NEW NEIGHBOURS TO GOSSIP ABOUT: PEOPLE'S ATTITUDES TOWARDS ALIEN PARAKEETS IN PORTO

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O Presidente do Júri,

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Abstract

Invasive species are widely recognized as one of the biggest threats to biodiversity, ecological and economic wellbeing of the world. Several human activities promote the trade of animals and plants throughout the world, one of them being the pet industry. Psittacines, commonly traded as pets all over the world, have established numerous populations in territories where previously absent. Among them, the Rose-ringed parakeet (*Psittacula krameri*) and the Monk parakeet (*Myiopsitta monachus*) are two of the most successful invaders.

Invasive Alien Species (IAS) control or eradication projects can generate great controversy, especially when the target species are considered attractive or desirable by members of the public, as it happens with the parakeets. Effective IAS management needs to have full public support and understanding. As such, it is important to gain full knowledge of public opinions and attitudes towards the target species from the start.

In this study, we first identified and dimensioned the two biggest parakeet populations in the city Porto. We then collected and analyzed people´s perceptions of Rose-ringed and Monk parakeets, in this same metropolitan area. For this, we developed an in-person questionnaire, using a visual approach, followed by a question-based survey specifically on the species of interest, which was applied to four different predefined groups, aggregated accordingly to their different levels of interaction with the parakeets.

The results showed that the majority of people questioned recognized the target species as Psittacines, but some demographic groups were more open than others to have the parakeet as part of our avifauna. We did not find significant differences of preference or perception between the different predefined groups. We also found that most people had a good opinion of the parakeets, and did not consider them a potential nuisance. This could be due to lack of information about the impacts alien species can potentially cause to the environment, or because the current parakeet populations in Porto are not as numerous as to noticeably negatively impact the locals. Our results show that more education of the general public is urgently needed, if we are to have successful IAS management.

Key words: Invasive alien species, Psittacidae, Rose-Ringed parakeet, Monk parakeet, survey, social perception

Sumário

As espécies invasoras são amplamente reconhecidas como uma das maiores ameaças à biodiversidade, ao bem-estar ecológico e económico do mundo. Os Psittacideos, muito comercializados em todo o mundo como animais de estimação, conseguiram estabelecer varias populações em territórios onde previamente estavam ausentes. Entre eles, o periquito-de-colar e o periquito-monge são os invasores mais bem-sucedidos.

Projetos para o controlo e erradicação de espécies invasoras podem causar grande controvérsia, especialmente quando as espécies alvo são consideradas atraentes ou desejáveis pelo publico, como é o caso dos periquitos. Assim, é essencial que o controlo de espécies invasoras tenha o apoio e compreensão do publico, para garantir o sucesso das suas ações. Para tal, é importante que, primeiro, entendamos as opiniões e atitudes do publico em relação às espécies alvo. Com este estudo, pretendemos, em primeiro lugar, identificar e dimensionar as duas maiores colonias de periquitos da cidade do Porto. Em segundo lugar, pretendemos recolher informação sobre a perceção dos habitantes da área metropolitana do Porto sobre a presença dos periquitos nos nossos parques e jardins. Para tal, desenvolvemos um questionário com uma abordagem visual, seguido de algumas perguntas especificas sobre as espécies de interesse. Este inquérito foi aplicado, através de entrevistas presenciais, a quatro grupos predefinidos, agregados de acordo com os seus diferentes níveis de interação com os periquitos.

Os resultados mostram que a maioria das pessoas questionadas reconheceram as espécies alvo como membros da família Psittacidae. No entanto, descobrimos que alguns grupos demográficos estão mais recetivos a acolher estas espécies como membros da nossa avifauna. Para além disso, não encontramos diferenças significativas na opinião ou preferência entre os diferentes grupos predefinidos. Também descobrimos que, em geral, as pessoas inquiridas tinham uma boa opinião sobre os periquitos. Estes resultados podem ser devidos à ignorância geral no que diz respeito aos potenciais impactos que a presença destas espécies acarreta, ou devido ao ainda baixo número de periquitos presentes na cidade do Porto. Este estudo serve de aviso para o urgente envolvimento do publico na problemática das espécies invasoras.

Palavras chave: Espécies exóticas invasoras, Psittacidae, Periquito-de-colar, Periquito-monge, inquérito, perceção social

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Abbreviations

IAS – Invasive Alien Species

RRP – Rose-ringed parakeet

MP – Monk parakeet

PCA – Principal component analysis

GLM – Generalized Linear Model

1 Introduction

1.1 Framework: invasive alien species (IAS)

For a long time anthropogenic induced changes have been inflicted to the environment (Vitousek et al. 1996). One of the most relevant being the introduction of species outside their natural range. Several anthropogenic activities, such as agriculture, forestry, aquaculture, recreation, trade and tourism promote the deliberate or accidental introduction and spread of organisms beyond their natural dispersal barriers (Kolar and Lodge 2001; McNeely 2001; Blackburn, Lockwood, and Cassey 2009). This phenomenon has greatly enriched the lives of people everywhere, by giving them access to a greater share of the world's biological diversity (McNeely 2001). As a consequence, worldwide biodiversity and its distribution is shifting at an unprecedented speed and becoming increasingly homogeneous (Pimm et al. 1995; IUCN 2010).

The scale of the international wildlife trade is enormous, with estimates of billions of live animals, plants and their products traded globally each year (Karesh et al. 2005; Jenkins 2007). While many of the transported specimens die during transport, or soon after being released, many others are able to establish, spread and occupy the environments where introduced, those are called exotic or alien species (Kolar and Lodge 2001; IUCN 2010). Among the ones who thrive in foreign environments, some will be harmful and inflict injurious changes to the environment, therefore, those are called invasive alien species (henceforth called IAS) (Hulme 2007; IUCN 2010).

Some alien species have been traded worldwide for their nutritious value for humans. Nowadays, some of this species serve as foundations for modern agriculture and commerce. For example, introduced species, such as corn, wheat, rice, and other food crops, cattle, poultry and other livestock, currently provide more than 98% of the U.S. food system at a value of approximately US$800 billion per year (USBC 2001; Pimentel, Zuniga, and Morrison 2005). Yet, most of these non-indigenous species appear to pose little to no threat to the natural environment, since they seem to be mostly restricted to the highly altered environment of modern agriculture (Miller and Gunderson 2006).

When it comes to IAS, their progressively wider spread is now recognized as one of the biggest threat to the ecological and economic wellbeing of the world (McNeely 2001). The introduction and dissemination of predators, pathogens or competitors, for example, have all been implicated in the loss of native species in a great number of different ecosystems (Williamson and Fitter 1996). Accordingly, IAS are now commonly

referred to as the second most important cause of biodiversity loss after habitat alteration and destruction (Glowka et al. 1994).

When alien species establish in novel environment, they have the potential to greatly contribute to ecological and evolutionary biology since they are now present in an environment different than the one they evolved in, meaning that, now, they must deal with new predators, competitors, parasites, food sources as well as a different climate (Blackburn, Lockwood, and Cassey 2009). Furthermore, the creation of this novel affiliations will ultimately cause changes in the community's structure, alter the genetic diversity of the community and change ecosystem processes and function. All this can lead to a decrease of native species richness and abundance (Blackburn, Lockwood, and Cassey 2009; Gaertner et al. 2009; Hejda, Pyšek, and Jarošík 2009). In fact, if that decrease happens to several species from the same functional group, it can have severe implications for the sensitivity of the ecosystem to the variation of environmental conditions and compromise the provisioning of the ecosystem services related to that function. More specifically, it affects the ability of the system to absorb anthropogenic and environmental stresses without losing resilience (Scheffer, Brock, and Westley 2000; Walker et al. 2004; Kinzig et al. 2006; Walker et al. 2006;). This entails a decrease in the security with which ecosystems are capable of suppling something people depend on and care about: the provisioning and cultural services (Perrings, Mooney, and Williamson 2010).

