certain environment.
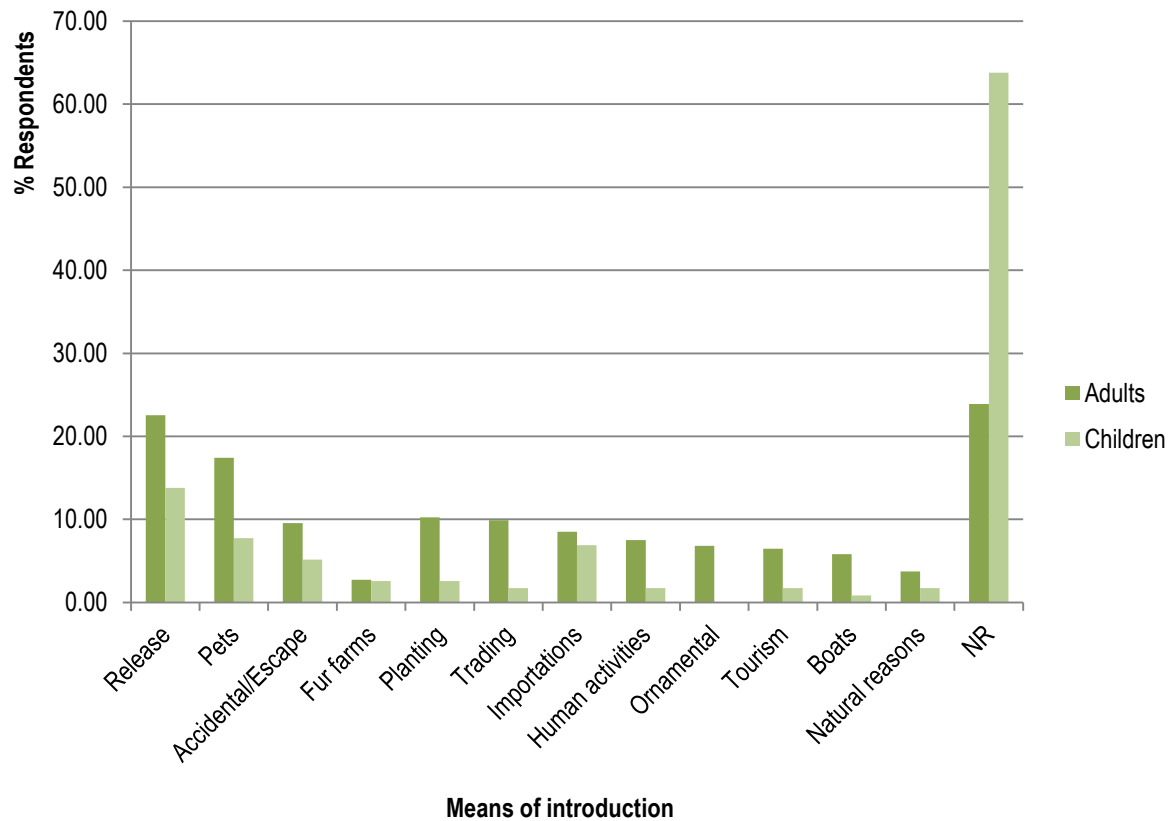
Fig. 24. Main means of introduction of invasive species, by age category of respondents.

In order to assess their knowledge on specific invasive species, respondents were asked to identify invasive species from a list containing invasive and native species widespread in both Spain and Portugal. For each invasive species correctly identified, one point was given. For each native species incorrectly identified as invasive, one point was withdrawn. The final marks were converted to a percentage scale.

The final marks presented significant differences (F=23.590, P=0.000) between **age categories**, with adults (mean score=40.06±32.83) achieving better scores than children (mean score=23.27±27.85). The marks obtained for the identification of invasive plant species also differed (F=15.017, P=0.000) between age categories, with adults (mean score=33.28±37.38) achieving better scores than children (mean score=18.53±26.61). The marks obtained for the identification of invasive animal species also differed (F=15.609, P=0.000) between age categories, with adults (mean score=48.84±38.94) achieving better scores than children (mean score=29.60±41.88).

There were significant differences between the grades obtained for the identification of invasive species type (**plants and animals**) both within adults (F=18.509, P=0.000) and children (F=5.767, P=0.017).

We also found significant differences between the marks obtained by adult respondents from different **countries** – it was not possible to test for differences between children due to the reduced size of the sample of Portuguese children. The marks obtained in the identification of invasive <u>plants</u> presented significant differences (F=50.232, P=0.000), with Portuguese respondents (mean score=59.95±34.27) achieving better marks than Spanish respondents (mean score=23.36±34.73). The marks obtained in the identification of invasive <u>animal</u> species did not present significant differences between nationalities (F=0.230, P=0.632); Portuguese respondents achieved a mean score of 48.42±34.17 and Spanish respondents a mean score of 46.09±41.09. The <u>final marks</u> (identification of both plants and animals) significantly differed (F=17.032, P=0.000) with the nationality of the respondents with Portuguese respondents (mean score=51.18±29.96) achieving better marks than Spanish respondents (mean score=34.72±32.87).

The marks obtained by adult respondents also differed with their **training area/occupational field**. The marks obtained in the identification of invasive <u>plants</u> presented significant differences (F=4.797, P=0.000). The highest marks were obtained by professionals of life (mean score=63.84±35.01) and land/territory sciences (mean score=56.25±45.81), and the lowest by law professionals (mean score=15.00±13.69), and administrators/managers (mean score=15.63±30.95). The marks obtained in the identification of invasive <u>animal species</u> presented significant differences (F=3.371, P=0.000). The highest marks were obtained by professionals of land/territory sciences (mean score=81.25±43.81) and artists (mean score=66.67±33.07) such as musicians and artisans, and the lowest by marketeers/advertisers (mean score=22.92±36.80), and students (mean score=23.61±30.28). The <u>final marks</u> (identification of both plants and animals) also presented significant differences (F=4.821, P=0.000) with the occupational field. The highest marks were obtained by professionals of land/territory (mean score=68.75±42.78) and life sciences (mean score=62.95±31.08), and the lowest by architects/constructors (mean score=20.83±14.43) and marketeers/advertisers (mean score=21.95±24.58).

The marks obtained by adult respondents in the identification of invasive <u>plant species</u>, <u>animal species</u> and the <u>final marks</u>, all positive and significantly correlated with going more often outdoors, going more to protected areas, and with their concerns and awareness towards nature conservation. The marks obtained by children only positive and significantly correlated with their concerns towards nature conservation with respect to <u>animal species</u> and <u>final marks</u> (Table 9).

Table 9. Spearman's correlation coefficient between the obtained marks and respondents' behaviours and attitudes towards nature.

			Outdoors	Protected areas	Concern	Commitment
ADULTS	**PLANTS mark**	Spearman's rho	**0.232**	**0.321**	**0.322**	**0.367**
		Sig. (2-tailed)	**0.000**	**0.000**	**0.000**	**0.000**
	ANIMALS mark	Spearman's rho	**0.262**	**0.370**	**0.376**	**0.361**
		Sig. (2-tailed)	**0.000**	**0.000**	**0.000**	**0.000**
	FINAL mark	Spearman's rho	**0.283**	**0.386**	**0.402**	**0.420**
		Sig. (2-tailed)	**0.000**	**0.000**	**0.000**	**0.000**
CHILDREN	**PLANTS mark**	Spearman's rho	-0.073	0.031	0.159	-
		Sig. (2-tailed)	0.436	0.740	0.091	-
	ANIMALS mark	Spearman's rho	0.137	0.148	**0.193**	-
		Sig. (2-tailed)	0.144	0.115	**0.040**	-
	FINAL mark	Spearman's rho	0.053	0.133	**0.207**	-
		Sig. (2-tailed)	0.571	0.159	**0.027**	-

6.9. Perception of the impacts of invasive species

Respondents were asked to rate (from -1 to 5) the impact of invasive species on several criteria. The criteria questioned in adult and children's surveys are presented in Table 10.

Table 10. Criteria considered in the survey for rating the impacts of invasive species.

Criterion	Adults	Children
Biodiversity	x	x
Ecosystem services	x	x
Agriculture/Forests	x	x
Climate change	x	
Landscape/Aesthetics	x	
Economy	x	
Public health	x	
Historical/Cultural values	x	

The distribution of the ratings attributed to each criterion by children is presented in Fig. 25, and by adults in Fig. 26.
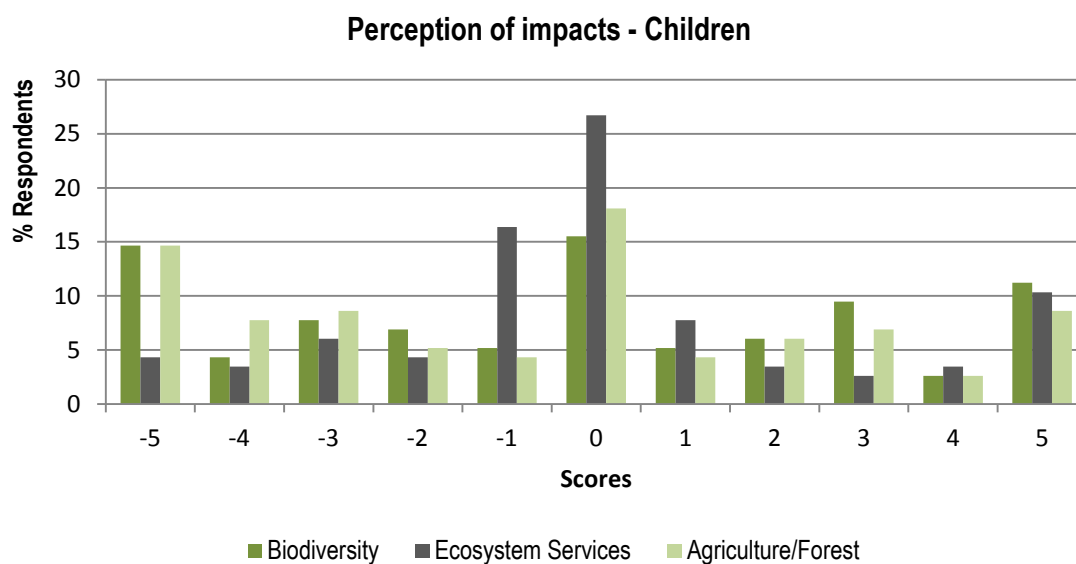