From very early times, biological invasions have been real and constantly present threat to human life, in many cases having a devastating impact in human society and demography (e.g. human pathogens and diseases) (Perrings, Mooney, and Williamson 2010). However important, human pathogens are not the only IAS that affect human health and livelihood. The rapid spread of IAS can also cause impacts in fundamental human activities, such as agriculture or aquaculture, since some of the introduced species may be weeds, pathogens or pests that can seriously jeopardize these vital human activities and, therefore, have serious economic implications, due to the enormous amount of money spent on their control, management and eradication (IUCN 2010; Perrings, Mooney, and Williamson 2010;). Bright (1999) estimated that introduced animals, plants and microbes costed between US$55 to US$248 billion to world's agriculture. Pimentel (2001,2005), predicted that, in the United States alone, US$100 billion are lost annually because of IAS. However, some authors consider this number an underestimation (Lodge et al. 2006). When it comes to Europe the numbers are lower but still around €12 billion per year, probably also a significant underestimation (Kettunen et al. 2009; Ham, Genovesi, and Scalera 2013). The ecological and economic impacts of invasive species are very much entwined, since most of the ecological changes that

make ecosystems susceptible to invasion, such as habitat fragmentation, pollution, loss of native biodiversity, are very often a direct consequence of economic activities (Perrings, Mooney, and Williamson 2010).

Once established and recognized as an IAS, the next ideal step would be the eradication of that species from the invaded environment. However, eradication, and other numerical control procedures, are extremely expensive and often impossible, for instance when the species has already become well-established and well-spread (Pimentel et al. 2001; Genovesi and Shine 2004; Hart and Downs 2014). Therefore, it is widely accepted that to decelerate the seemingly unavoidable homogenization of the world's diversity, the priority should be given to preventing unauthorized introduction and spread of invasive species and to the early detection of those introduced (Wittenberg and Cock 2001; Leung et al. 2002). In order to further reinforce the importance of prevention, in 2002, the CBD (Convention of Biological Diversity) Conference of the Parties implemented the Decision VI/23 and Guiding Principles introducing a "three-stage hierarchical approach" as the guidelines for all actions regarding IAS. Putting the emphasis on prevention of IAS introductions as the first line of defence, followed by the early detection and rapid action once prevention fails and, lastly, eradication as the preferred method to manage established IAS and containment and long term control measures as a last resort (IUCN 2010).

Due to the potential socioeconomic importance of IAS, the solution to this problem should regard both ecological and socioeconomic factors (Zavaleta, Hobbs, and Mooney 2001). In fact, humans are somewhat involved in the entire invasion process (García-Llorente et al. 2008), as a vector for introductions, accidental or intentional and as direct or indirect victims of their impacts. However, little attention has been focused on public attitudes towards IAS, probably because the difficult in measuring social impacts and the conflicts between different stakeholders (García-Llorente et al. 2008). Humans hold the mighty power to act and manage these species. So, it is imperative that we begin to understand how far the world's population is aware and sensitized for this problem.

1.2 The role of urbanized habitats in the success of IAS

The urban environment is defined as artificially covered surfaces (e.g. residential areas, industrial and commercial sites), corresponding to the geographical areas covered by cities, towns and their surrounding areas (Ham, Genovesi, and Scalera 2013). It is also characterized for having high levels of disturbance, high intensity of transport and high environmental heterogeneity (Ham, Genovesi, and Scalera 2013).

This type of habitat tends to have several consistent characteristics independently of their geographical location, since they are conceived and preserved to satisfy a limited set of human needs (McKinney 2006).

Human altered habitats, such as urban habitats, are commonly considered to play a key role on biological invasions (Czajka 2011; Ham, Genovesi, and Scalera 2013). Indeed, many IAS attain their highest densities in urban and peri-urban environments, not only because it is where the population of captive animals is bigger, and consequently there are more opportunities for escapes and liberations, but also because it is where lengthy history of human disturbance has left behind greatly damaged landscapes and therefor many openings for invasion (McNeely 2001; Blackburn, Lockwood, and Cassey 2009). Not only that but, cities are the focal point of the global economy and consequently, the entry point of many IAS (Ham, Genovesi, and Scalera 2013). This happens because of the considerable number of pathways, vectors and final recipients of alien species trade that are concentrated on urban areas. So, a big number of commodities arrive and pass through cities for trade and commercial activities, like botanical gardens, zoos, private and public gardens, nurseries and the pet industry, which can, ultimately, lead to the intentional or accidental introduction of IAS, increasing the propagule pressure (i.e. the number of released individuals) which facilitates the invasion process (Ham, Genovesi, and Scalera 2013).

Another issue that contributes to the vulnerability of cities to biological invasions is the wide variety of different habitat niches available, created by human activities that fragment landscapes and create artificial habitats, increasing the chances of a species finding a suitable habitat to settle into (Ham, Genovesi, and Scalera 2013; Strubbe and Matthysen 2009a). For example, urban parks are usually embedded in human landscapes and host peculiar ecosystem, biological communities and species (Rebele 1994; Clergeau et al. 2006). Additionally, the propagation of the invasive species into neighbouring landscapes is facilitated by the presence of transport corridors like water lines, railways and roads (Ham, Genovesi, and Scalera 2013). Also, the wide variety of shelter and food provided by human settlements, along with the lack of control, inexistence of predators and unaware citizens, that most of the time have no good understanding of natural processes and scenarios, make urban centres a good point of entry and settlement for IAS (Ham, Genovesi, and Scalera 2013).

1.3 Human dimension

Human population and activities have direct and indirect effects on the establishment of IAS. As a direct effect, human occupation and activities increase the probability of repeated releases and strengthen the introduction effort (i.e. number of individuals introduced and frequency of introduction). Indirect effects include ecosystem disturbance, habitat fragmentation and food provisioning (Strubbe and Matthysen 2009b). Humans can increase food availability either by direct food provisioning in parks or backyard birdfeeders or by introducing a wide variety of exotic plant species in urban parks and gardens (Chace and Walsh 2006). So, when acting on managing IAS it is imperative to include the human dimension in the battle.

Half of the world's population lived in urban areas on the turn of the 21st century, and this tendency has continued to grow, with the world becoming increasingly urbanized (McNeely 2001). Urbanization implies large populations with fast lifestyles that can easily escape the environmental consequences from miss-using resources (Staples 2001). Cities' fast lifestyle hinders people's capacity to develop a connection with the natural environment making it difficult for them to distinguish between native and alien species, or be concerned about the difference (McNeely 2001). In addition, the human perception of the presence and cost of IAS is very limited as biological invasions happen almost invisibly, without clear responsibility and with very limited initial impacts (McNeely 2001).

As well as having a big part on the introduction, establishment and spread of IAS, public attitudes greatly affect success rate of the eradication or control projects (Bertolino and Genovesi 2003; Burt et al. 2007; Cohen, Mirotchnick, and Leung 2007; Crall et al. 2010). The lack of political and public support and awareness of possible IAS threats, the generalized conception that eradication is impossible and lack of enthusiasm amongst conservationists for an activity many people find distasteful are some of the possible reasons for the low success rate of eradication projects in Europe (Temple 1990; Bertolino and Genovesi 2003;). Conservationist managers are aware that public support for their activities can be essential to the success or failure of the projects they take on (Bremner and Park 2007). The species involved and the methods of control used are also likely to affect the level of public support, especially for animals or plants the public find appealing or have cultural associations with (Manchester and Bullock 2000; Fraser 2006; White et al. 2011). Other factors influencing social perception include the severity and type of impacts caused by the species concerned (Reiter, Brunson, and Schmidt 1999; Fulton et al. 2004). One good example of the necessity of public understanding and evolvement in eradication projects is the case of the great effort to reduce the feral population of Monk parakeets (*Myiopsitta monachus*) in the U.S, made

in 1970, that successfully reduced the population by half. However, their popularity as pets meant that, once the eradication efforts ceased, the population rapidly recovered to original numbers (Butler 2003).

It is essential that people have a rather personal experience and grasp how IAS damage the environment and biodiversity, otherwise they will not realize the benefits of control and eradication programmes (Fraser 2006). An increasingly higher number of researchers are recognizing that the subject of the IAS is as much a social issue, encompassing political, economic and human factors, as it is a scientific one (Reaser 2001). The politics and society are part of the management of nature, and not having the support of the citizens or pressure groups can have negative consequences on environmental actions, such as eradication projects (Bertolino and Genovesi 2003). With the raising recognition of the need to involve the public on the decision-making process (Decker et al. 1996), public attitudes towards IAS must be better understood (Bremner and Park 2007).