Fig. 25. Distribution of the ratings attributed to each criterion by children respondents.
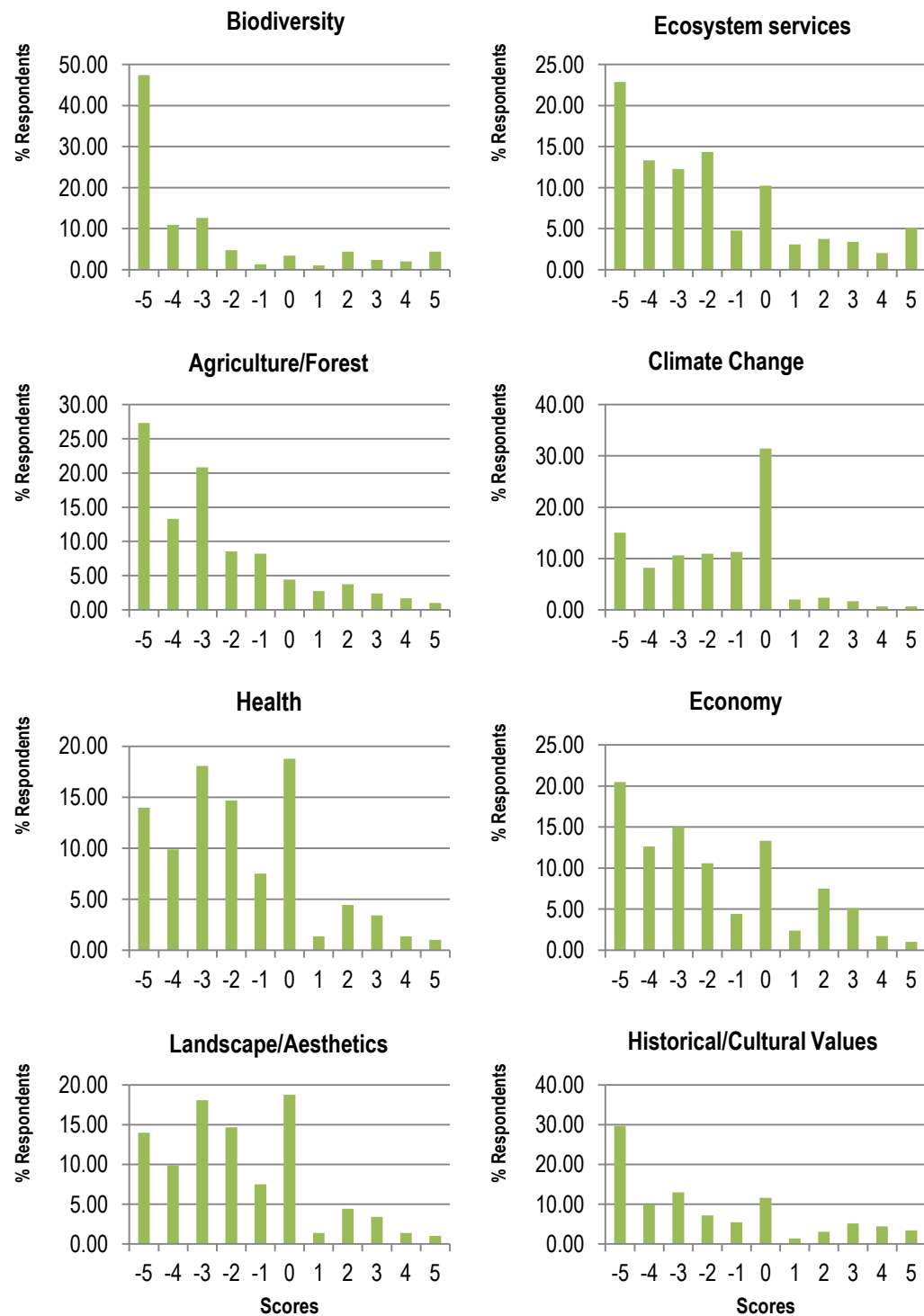
Fig. 26. Distribution of the ratings attributed to each criterion by adult respondents.

We found significant differences between the impacts attributed to each **criterion** within adults (F=10.720, P=0.000) but not within children (F=1.437, P=0.239). In general, adults rated more negative impacts of invasive species than children (Fig. 27). Biodiversity (mean score = -2.97±1.82) and agriculture/forests (mean score = -2.63±1.94) were acknowledged by adults as suffering the greatest negative impacts from invasive species.

Fig. 27. Scores attributed (from -5 to 5) to the impacts of invasive species in different considered criteria, by age category of the adult respondents. Mean ± 95% Confidence Interval.

Ratings of biodiversity (F=59.758, P=0.000), ecosystem services (F=38.166, P=0.000) and agriculture/forest (F=41.445, P=0.000) - the three criteria commonly questioned to adults and children - presented significant differences between the **age** categories of the respondents. Adults consistently attributed invasive species more harmful impacts than children (Fig. 27).

The perception of the impacts of invasive species varied according to the **country** of residence of the adult respondents – it was not possible to test for differences between children due to the reduced size of the sample of Portuguese children.

In general, and consistently in all criteria, Portuguese respondents rated the impacts of invasive species more negatively than Spanish (Fig. 28), with statistically significant differences in six criteria: Biodiversity (F=19.775, P=0.000), Ecosystem services (F=19.085, P=0.000), Agriculture/Forests (F=8.855, P=0.003), Landscape/Aesthetics (F=13.878, P=0.000), Economy (F=5.485, P=0.020), and Historical/Cultural Values (F=24.948, P=0.000).