IAS are, ultimately, a result of human values, decisions, behaviours and activities. However, these are also the key to the solution (Poorter 2001). IAS prevention and control are as much a science of managing IAS as they are a science of managing people. Public interest, participation and support of IAS prevention and management needs to be maximized (Witmer et al. 2009). Once we stop directing all our attention on IAS as the main problem and refocus on people's beliefs and consequent behaviour, new solutions will become apparent (McNeely 2001).

1.4 Invasive Pets

The ever growing trade of alien animals for the pet industry has opened the main gates for invasive species (Brown 2006). However, most new exotic pet owners are not aware of the commitment, financial burden and environmental risk owning an exotic pet implies (Henn 2015). Most of traded alien animals will not survive if released into a new environment, especially since we are now considering pets that are often raised by humans from a very young age and become dependent on us to survive but, there is a possibility that some will thrive in the new environment. The release can happen by accident (e.g. inadequate caging) or intentionally, once the animal becomes a nuisance to maintain or once financial problems emerge, for example (Witmer et al. 2009). However, it can also be done by breeders or pet dealers as consequence of economic fluctuations, for example, in the cage bird market that might leave breeders with birds that are costly to keep but that sell for little. The most likely outcome is that those breeders will release the unwanted birds (Blackburn, Lockwood, and Cassey 2009).

The global pet-trade is an international business and is vast in its reach, with approximately 40,000 primates, 4 million birds and 640,000 reptiles and 350 million fish are sold globally each year (Karesh et al. 2005). Global trade of all taxa is estimated to be around U.S $20 billion (Karesh et al. 2007).

Unsurprisingly, species more often kept in captivity as pets are more likely to have been transported beyond their native range (Cassey et al. 2004). The most commonly found species in captivity are also the most likely to become invasive, simply because a greater number of those individuals is probable to escape (Carrete and Tella 2008).

Wild-caught birds are among the most commonly traded vertebrate taxa with a considerable number of species having been introduced in foreign environments (Carrete and Tella 2008; Blackburn, Gaston, and Parnell 2010). Among these, Psittaciformes are one of the most heavily traded groups, mainly because of their popularity as pets (Tella and Hiraldo 2014). Not suprizingly, several parrot species have established non-native populations world wide (Lever 2005; Menchetti, Scalera, and Mori 2014).

1.5 Psittaciformes

Psittaciformes represent one of the most readily distinguishable avian taxonomic orders due to their vividly coloured plumage and popularity as pets, playing a predominant role among the alien species traded all over the world, being the most famous group of bird pets (Juniper and Parr 1998; Di Febbraro and Mori 2014). The most recognizable trait, is the characteristic curved beak. Another particularity of this order is the zygodactyl feet, with two toes pointing forward and two facing back, providing a very strong grip and, used with the bill as a kind of grappling hook enable this large arboreal group of birds to climb with great agility (Juniper and Parr 1998)

At present, 355 species are recognized in this order (del Hoyo et al. 1997; Juniper and Parr 1998). Among those, about two-thirds of all parrot species (approximately 237 species), are recorded as commonly transported beyond their natural geographic distribution (Cassey et al. 2004; Blackburn, Lockwood, and Cassey 2009;). Of those, almost one quarter find their way into exotic environments, some of which are highly invasive (Lowe et al. 2000; Cassey et al. 2004). About 60 parrot species (16.6% of total living species) are currently breeding in at least one country outside their native range, with populations mainly deriving from unintentional releases that are responsible for the presence of at least 31 species of Psittaciformes all over Europe, 11 of them currently breeding in at least one country (Di Febbraro and Mori 2014; Menchetti and Mori 2014). Considering all these numbers it is possible to say that this group of birds present all the

necessary features that characterize the "best invader" such as high ecological plasticity and synanthropy (Duncan, Blackburn, and Sol 2003; Blackburn, Lockwood, and Cassey 2009; Di Febbraro and Mori 2014).

1.6 Especially invasive parrots: the case of the Monk parakeet and the Rose-ringed parakeet

Small to medium-sized, widely distributed species (e.g. *Agaponis* spp.*; Amazona* spp.*; Myiopsitta monachus, Psittacula* spp.) are the most prone to establish non-native populations, because they are: more traded than others, commonly sold at relatively low prices, highly synanthropic and adapted to live in a variety of environmental conditions, i.e., different latitudes and habitat types (e.g. Duncan, Blackburn, and Sol 2003; Cassey et al 2004). Among them, the Rose-ringed parakeet (*Psittacula krameri*) and the Monk parakeet (*Myiopsitta monachus*) are considered the most effective Psittacines species to colonize new territories where historically absent (Cramp and Brooks 1992; del Hoyo et al. 1997;).

Rose-ringed parakeet has long been a popular pet. Escapes and releases resulted in the establishment of many alien populations (Clergeau and Vergnes 2011). It is currently considered as the most globally invasive parrot species and the most widely distributed Psittacine, with established populations in at least 35 countries outside its natural dispersion (Juniper and Parr 1998; Butler 2003). In those invaded areas, the Rose-ringed parakeet populations reach incredible dimensions. In Europe, where this species established during the late 1960s and early 1970s, there currently exists a total population of 85,120 birds, with a strong hold in large metropolitan areas. This has landed this species in the list of the 100 most invasive species in Europe (Butler 2003 DAISIE 2009; Czajka 2011; Pârâu et al. 2016). One of the biggest European populations is settled in the United Kingdom where the population has reached 31,000 individuals (Pârâu et al. 2016). Other examples throughout Europe include: Belgium with approximately 10,800 individuals, Germany with 10,960, the Netherlands with 10,000 and, finally, Portugal, who currently holds around 800 individuals (Pârâu et al. 2016).

Rose-ringed parakeet (*Psittacula krameri*), naturally occurs in two distinctive areas: i) Africa, in tropical sub-Saharan regions, such as Senegambia and Somalia. ii) in some areas of southern Asia, from western Pakistan to central Burma and in India. It has been introduced in countries as diverse as the USA, northern Egypt, Singapore and many others places (Juniper and Parr 1998; Butler 2003).

It is a medium sized (38-42 cm) slim, predominantly green bird with a large red bill, whose tail accounts for more than half of its length (up to 25 cm). A band of rose, or light red, encircles the neck of the males, along with a black bib that extends from underneath the bill and encircles the neck, it many also develop a blue sheen on the back of the head. The ring appears in males by the time they reach three years of age. Females lack the rose-coloured ring, having instead an emerald ring that is nearly indistinctive (Figure 1) (Juniper and Parr 1998; Butler 2003; Forshaw 2010).

Figure 1 - Rose-ringed Parakeets (Photo by: Alvaro Luna©).

This parakeet is able adapt to many habitat types characterized by the presence of trees and cavities (Cramp and Brooks 1992). It occurs in a variety of woodland types, from light secondary moist forest, riparian woodland, mangroves through savanna grassland, open farmland with scattered trees, parks and gardens in urban areas. Like most parakeets, it's a highly gregarious species, especially outside breeding season, forming large noisy flocks, sometimes of several thousands of birds, it breeds in loose colonies, feeds in groups and roosts in large gatherings (Forshaw 2010).

As secondary cavity nesters, the Rose-ringed parakeet depends on holes made by other species, such as the great spotted-woodpecker (*Dendrocopos major*) and the green-woodpecker (*Picus viridis*), or natural cavities, to nest. But, there has also been records of birds nesting in rock cavities, building cavities and nest boxes (Juniper and Parr 1998; Butler 2003). Regarding its diet, the Rose-ringed Parakeet feeds on a big variety of food items such as fleshy-fruit, dry seeds and insect larvae (Juniper and Parr 1998; Martin et al. 2014). The flexibility of the diet of this bird species may indeed be the reason that allows it to exploit such a wide variety of natural, cultures and supplemented food sources, and be the key to its invasive success (Clergeau and Vergnes 2011).

In the native range, especially in the Indian peninsula, the Rose-ringed parakeet is considered the worst pest species (Dhindsa and Saini 1994). As for the introduced regions, records of agricultural damage caused by this species are locally significant and growing (Butler 2003; Chapman 2005). Another concern with this species is their potential ability to transmit diseases to both humans and native avifauna (Menchetti and Mori 2014). Additionally, cavities are considered a limited resource in urban and suburban areas, where most decaying trees are eliminated (Wesołowski 2007). This has

been suggested to incite direct competition with native fauna that uses the same method for nesting, such as squirrels, bats or other birds (Cramp and Brooks 1992; Fletcher and Askew 2007; Dodaro and Battisti 2014; Hernández-Brito et al. 2014).

Likewise, the Monk parakeet (*Myiopsitta monachus*) is a very successful invader (Lever 2005). Due to the parrot trade, escapes from captivity and deliberate releases by people that kept them as pets, this species has been able to establish several breeding populations in countries outside their natural dispersion area, such as the USA, Puerto Rico, England, Belgium, Italy, Spain, Israel and many others (Spreyer and Bucher 1998). This incredible ability has landed this species the spot as the most abundant and widely distributed parrot in both Spain and the USA (Muñoz and Real 2006). As an illustration, in Barcelona only, the current Monk parakeet population is thought to reach over 5,000 individuals (Senar et al. 2016). Naturally, this species occurs in south America, from central Bolivia and southern Brazil to central Argentina (Forshaw 2010), where it inhabits open forests, forestry plantations, orchards, savannas and urban settlements (Davis 1974; Sol et al. 1997; Aramburú and Corbalán 2000).

The Monk parakeets are non-territorial, highly social parrots with a very complex communication system (Sol et al. 1997). It is slightly smaller than the Rose-ringed parakeet at only around 33 cm in length. The feathering is mostly green with a conspicuous grey chest, throat and forehead. On the wings, the secondaries and flight feathers are blue. The tail is blueish-green, long and pointed. The beak is rosy to dull flesh colour (Figure 2) (Davis 1974; Juniper and Parr 1998). Contrary to Rose-ringed parakeet there is no sexual dimorphism, but females tend to be bulkier and have a longer and stronger beak (Davis 1974). Their diet consists of seeds, fruit, berries, nuts, leaf buds and blossoms of a great variety of plants and, in some cases, insect larvae (Sol et al. 1997).

Figure 2 - Monk Parakeet in its nest in Passeio Alegre (Porto) (Photo by: Inês Carneiro©).

Unlike the great majority of Psittacines, the Monk parakeet is not a cavity nester, instead, this species has developed the ability to build large nest structures out of entangled twigs (Figure 2), with several chambers for individual breeding pairs, built on tree brunches and man-made structures (Avery et al. 2002). Often, several nests are clustered in the same or nearby trees, forming colonies used for roosting year-round as

well as during breeding season, being the centre of most of their daily activities (e.g. nest maintenance, allopreening etc.) (Eberhard 1998).

The presence of Monk parakeets implies problems with noise pollution, falling nests, damage to agriculture (e.g. fruit crops in Florida, USA (Pruett-Jones and Tarvin 1998)) and aggressiveness towards native avifauna (Davis 1974; Freeland 1972; Long 1981;Temple 1992). This parakeet has been characterized as highly aggressive towards other birds, especially while defending their nests and feeding sites, there are records of Monk parakeets killing blue-jays (*Cyanocitta cristata*), American robins (*Turdus migratorius*) and House sparrows (*Passer domesticus*) (Freeland 1972; Davis 1974; Long 1981). When in urban environment, this species seems to have a preference for building their nests on man-made structures, such as power transformers or electrical posts, creating the perfect setting for hazardous consequences, like short-circuits and electric fires (Pruett-Jones and Tarvin 1998; Avery et al. 2006; Menchetti and Mori 2014). Lastly, the Monk parakeet also has a great potential for the dissemination of the Newcastle disease (Fitzwater 1988; Butler 2003).

Both Rose-ringed parakeet and the Monk parakeet are rowdy and continuously vocal when in flight, thus causing a constant nuisance in the surroundings of resting and breeding sites (e.g. residential areas, urban parks) (Stafford 2003; Chapman 2005; Menchetti and Mori 2014). A small group of eight to ten Monk parakeets can produce an unbelievable amount of harsh squawking that can be hear from a distance of five city blocks (Davis 1974).

Despite being considered an annoyance by some, the conspicuousness and attractiveness of these two parakeets, so distinctive from our native avifauna, often makes them favourites for local birdwatchers and animal lovers making these species a valued and charismatic component of the local avifauna in many communities (Avery et al. 2006). Residents and workers of neighbouring dormitories provide food, encourage the bird's presence and facilitate their survival during the winter. Ultimately, many people consider the parakeets as a positive community resource and efforts to remove the birds or their nests are often met with serious opposition (Russello, Avery, and Wright 2008).

1.7 Goals

With this study, our first goal was to identify and dimension the two biggest colonies of Monk parakeets and Rose-ringed parakeets in the city of Porto, through weekly roost counts. Then, we aimed to collect and analyse information on the perception of the people of the metropolitan area of Porto about the populations of Rose-ringed parakeet and the Monk parakeet. For this, we developed a questionnaire to question

people about their opinion about the recent and growing presence of the parakeet in Porto gardens and parks. Additionally, we also tested whether perception changes when people are informed or reminded that the parakeets are non-native. With this we hoped to get a better insight, not only to what extent local people can discriminate between native and exotic avifauna and to which extent they are sensitized for the issue of invasive species, but mainly, their opinion about the parakeet population.

2 Non-native Psittaciformes in the city of Porto

The presence of Psittaciformes flying freely alongside the native avifauna is not something new in the city of Porto. Several species have been spotted in various places, in the city of Porto and in its metropolitan area. Common pet species like the common pet Budgerigar (*Melopsittacus undulatus*), the Cockatiel (*Nymphicus hollandicus*) and the Fischer's lovebird (*Agapornis fischeri*) have all been registered in the wild (Matias, 2011a, 2011b), though they failed to establish viable populations.

The Rose-ringed parakeet has lived along-side our native avifauna, at least, since 1977 (Matias, 2008). In Porto, it has been present for around 15 years, with observations of isolated individuals occurring since 2002 (Matias, 2002, 2003, 2004). The first record of the Monk parakeet was in Lisbon, in 1999, on the free access gardens of the zoo (Matias, 2011a). In Porto, the first official registration was in 2008 (Matias, 2011a).

2.1 Rose-ringed parakeet in the city of Porto

Currently, this species can be frequently seen in Porto's city park, where the roost counts where conducted, and sporadically in other parks like S. Roque park. Porto's city park is considered the biggest urban park of Portugal, with a total area of 80 ha and 11 km of tracks. Its geographical location, on the northern border of the city, right alongside the coast, makes it one of the few urban parks in the world, and the only one in Europe, to have an ocean front and direct access to the beach (Câmara Municipal do Porto 2002)

In the beginning of the roosts counts, we believed that the roost was located in the Eucalyptus patch located in the northern part of the park. However, at present time, they seem to have moved to another location, possibly outside city park but nearby, as they still are very commonly seen foraging, flying and socializing in the park.

The roost counts were initiated an hour before sunset, in a location that allowed us to see the birds coming back to the roosts after spending the day foraging in other locations. During this period of the day, parakeets were generally flying and calling loudly on route to or at the roost, facilitating detection due to their loud and distinctive shriek (Hart and Downs 2014).

The change of roost site, the high tree density and tree height of the area where the Rose-ringed parakeet colony was located, greatly influenced bird detection, which resulted in a lack of consistency and veracity in our data. Therefore, we decided not to use any statistical analysis for the analysis of the results of the roost counts of this

species, instead we based our final result on the higher number of birds seen at the same time: 16 birds (Figure 3).