Both Spanish (F=5.689, P=0.000) and Portuguese (F=10.623, P=0.000) adult respondents consider invasive species more detrimental in some criteria than others, as ratings between criteria and within nationality presented significant differences (Fig. 28).
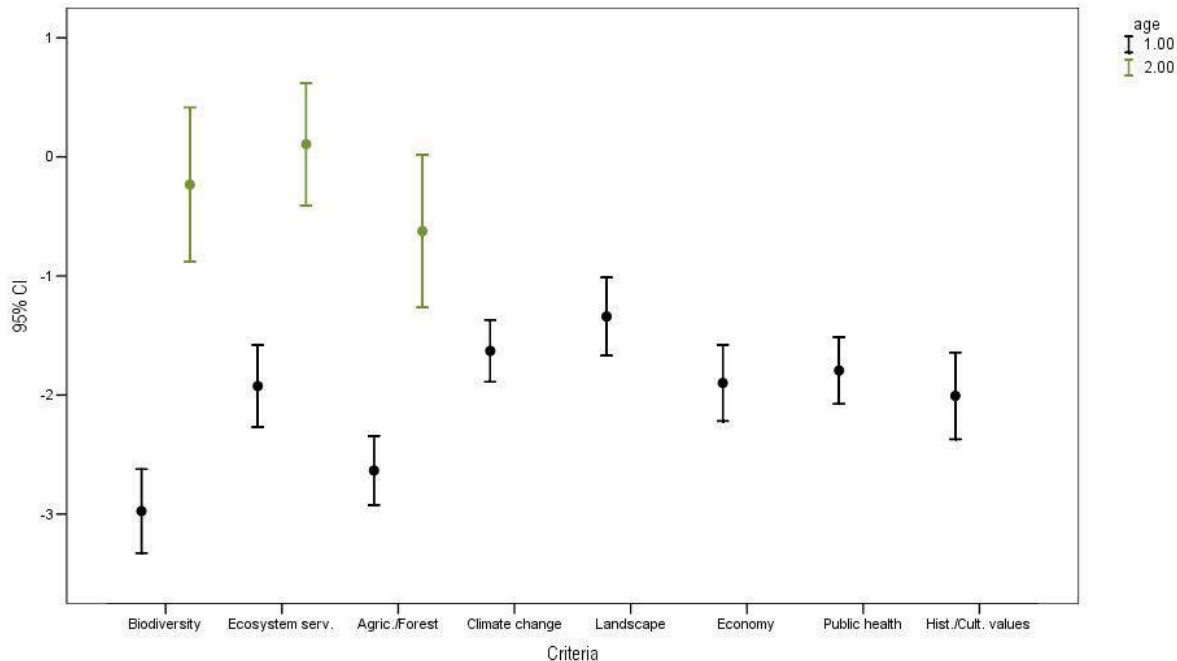
Fig. 28. Scores attributed (from -5 to 5) to the impacts of invasive species in different considered criteria, by country of residence of the adult respondents. Mean ± 95% Confidence Interval.

The **training/occupational field** of the respondents also has influence on their perception of the impacts of invasive species. Four criteria differed significantly with occupational fields/professions: Biodiversity (F=3.276, P=0.000), Ecosystem Services (F=1.750, P=0.035), Agriculture/Forest (F=2.020, P=0.011), Historical/Cultural Values (F=2.266, P=0.003) (Table 10).

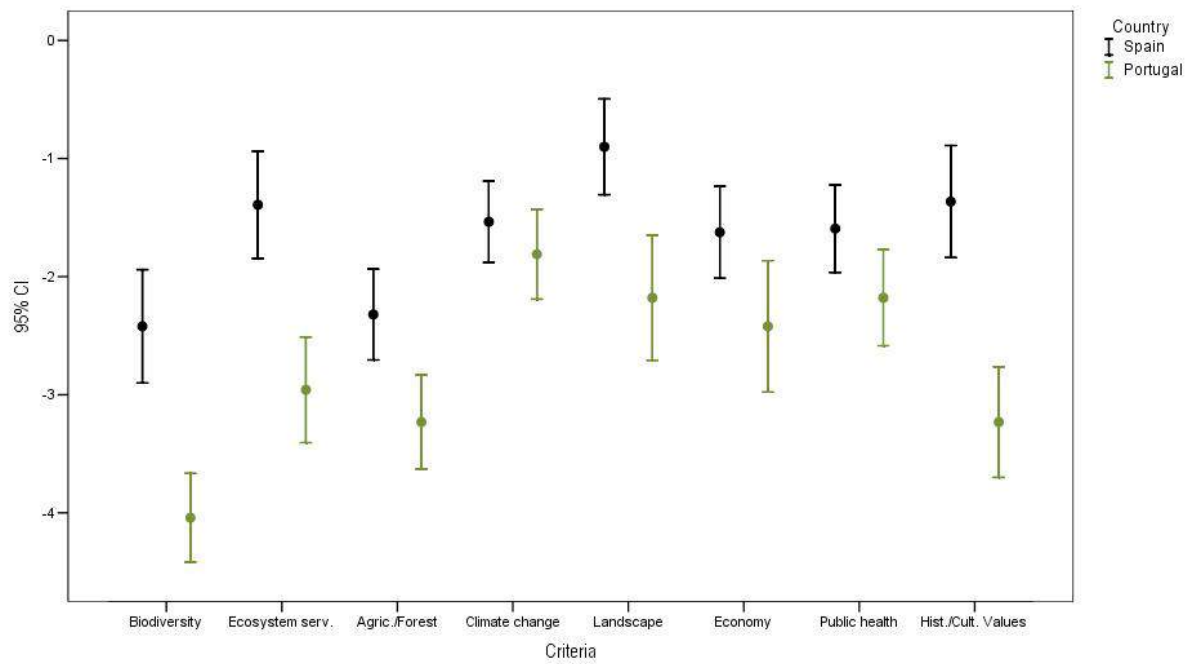**Table 11.** Mean scores attributed (from -5 to 5) to the impacts of invasive species in different considered criteria, by occupational field of the adult respondents using one-way ANOVA. ***Indicates** significance (α<0.05). Mean score and standard deviation presented for each criteria/occupation.

Results highlighted in **bold and green** indicate the most negative mean score attributed within each criterion.