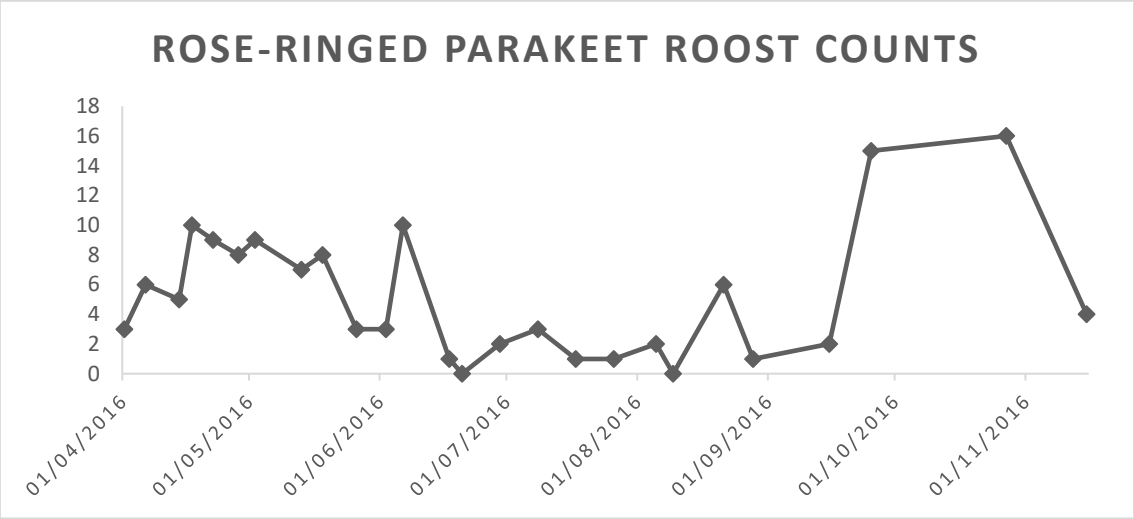

Figure 3 - Temporal distribution of Rose-ringed parakeet roost counts totals in Porto City Park.

2.2 Monk parakeet in the city of Porto

Nowadays, the main group of Monk parakeets in Porto has its nests set on the palm trees of Passeio Alegre Garden. This emblematic garden is located near the mouth of Douro river, in Porto side of the river. This public garden is one of the most singular green areas of the city. With a total of 41.000 m^2, its flanked, on the river side, by the famously called "Palm Avenue". Those palm trees (*Phoenix canariensis*) were given the status of public interest, due to their age, around 100 years old, and their high equity, ecological, landscape, cultural and historical values (Câmara Municipal do Porto 2017).

The Monk parakeet roost counts were done in a similar fashion to the ones made for the Rose-ringed parakeet. The counts started one hour before sunset, in a place that enabled us to view all the nests, and the parakeets entering and leaving the nests were registered. Like the

Monk parakeet	
Mean	31
Standard Error	1
Median	31
Mode	31
Standard Deviation	6.405
Sample Variance	41.028
Kurtosis	0.164
Skewness	-0.561
Range	28
Minimum	13
Maximum	41
Sum	1572
Count	51
Confidence level (95.0%)	1.801528

Table 1 - Statistical results for the Monk parakeet roost counts in Passeio Alegre (Porto).

Rose-ringed parakeets, during these times of the day, the Monk parakeets were frequently calling loudly, facilitating detection due to their loud and distinctive shriek.

For the analysis of the Monk parakeets roost counts we decided to use a basic descriptive statistical analysis with Microsoft Excel (2016). In total, we did 51 counting sessions over the course of approximately 1 year (Figure 4). The average bird count achieved on the weekly counting sessions was 31 birds (Table 1).

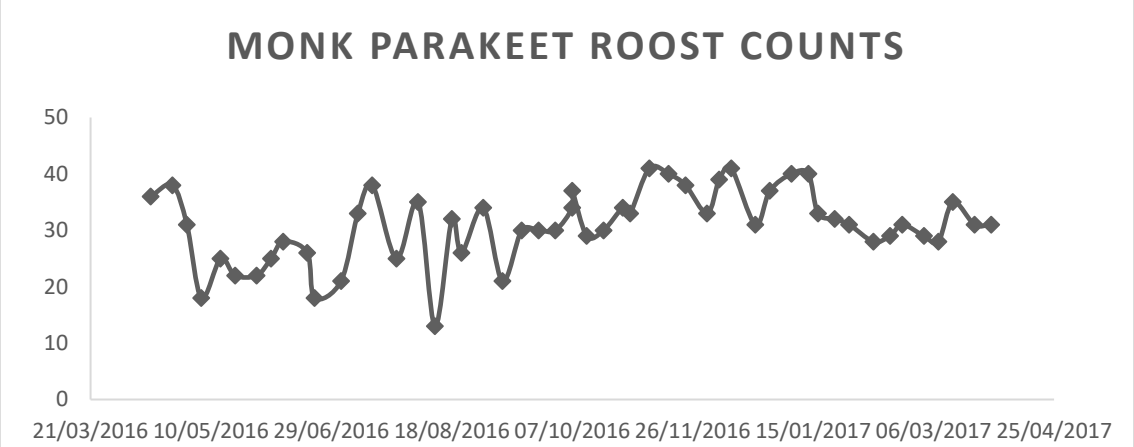

Figure 4 - Temporal distribution of Monk parakeet roost counts totals in Passeio Alegre Gardens.

2.3 Current situation of the two biggest parakeet colonies of Porto

According to the results obtained through our weekly roost counts, both species seem to be in an early stage of establishment and spread, especially the Rose-ringed parakeet that is still far from reaching population levels of Lisbon where, in 2003, were over 150 birds in a single roost (Matias, 2008). However, from our experience in the different parks and gardens of the city, it's clear that both species are in the process of colonizing more green spaces of Porto. One example of this is the newly presence of Rose-ringed parakeets in the eastrn part of the city, namely in S. Roque park and garden Dr. Francisco Sá Carneiro (pers. obs). The same happened with the Monk parakeets, who in November built a nest in Praça da Républica gardens, having abandoned it shortly after (pers. obs). The Monk parakeets has also been recently seen in Planetarium gardens (pers. obs) (Figure 5).

Figure 5 - Localization of counted roosts (Rose-ringed parakeet in blue; Monk parakeet in green) and new parakeet sightings (Rose-ringed parakeet in red; Monk parakeet in purple) (Source: Google maps accessed on 15-07-2017).

3 Social perception towards alien populations of parakeets: the case of the Monk parakeet and the Rose-ringed parakeet

Invasive species are a classical example of how different groups of people can have different values, perceptions and knowledge about an ecological question (García-Llorente et al. 2008; Webb and Raffaelli 2008). Since we are dealing with two potentially invasive species, the Rose-ringed parakeet and the Monk parakeet, with proven socioeconomic and ecological impacts, it is of major interest to study, in depth, all their populations outside native areas. In the city of Porto, we have the "advantage" of these species apparently being at an initial stage of invasion/establishment, as seen on the previous chapter. However, these species are now a small numbered but common presence in parks and gardens of Porto, and therefore studies should be conducted in order to better control these populations, before they reach levels that make intervention difficult or even impossible. It is also of interest, to understand to what point people are interested, sensitized and understand the need to control invasive species, hence the interest in knowing the perception in the metropolitan area of Porto.

Questionnaires, or social surveys, are used to test research hypotheses when information from a specific human target population is required. A subset of the target population is approached by the researchers and asked to participate in the questionnaire by providing information. Data is collected from respondents and analysed to test the hypotheses (White et al. 2005).

The use of questionnaires in ecology has increased over the last decade, since questionnaires are considered especially suitable tools for approaching certain topics in ecology, such as, studies of public or stakeholder insights on ecological management and interdisciplinary studies that include ecological and non-ecological components. Another good example are the studies concerning human impacts on wild species and human behaviour in relation to wild species, where questionnaires often provide the best means of obtaining quantitative data from a large number of sites. Questionnaires are also useful for quantifying human behaviour, for example, perceptions or attitudes towards conservation strategies and/or the implementation of environmental conservation directives (Kerr and Cullen 1995; White, Bennett, and Hayes 2001; Jim and Xu 2002; Bouton and Frederick 2003; White et al. 2003).

Postal surveys are the most commonly used method to implement questionnaires, followed by in-person interviews and phone surveys (White et al. 2005). We decided to use in-person interviews, not only to prevented respondents from seeking

information but also from forming groups to answer the survey. One considerable problem of most surveys is people's unwillingness to collaborate or doing it with little enthusiasm (White et al. 2003). Further, people frequently ask or try to guess the nature of the underlying question, which might influence their answers (Fernández 2014). Thereat, we opted to use a visual approach which was appealing, easy to do, and gave away minimum information about the purpose of the survey.

3.1 Methods

3.1.1 Study area

The city of Porto is located on the northwest coast of Portugal and has a total area of 45 km^2 and a population of approximately 214.349 residents (INE and PORDATA 2017). It is the second biggest city of Portugal, capital of the northern region of the country and of the metropolitan area of Porto, which holds 1.721.320 habitants (INE and PORDATA 2017). The city is geographically limited by the counties of Matosinhos and Maia on the north, Gondomar in the east, Douro river on the south (12 km of river coast) and the Atlantic Ocean on the west (5km of sea coast) (Figure 6). (Visitporto 2013)

Figure 6 - Geographical localization of Porto city (Source: Google Earth accessed on 20-08-2017).

3.1.2 Population inquiries on social perception of alien parakeets

For the questionnaire, previously developed and used in Seville (Alvaro Fernandez, Pimm Edelaar and Assaf Schwartz, unpublished work), we developed a plate with images of twenty bird species (Appendix 1 Figure 13). The species selected to be present in the plate had to meet the following criteria: i) species that commonly occur in the parks and gardens of the city of Porto, ii) species that are easily recognizable by the public and iii) belong to different taxonomic groups, such as granivorous, insectivorous, birds of prey and even marine birds. We also included the Rose-ringed parakeet and the Monk parakeet. Along with the parakeets we included four more exotic bird species, some present in Porto, other present in other parts of Portugal where they register considerable numbers Crested myna (*Acridotheres cristatellus*), Common waxbill (*Estrilda astrild*), Rock dove (*Columba livia*), Yellow-crowned bishop (*Euplectes afer*)). The selected species also differed in colour, including a gradient from colourful species to single monochromatic species. Though they also differ in size, we decided to portray them in the same size on the plate, to avoid biases with respect to visibility and

conspicuousness. Moreover, the position or specific characteristics of any given image may influence whether it is selected or not. Therefore, we developed six different plates, always using the same set of 20 species (Appendix 1 Figure 13). For this, we selected three different images for each species: one in which the bird appeared with muted colours and rather unimpressive, one intermediate, and another with bright colours. Next, the location of the species in each of those plates was selected randomly, so that each plate of a given colour had two versions where the birds appeared in different positions. With this approach, we tried to avoid effects in the selection of the species due to the position in the plate or due to the appearance of the species in one particular image, thereby obtaining more general results.

Besides testing for differences in social perception of the parakeet due to prior experience and potential impacts, we also tested if there was a social norm to have a negative opinion and/or act against non-native species. So, we developed three more versions of the plates, one bright, one medium and one of dark colour, where the exotic species where identified with the text "Non-native". With these versions, we expected that people would be less disposed to select a non-native species, due to the negative connotation of the expression, whereas people who favour novelty may be more prone to select them.

To test whether social perception of the parakeets depends on prior experience or potential impacts of the parakeet presence, we rendered this survey to four predefined groups of people that, we believed, had different perceptions of the parakeet because of their different levels exposure to the parakeets. The groups were: visitors of parks with parakeet, visitors of parks without parakeets, workers of parks with parakeets and Passeio Alegre's recreational fishermen. This last group was taken into account since they spend long hours fishing right under the nests of the Monk parakeets, so we expected them to have an interesting perception.

We carried out between 50 to 60 surveys per group. In the case of visitors of parks, to select people in an unbiased way, we invited every third person encountered to carry out the survey. When the third person was less than 16 years old or someone who was not from the metropolitan area of Porto, we again took the third person encountered. In the case of fishermen and workers, due to the limited numbers of people available in these groups, the surveys were made to all suitable subjects encountered. Regarding the visitors of parks without parakeets, we selected parks without known presence of parakeets within the city Porto. The surveys of the group fishermen were done only on Passeio Alegre. The surveys of the group visitors of parks with parakeets where done in: Passeio Alegre garden, Porto city park, S. Roque park and Praça da Républica, the last two also used as parks without parakeets before the first sightings of

parakeets. In total, the surveys where done in 11 different green spaces of Porto, namely: Jardim da corujeira, Jardim do Marquês, Rotunda da Boavista, Jardim da Cordoaria, Palácio de Cristal, Jardim das Virtudes, Jardim Botânico, Jardim Francisco Sá Carneiro e Parque de S.Roque.

On the first approach, respondents were asked to answer a few questions for a University of Porto study. If the answer was positive, we first asked each respondent to choose ten out of the twenty birds, on the randomly selected version of the plate, that he or she would like to see present on the environment (garden or park) in which that particular survey was done. We expected that if the parakeets were positively perceived, it would be included in the set of 10 birds with a greater possibility. By not asking anything specific about the parakeet and by not responding to any question about the purpose of the survey or the species shown, we hoped to avoid influencing people's answers.

After this visual part of the survey, we asked three questions that allowed us to evaluate the level of knowledge of the subjects. The questions where: "Do you know this bird?"; "Could you say its name?"; "Have you seen this bird here?". In Porto, the two target parakeet species are present in different parks/gardens so, the visitors of parks with parakeets and the workers of parks with parakeets, where asked accordingly to the species present in the park or garden where the surveys were done. When in parks without parakeets we alternated, meaning that the first person was asked about the Monk parakeet, the next was asked about the Rose-ringed parakeet and so on, so that, in the end, we had equal number of questionnaires about both species. The Fishermen were only asked about the Monk parakeet since that's the specie present in Passeio Alegre.

Then, we presented them with the second part of the survey, where the subjects had to value 11 different characteristics attributed to the Rose-ringed parakeet or Monk parakeet, accordingly to the species they were asked about in the previous part. The characteristics ranged between positive and negative adjectives (e.g. Ugly vs. Pretty; Clean vs. Dirty etc.) (Appendix 1 figure 14). We chose characteristics that, to some extent, overlapped or had somewhat similar meanings (e.g. Unfriendly and Harmful), so that we could check if people answered consistently. To prevent unthoughtful answers, the position of the adjectives where randomly assigned, which means that the negative adjectives could be either on the left or the right side of the scale. We expected that if people had a more positive opinion about the parakeets, they would give scores more towards the positive adjectives, and that those people would be the same ones that selected the parakeet on the visual part of the survey.

To finish the survey, we asked a short series of social and demographic questions which allowed us to characterize differences among subjects, which may also influence social perception and differ between our pre-defined groups. We asked for information

about gender, year of birth, city where lived before 16 years of age, city where currently lives and last educational degree achieved.

3.1.3 Statistical analysis of population inquiries on social perception of feral parakeets: Factors affecting the selection of the parakeets

To test which variables determined the selection, or not, of the parakeets, we started by fitting Generalized Linear Models (GLM) with all predictors of interest (the full models). Besides testing for the main effects of interest – the groups and the availability of information of non-native information – we also tested for possible effects of all other socioeconomic factors, prior knowledge and experience and the effect of plates of different colours. The GLM's, using the binomial error and a logistic link function, were fitted using the following fixed effects: Group (4 categories), Non-native information on the plate (yes or no), gender (male or female), age (numeral), place where respondent lived before the age of 16 (city<Porto, Porto, city>Porto), place where respondent currently lives (city<Porto, Porto, city>Porto), last educational degree, the answer to the questions "Do you know this species?" and "Have you seen this bird here?" (yes or no), and type of plate. The selection of the parakeets was used as dependent variable.

Before proceeding, we checked whether there was collinearity within the model predictors, by computing the variance inflation factor. Since none of our variables showed values higher than 5 (VIF>5) we considered all variables in the subsequent analyses.

From the full models, we selected the variables that had a higher importance in the model prediction, to later use them in a final GLM model, using an Information Theoretic approach. We used the function "dredge" (automated model selection) to fit every possible model with the full set of variables and then, the function "model averaging" to obtain the importance value for each variable. The importance value was computed as, the sum of all Akaike weights of the models in which the variable was present (Barton 2015). We then picked the variables with an importance value higher than 0.5, and fitted a final GLM for the selection of the parakeet using only those variables as predictors.

All these analysis, were conducted separately for the selection of the Rose-ringed parakeet and for the selection of the Monk parakeet.