	Biodiversity		Ecosystem services		Agriculture / Forest		Climate change		Landscape / Aesthetics		Economy		Public health		Historical / Cultural Values	
	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P
	3.276	*0.000	1.750	*0.035	2.020	*0.011	1.051	0.403	0.922	0.548	1.427	0.124	1.550	0.078	2.266	*0.003
Occupation	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Administration/ Management	-0.53	3.68	-0.63	3.43	-1.03	2.67	-1.53	2.67	-0.43	3.02	-0.63	2.68	-0.40	2.86	0.23	3.38
Architecture/ Construction	-4.00	1.73	-3.00	2.00	-3.00	2.00	-2.67	1.53	-2.33	2.08	-1.67	2.08	-3.00	1.73	**-3.67**	2.31
Arts	-3.78	2.28	-2.11	3.06	-3.38	1.69	**-3.22**	2.11	-2.78	2.59	-2.22	2.64	-1.67	3.16	-1.44	3.94
Life/Environm. sciences	-3.93	2.34	-2.55	2.46	-2.75	2.64	-1.21	1.70	-1.77	2.64	-2.36	2.71	-2.21	2.25	-3.05	2.62
Land/Territory sciences	-3.63	2.39	-2.25	2.25	-2.63	1.85	-2.00	2.27	-2.13	1.73	-3.63	1.06	**-3.13**	1.46	-3.13	1.81
Exact science/ Engineering	-3.42	2.83	-2.00	3.25	-3.26	2.16	-2.37	2.48	-1.32	2.75	-1.63	3.18	-1.68	2.16	-2.83	2.73
Social sciences	-2.38	3.38	-1.75	3.20	-3.38	0.92	-3.00	1.69	-0.38	3.42	-1.63	2.83	-1.38	2.13	-1.00	3.34
Business	-1.43	3.55	-0.20	3.05	-2.27	2.91	-0.87	2.67	-0.73	2.99	-1.60	3.04	-1.67	2.35	-1.20	3.12
Law	**-4.60**	0.89	-3.20	1.30	-4.00	1.41	-1.80	2.05	-1.80	1.30	-2.60	1.82	-1.60	1.52	-2.40	2.51
Education	-3.25	2.76	-2.69	2.67	-2.87	1.82	-1.44	1.66	-1.32	2.15	-1.70	2.37	-1.88	1.81	-2.25	3.15
Humanities	-4.17	1.17	-2.00	2.10	-4.17	1.17	-1.00	1.67	-1.17	2.04	**-3.83**	1.47	-1.83	2.23	-2.67	2.34
Marketing/ Advertising	-1.71	3.20	-0.76	3.08	-1.85	2.68	-1.10	2.13	-0.70	2.90	-1.25	2.59	-1.45	1.93	-1.25	2.59
Health	-4.21	1.12	-3.43	1.79	-3.07	1.94	-2.14	1.99	-1.50	3.39	-2.07	2.76	-2.21	2.22	-3.21	1.72
Tourism	-4.33	1.03	**-3.83**	2.04	-3.83	2.04	-1.50	3.78	**-2.83**	2.48	-3.33	2.07	-3.83	2.04	-3.00	2.45
Others/Services	-4.20	1.48	-1.60	2.72	**-4.30**	1.16	-2.10	3.07	-2.33	2.35	-2.80	2.39	-2.78	2.44	-2.40	3.03
Students	-3.40	2.23	-1.93	3.03	-2.87	1.92	-1.67	1.84	-1.60	3.25	-2.47	2.83	-2.13	2.39	-2.07	3.22
Unemployed	-3.80	2.17	-1.00	3.54	-2.80	2.95	-1.60	2.07	-1.00	2.65	0.20	3.56	-0.40	3.65	-1.20	3.56

With respect to the **economic losses** caused by invasive species each year in the EU alone, only 29.01% (n=85) of adults answered correctly (12 000 000 000 €) (Fig. 29). Most children did not answer that question.
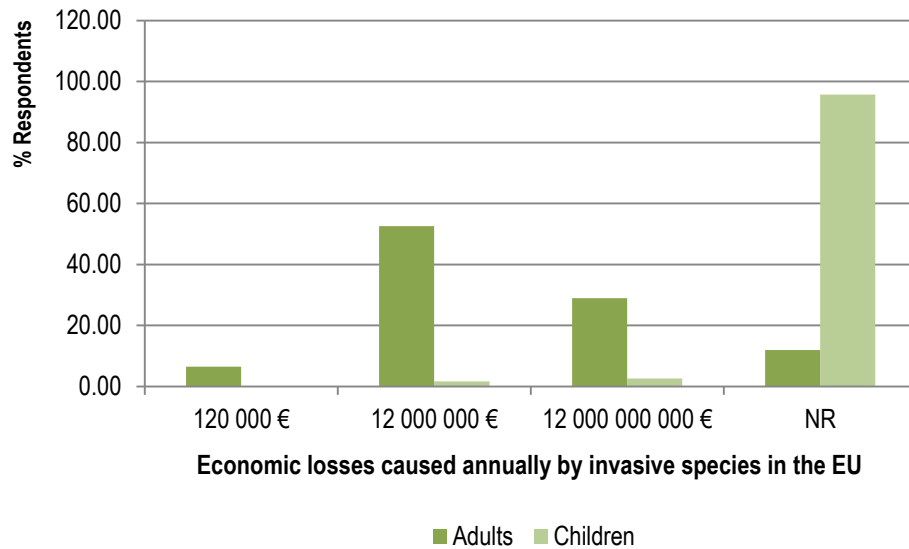

Fig. 29. Distribution of the answers obtained for the question "How much economic losses you think invasive species cause per year, in Europe?", per age category.

6.10. Attitude towards invasive species control

When asked if nature needs human aid with respect to invasive species (rating from 1 to 5), the respondents' opinion presented significant differences according to **age** category (F=28.391, P=0.000), with adults (mean score = 4.35±0.86) considering more firmly than children (mean score = 3.79±1.11) that man should intervene controlling ecological invasions. About half (52.90%, n=155) of the adults and 31.03% (n=36) of the children highly agreed (responding with the score of 5) nature needs help with respect to invasive species. A minority of both adults (1.37%, n=4) and children (3.45%, n=4) strongly disagreed, responding with the score of 1.

The respondents' opinion also varied significantly (F=11.122, P=0.001) with the **country** of residence, with Portuguese (mean score = 4.59±0.61) responding with a higher score than Spanish (Mean score = 4.23±0.95) respondents.

The respondents' opinion did not vary with their **occupational field** (F=0.587, P=0.901).

Adult respondents were asked if they specifically agreed (rating from 1 to 5) with the implementation of control programs of invasive species by local/regional/national competent entities. The mean score of all answers was 4.49±0.79. Again, the respondents' opinion varied significantly (F=15.298, P=0.001) with the **country** of residence, with Portuguese (mean score = 4.74±0.49) responding with a higher score than Spanish (mean score = 4.36±0.88) respondents. The respondents' opinion did not vary with their **occupational field** (F=1.476, P=0.103).

The majority of respondents did not **know any control program** of invasive species taking place in their home area (Fig.30). Adult respondents that knew control programs (25.94%, n=76) mostly mentioned Life projects (for instance dealing with *Acacia* sp. and *Trachemys scripta elegans*), and programs developed by municipalities or ONGs. Children that knew control programs (15.52%, n=18) mostly mentioned programs carried out nationally by the authorities (e.g. SEPRONA in Spain), but also local environmental education centres.
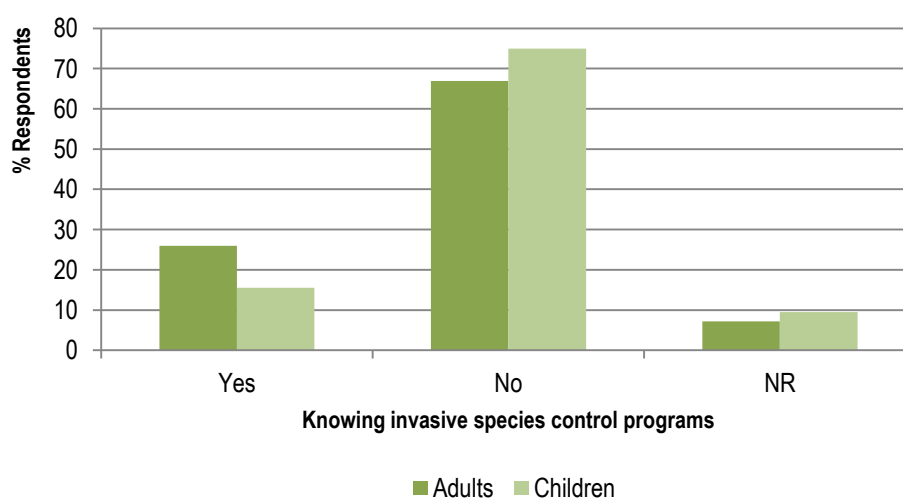

Fig. 30. Respondents' knowledge on invasive species control programs.

There were significant differences between the proportion of respondents knowing control programs between **countries** (χ^2=8.414, *P*=0.004), with more Portuguese knowing programs that Spanish.

We found no differences between the amount of respondents knowing control programs and **their** occupational fields (χ^2=25.859, *P*=0.103).

Knowing control programs positive and significantly correlated with respondents going more often outdoors (Spearman's ρ=0.291, P=0.000), going more to protected areas (ρ=0.290, P=0.000), and with their commitment (ρ=0.297, P=0.000) and awareness (ρ=0.206, P=0.001) towards nature conservation.

Control programs of particular species were mentioned by a considerable amount of adult respondents (among those who knew any programs) (Table 12). Only one child mentioned the control program of a specific species, the raccoon.

Table 12. Invasive species control programs mentioned by adult respondents.

Common name	Latin name	% Respondents
Thorn trees	*Acacia* sp.	22.37
Monk parakeet	*Myiopsitta monachus*	9.21
Raccoon	*Procyon lotor*	19.74
Red-eared slider	*Trachemys scripta elegans*	1.32
Ailanthus	*Ailanthus altissima*	6.58
Hottentot-fig	*Carpobrotus edulis*	6.58
Water hyacinth	*Eichhornia crassipes*	1.32

Adult respondents were questioned about their **ethical concerns** in relation to the control of invasive species. Regarding both plant and animal species control, most respondents declared they had no ethical issues, but the number of respondents with ethical concerns significantly increased when referring to animals (χ^2=54.078, *P*=0.000) (Fig. 31).

Ethical concerns negative and significantly correlated with the respondents' agreement with human interventions to control invasive species. That is, the stronger respondents agreed with the need of invasive species control, the less they presented ethical concerns with those interventions, both for plants (Spearman's ρ = -0.225, *P* = 0.000) and animals (ρ = -0.152, *P* = 0.019).
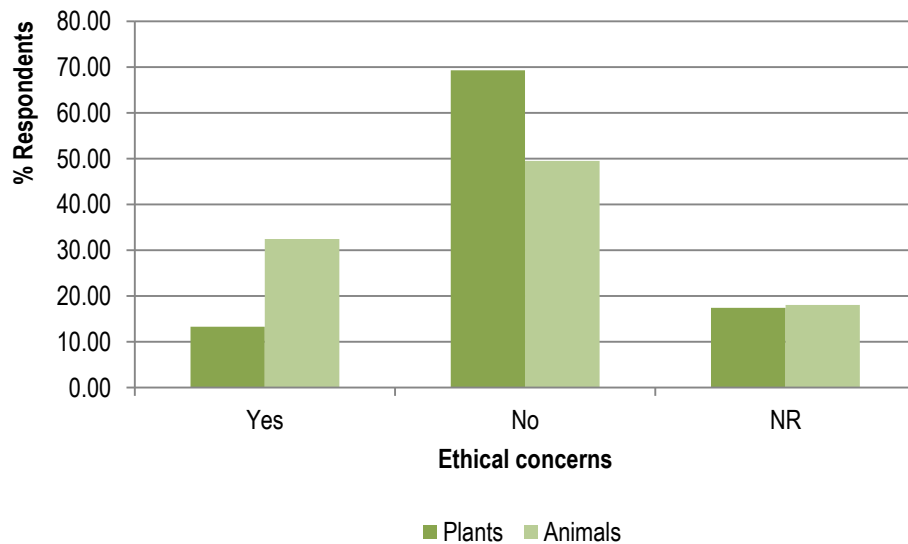
Fig. 31. Ethical concerns of adult respondents with respect to invasive species control.