3.1.4 Non-native information effect on the selection of the non-native species

To investigate the effect of the presence of the non-native information on some versions of the plate we used the model for each non-native species, with the factor "presence of non-native information" as a fixed effect and the selection of the species as a dependable variable.

3.1.5 Factors affecting the attitude towards the parakeets

To determine which variables influenced the overall attitude of the respondents towards the parakeets, we fitted GLMs with the same set of predictor variables as before, but using the overall attitude - i.e. the sum of the 11 scores given on this part of the survey - as the dependent variable.

We repeated the same procedure as above (dredge, model averaging and variable importance) with these models to fit a final GLM including only those variables with an importance value higher than 0.5. These analyses were done separately for both parakeet species.

We then analyzed in more detail which components of the overall attitude were more influenced by those variables. To do so, we summarized the results of the second part of the survey (i.e. the scores people gave to certain characteristics of the parakeets), with a Principal Component Analysis (PCA) using the function "prcomp". We used the loadings of each variable on the principal components to interpret the main axes of variation in people's attitude and assess which parakeet characteristics were directly or inversely correlated. Then, to ascertain which variables determined the opinion of the respondents, we did another GLM using the same independent variables as before, but using the scores of the principal component as dependent variable, instead of the overall attitude.

Finally, to test the hypothesis that the selection of the parakeet was intimately related with the attitude or opinion of the respondent towards the parakeet, we performed a Pearson correlation test between the selection of the parakeet and the PCA scores of the first two axis. This was done separately for the Rose-ringed parakeet and for the Monk parakeet.

We used the statistical software R (R Core Team 2014) to perform some basic data analysis, to execute Generalized Linear Models (GLM) and to perform PCA. We used the following packages:"ade4"; "psy"; "VIF"; "psych"; "ade4TkGUI"; "lattice"; "CAR"; "AER"; "MuMIn"; "effects"; "lmerTest". The variable codification used for the statistical analysis is available in Appendix 2.

3.2 Results

3.2.1 Parakeets selection

A total of 223 surveys were conducted, namely: i) 50 surveys assigned to workers of parks with parakeets, ii) 60 surveys assigned to visitors of parks with parakeets, iii) 60 to visitors of parks without parakeets and iv) 53 assigned to recreational fishermen in Passeio Alegre.

Regarding the first part of the survey, where people had to choose 10 species, over half of respondents chose a parakeet and only about 20% chose neither species of parakeets (Figure 7).

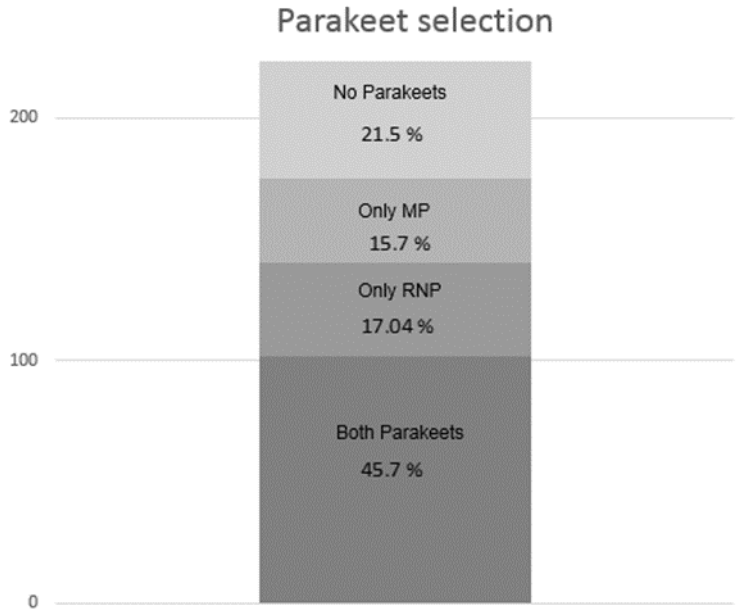

Figure 7 - Results for the selection of the Parakeets in the first part of the survey, where respondents had to select 10 out of 20 species (n=223).

3.2.2 Factors affecting the selection of the parakeets

The GLM results, for both species, showed very low percentages of deviance explained (Table 2). Regarding the Rose-ringed parakeet, the variable "Age" seems to be the one who had a slight influence on the selection of this species (p=0.043; percentage of deviance explained =1.42%) (Appendix 3 Table 8). The coefficient suggests that older people are less likely to select this species, while younger people selected it more frequently. The same analysis for the Monk parakeet showed that the

variable "place where lived before the age of 16" was the most relevant variable (p= 0.027; percentage of deviance explained = 1.66%) (Appendix 3 Table 9). The coefficient suggests that people who lived in cities smaller than Porto before the age of 16 tended to select the Monk parakeet more often than those who lived in Porto or in cities bigger than Porto.

Table 2 - GLM results for the important variables effects on selection and attitude towards the parakeets.

Model	Variable	Coefficient	Standard error	t value	Pr (>|z|)	% deviance explained
GLM for the selection of RRP	Age	-0.0167	0.008	-2.023	0.043	1.42
GLM for the selection of MP	Place where lived before the age of 16	-0.616	0.278	-2.215	0.027	1.66
GLM for attitude RRP	Gender	-3.94	1.827	-2.157	0.034	13.88
	Last diploma	-1.74	0.784	-2.217	0.029	
	Information native	3.04	1.903	1.599	0.114	
GLM for attitude MP	Age	0.101	0.037	2.734	0.007	5.21

3.2.3 Level of knowledge about the parakeets

The results of the analysis of the answers to the questions performed to evaluate the level of knowledge of the respondents about the two species of parakeets, showed that, overall, the Monk parakeet had the most positive answers to the question "Do you know this species?" (Figure 8). The groups "Recreational fisherman" (n=53) and "workers of parks with parakeets" (n=25) were those who better knew this species. Considering the Rose-ringed parakeet, the groups of visitors of parks with (n=30) and without parakeets (n=30) were the ones who better knew this species.

When questioned about the name of the species all respondents mentioned names that are associated with the Psittacidae family (Figure 9). The category "others" includes: Agaponis, Macaw, Cockatiel and Loris. Only in the case of the Rose-ringed parakeet, a total of three people aswered the exact name of the species or a synonym like "periquito rabijunco".

Regarding the question "Have you seen this species here?" the Monk parakeet had a considerably higher percentage of sightings than the Rose-ringed parakeet (Figure 10). Recreational fishermen were the group who more frequently answered positively to this question.

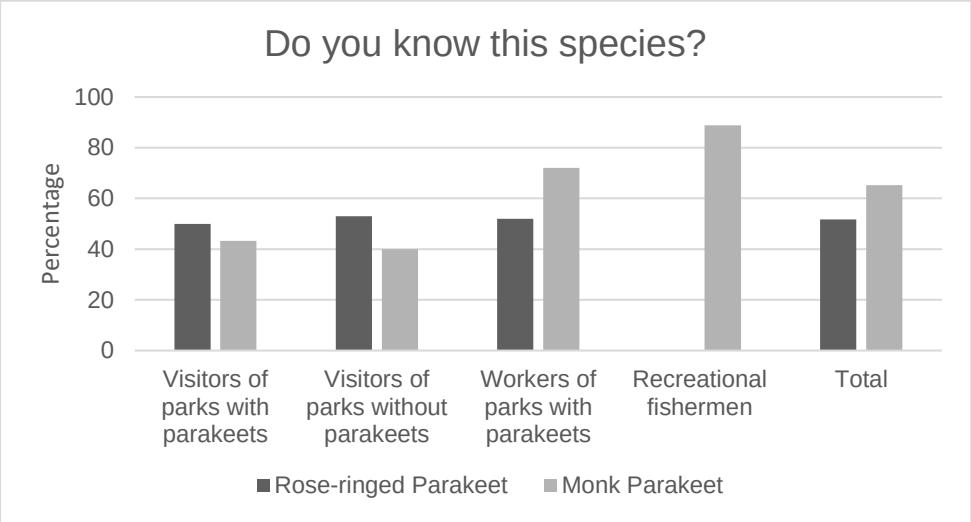

Figure 8 - Percentage of positive answers to the question "Do you know this species?" (visitors of parks with parakeets n=60; visitors of parks without parakeets n=60; workers of parks with parakeets n =50; recreational fishermen n=53).