The level of ethical concerns did not vary with the respondents' **nationality** when regarding plants elimination (χ^2=0.043, *P*=0.836), but did present significant differences when concerning animals (χ^2=11.726, *P*=0.001), with Portuguese presenting a higher proportion of individuals ethically bothered with animal elimination.

The level of ethical concerns did not vary with the respondents' **occupation** either when regarding plant (χ^2=18.033, *P*=0.387) or animal elimination (χ^2=21.686, *P*=0.197).

Knowing invasive control programs had no influence on ethic concerns referring to plant (χ^2=3.799, *P*=0.051) or animal (χ^2=0.658, *P*=0.417) elimination.

When asked if they would like to present any alternative method to the control of invasive animals by elimination, the majority (71.67%, n=210) of adult respondents did not answer. A summary of the alternatives suggested is presented in Table 13.

Table 13. Alternative invasive species control methods suggested by respondents (% of those who presented an alternative).

Suggested alternative method	n	% Respondents
Preventions / Vigilance	11	13.25
Castration / Prevent reproduction	8	9.64
Exportation to native areas	8	9.64
Create special reserves / Zoos	8	9.64
Control trade or sales	6	7.23
Hunting / Elimination	6	7.23
Biological control	5	6.02
Capture	5	6.02
Information	5	6.02
Gastronomy	1	1.20

6.11. Willingness to receive more information

Adult respondents were asked if they would like to receive more information about: (i) the conclusions of this study, (ii) invasive species, (ii) conservation and education actions of Parque Regional de Sureste. Most participants responded yes to all questions (Fig. 32) and 185 email addresses were registered.
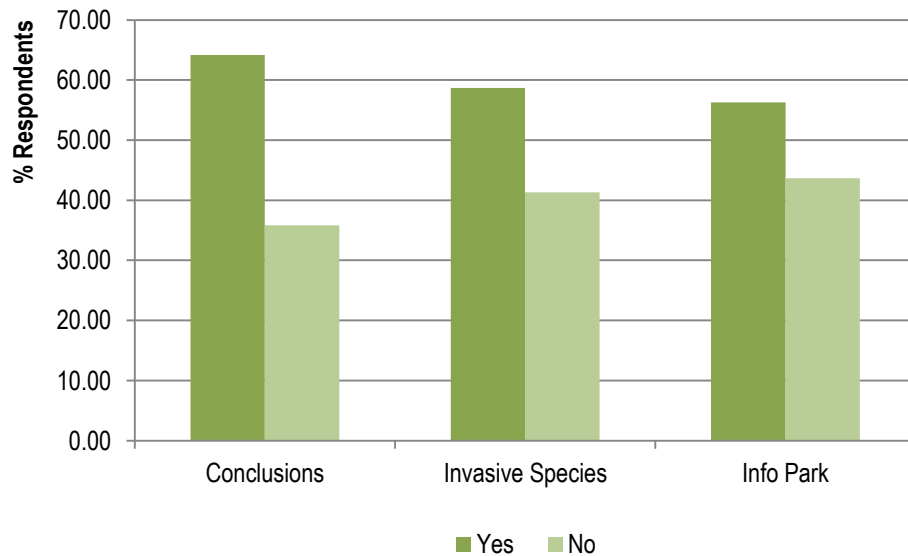

Fig. 32. Willingness of respondents in receiving more information.

7. Discussion

The surveys allowed collecting valuable information on the public perception that respondents have on invasive species. Probably the set of respondents in not representative of the entire population – the general public – but it should represent the generality of people visiting natural areas or interested in outdoor activities. In general, our audience is comprised by children/teenagers (12-15 years old) and educated adults from 20-60 years old, with a majority on their thirties. Adult samples were in a number sufficient to draw conclusions both for Spain and Portugal, and for several professional fields. The educational level of the Portuguese and Spanish sets of respondents presented no differences, allowing fair and valid comparisons between them – although differences related to the occupational fields must be accounted for.

Results clearly support that greater efforts must be undertaken in order to **engage children/youth** towards nature conservation and raise their awareness. Children consistently demonstrated having less interest and knowledge than adults on nature conservation in general and invasive species in particular. This outcome was surprising, as today's children are constantly invited to participate in nature-related extracurricular projects and activities. But it is understood that modern educative systems, which are overwhelmingly bureaucratic and time and budget-strict, are precluding teachers and educators to take children outside and engage in practical and direct contact with nature. The hands-on contact has been progressively substituted by digital surrogates. Today there are hardly any educational initiatives (particularly in the environmental area) that resist the immediacy of a website, an app or an interactive game. However, in the context of pedagogy, several authors raise a number of concerns related to this "escape" from the analogical era (e.g. Bauerlein, 2008; Gulley, 2003; Luke, 2003; Pergams and Zaradic, 2006). These concerns relate to (i) equality (in the context of the right to access, since not all people have - or have possessions to acquire - the same type of technology; (ii) obsolescence; (iii) "honesty / truthfulness" in online exercises/evaluations; (iv) alienation, when users tend to focus solely in a full virtual reality, disconnecting from the physical and social reality around them; (v) the collective loss of interpersonal communication skills, dialogue and questioning; and even (vi) public health issues associated with excessive use of lighted screens or other technologies. Nature exploration is an opportunity to generate attachment to natural values, but also to create socializing opportunities, dialogue, and interpersonal relations - especially within youth in ages between 12 and 18 years, the so-called *digital natives* (Prensky, 2004).

Although recognizing the fundamental importance of digital media in our modern society of information and virtual social networks, field trips are acknowledged as effective learning moments, enhancing young people's ability or willingness to retain information – at least when well organized and planned/presented ahead (Falk, 1983; Orion and Hofstein, 1994). These learning-enhancement effects are scientifically described for both the short and the long term (Farmer et al., 2007), particularly in the case of events related to ecology and biodiversity (Prokop et al., 2007).

Educative games also represent a valuable strategy to enhance children's mental availability to learn, independently of the technological approach (Galarneau, 2005; Ritterfeld et al., 2009). Scientific evidence shows that in the particular case of nature/conservation/biodiversity themes, the use of educational games enhances the youngsters' motivation and willingness to learn, being highly recommended approaches within environmental education (Barker and Elliott, 2000) and nature conservation (Sandbrook et al., 2015) programmes. There is also evidence that educative gaming has positive effects in enhancing youth's

engaging to causes in general, but also to management of protected areas in particular (Briot et al., 2011; Iscenco and Li, 2014).

Surveys also disclosed interesting results regarding the **profession** or occupational/training fields of the respondents. Education in nature-related fields had a positive influence on the *concern*, *engagement* and *knowledge* of general conservation/nature aspects. But regarding invasive species, although education in nature-related fields had a positive influence on *knowledge*, it had no effect on the *attitude* towards the subject. Similar results were obtained regarding forestry issues (Uliczka et al., 2004), where researchers suggested foresters should attain courses in order to have more informed and conscious opinions – which would lead to a better decision-making process. In this case, obviously we cannot suggest general people to voluntarily increase their knowledge on invasive species. On the contrary, it is the responsibility of nature practitioners and communicators to make efforts to raise general awareness, considering invasive species are a conservation issue with an influence to everyone's daily lives – even if people are not aware of it. Special efforts must be undertaken to carry the message to professional sectors which seem to be more disinterested from conservation, but play an important role in shaping our environment or society, respectively architectures/constructors and marketeers/advertisers and administrators.

The **nationality** of the respondents had an influence on the *concern*, *engagement* and *knowledge* of general conservation/nature aspects. With respect to invasive species, it had an influence on the knowledge but also on the attitudes towards the subject, at least with respect to animals. Consistently, Portuguese demonstrated higher levels of *concern*, *engagement* and *knowledge* and also revealed to have more ethical concerns with respect to invasive animal species control. Since both sets of respondents had a similar educational level, but the Portuguese demonstrated to seek outdoors and natural areas more often, it is plausible to conclude that a more regular contact with nature generates a greater awareness. We could hypothesize that as many natural areas in Portugal have Life or other conservation projects going on – the majority of such projects with a strong communication strategy, it could be possible that Portuguese respondents became generally more *informed* and *concerned* on conservation than Spanish respondents, who did not contact with the outdoors and natural areas as much. Actually, greater knowledge on invasive species and of control programs was clearly related to going outdoors and visiting protected areas more often, which underlines protected areas play a role in informing people. This pattern was also perceptible as in general respondents knew more invasive species according to the conservation programs taking place around them – for instance Portuguese mentioned fewer invasions by animals than Spanish, who have more programs controlling animal invasions.

This pattern then demonstrates that Protected Areas and conservation actions have an important impact on the public's *knowledge* on conservation issues, thus constituting a relevant information/education source.

Results demonstrated the complex **human dimension** of invasive species control. Although the vast majority of adults strongly agree that man must intervene in order to control invasive species, a considerable part of the respondents presented ethical concerns towards the elimination of living beings. As expected, those concerns were significantly higher when the invasive species are animals. However, an interesting pattern arose. Spanish respondents were significantly less ethically concerned with animal control than Portuguese respondents. In Portugal only one terrestrial vertebrate (red-eared slider) control

program is taking place, whilst in Spain, and in the Madrid region, there are several (red-eared slider, raccoon, parakeets). It is than plausible to think of a certain "desensitization" of the public, when getting used to such practices.

On the perception of the **effect of invasive species**, in general, adult respondents understand that invasive species pose an issue to biodiversity, ecosystems and historical values – recognizing there is something *changing* in terms of natural values present in the environment. The same recognition was clear when respondents pointed invasive species among the greatest threats in the environment, and even the top threat inside the Park.

However, respondents seem to be less sure of the effects on the economy, climate change, public health and aesthetics of the landscape. In terms of communication, this result indicates that the message of the detrimental effect of invasive species in nature is coming through, but indirect effects and losses are still not recognized by the general public - perhaps pointing a communication direction that is overlooked.

Indirectly, when pointing possible solutions to mitigate or control invasive species, the respondents acknowledged there is a need for more information not only among the public, but also among decision-makers and stakeholders. Prevention and information altogether accounted for the top solutions, pointed by around one fifth of the respondents who presented any solution/alternative.

Communication on invasive species has still a long way to go, but these results present some insights and directions to fulfil real gaps and achieve more effective communication. It also gives a positive feedback of the hard work Protected Areas and conservation practitioners have been doing.

So...
Let's roll our sleeves up and continue the good work!

8. Lessons learned & further work

As a conservationist, invasive species cause me great concern, and stimulate me to work and participate in seeking solutions. I live in a region that has severe problems with alien invasive species, even within protected and Natura 2000 sites. Besides my work on biodiversity conservation and invasive plant species control, I am passionate on communication and raising awareness. I am very happy with the study visit I made, as I had the opportunity to extend my knowledge with a highly professional team, which has achieved remarkable results and thus constitute a European role model on invasive vertebrate control plans.

The surveys provided important information and guidelines of what and how to prioritize communication work for nature conservation in general and invasive species in particular.

Combining the gathered knowledge and shared experiences with my current activities, I believe I will be able to more effectively contribute to the conservation of biodiversity of central Portugal, which is one of the richest in Europe. I intend to use the experience to help building a conservation framework tackling invasive species, specifically creating working documents to share with technical staff of the protected areas where I collaborate, and organizing training-in-action events.

Moreover, I expect to focus on communicating invasive species matters through educational multi-generational educative services (which I have access to) and other significant science communication vehicles to the academics, enterprises and general public, in order to generate awareness, fund raising and create mid-term conservation and social impacts.

I will do my best to largely share and multiply the outputs and significance of this project, uprightly applying them in the improvement of conservation/communication practices.

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