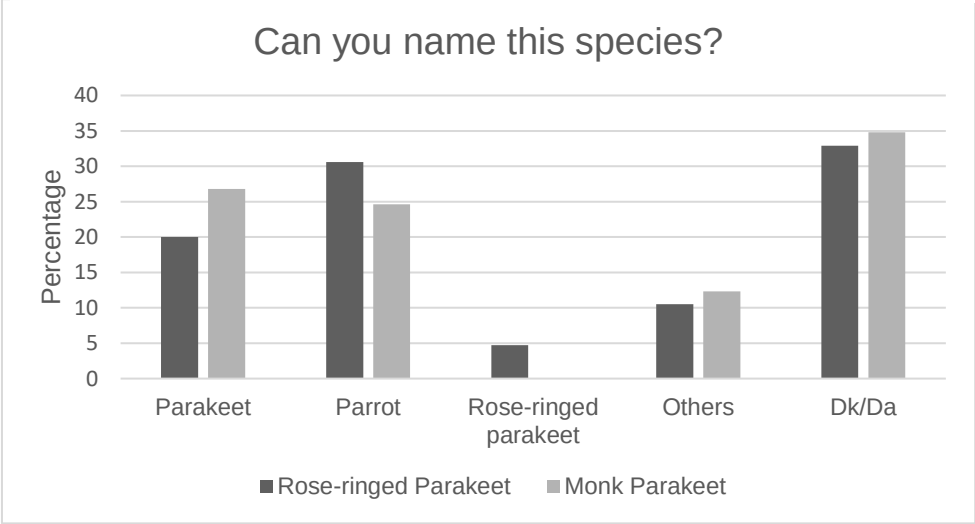

Figure 9 - Percentage of answers given to the question "Can you name this species?" (n=223).

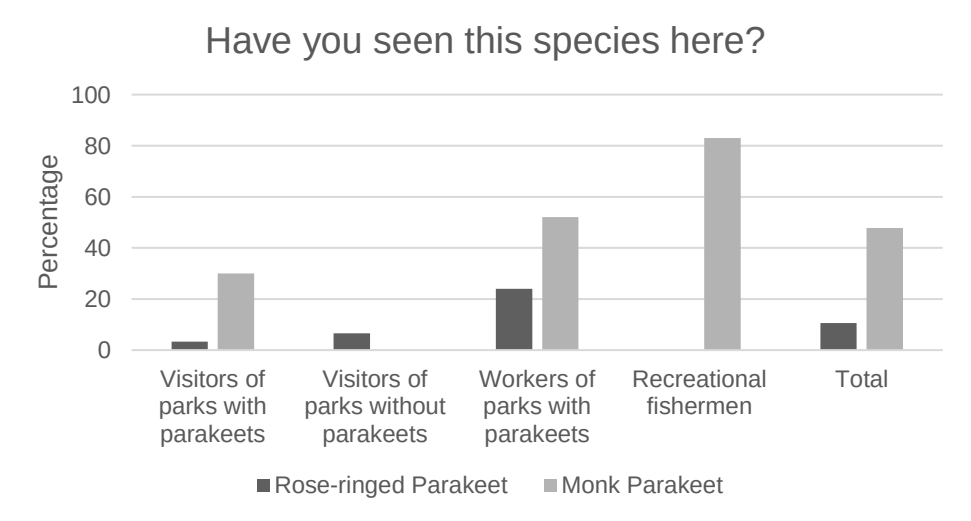

Figure 10 - Percentage of positive answers to the question "Have you seen this species here?" (visitors of parks with parakeets n=60; visitors of parks without parakeets =60; workers of parks with parakeets n =50; recreational fishermen n=53).

3.2.4 Effect of non-native information on the selection of the non-native species

The GLM results fitted to investigate the effect of the presence of the non-native information in some versions of the plates showed that only in the case of the Common waxbill, did the presence of non-native information have a significant effect over the selection of the species (Table 3). However, this effect was very weak (p=0.018; Percentage of deviance explained = 5%). The results suggest that people tended to select this species less when it was explicitly tagged as non-native.

Table 3 - GLM results fitted with the selection of the non-native species as a dependent variable and presence of non-native information as an independent variable.

Non-native Species	Coefficient	standard error	z value	Pr (>|z|)	% deviance explained
Rose-ringed Parakeet	-0.678	0.469	-1.446	0.148	1.856
Monk Parakeet	-0.303	0.464	-0.653	0.514	0.367
Rock dove	0.448	0.597	0.751	0.453	0.729
Common waxbill	-1.124	0.476	-2.359	0.018	5.053
Crested myna	-0.288	0.487	-0.591	0.555	0.317
Yellow-crowned bishop	-0.501	0.517	-0.969	0.333	0.975

3.2.5 Factors affecting the attitude towards the Rose-ringed parakeet

The GLM results showed that the variables "last diploma achieved" (p= 0.029), gender (p=0.034) and "Presence of non-native information on the plate" (p= 0.114) were the variables that had effect on the overall attitude towards this parakeet species (Appendix 3 Table 10), yet the effect was weak (percentage of deviance explained = 13.88 %) (Table 4). However, "Presence of non-native information" did not seem to have a significant effect (p>0.10). These results suggest that people with a lower schooling degree and males have a more positive attitude towards this species.

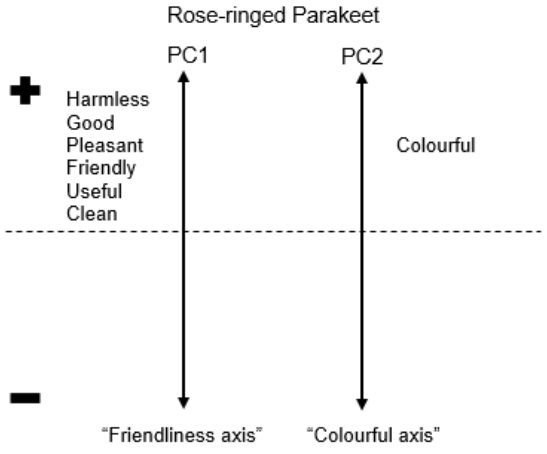

Figure 11 - Most important variables associated with each PCA axis. Variables presented in order of importance (loadings>0.30).

Regarding the PCA results, the first axis, henceforward called "friendliness axis", represents the gradient

of opinions among those people who think this parakeet is friendly, harmless, pleasant, good and useful versus those that think the opposite (Figure 11). The second axis, henceforward referred to as "colourful axis", shows the gradient between who think of the parakeet has a colourful bird versus those who find it muted coloured. The first axis accounts for 28.73% of the variance and the second one 16% (see Appendix 4, Table 12 and Figure 15).

The GLM modelling of the Friendliness axis (scores of PC1) as a function of the social variables, showed that the last diploma achieved (p=0.008), gender (p=0.09) and plate colour (p=0.075) were the most relevant variables influencing the friendliness opinion of people (percentage of deviance = 15.6%) (Appendix 5, Table 14). However, the variables "Plate colour" and gender seem to only have a marginal influence (p>0.05). The coefficients suggest that people with low levels of schooling and/or males, and people who were given the brighter coloured plates gave higher friendliness scores to this species.

The GLM fitted with the scores of the colourful axis showed that the last diploma achieved (p=0.088) and the answer to the question "Have you seen this species here?" (p=0.08) were the variables that influenced this axis the most (percentage of deviance explained =6.65%) (Appendix 5, Table 15). However, both variables seem to only have a marginal influence (p>0.05). The coefficients suggest that people with a higher level of schooling and people who had already seen the species, considered the parakeet to be colourful more often.

3.2.6 Factors affecting the attitude towards the Monk parakeet

The GLM results for the attitude towards the Monk parakeet showed that the overall attitude was mostly influenced by responders age (p=0.007) (Appendix 3, Table 11). Its coefficient hints that older people have a more positive attitude towards this species, though, this effect was very weak (percentage of deviance explained = 5.21%).

The PCA results for the first axis, henceforward called "colourful plus friendly axis", shows the gradient between

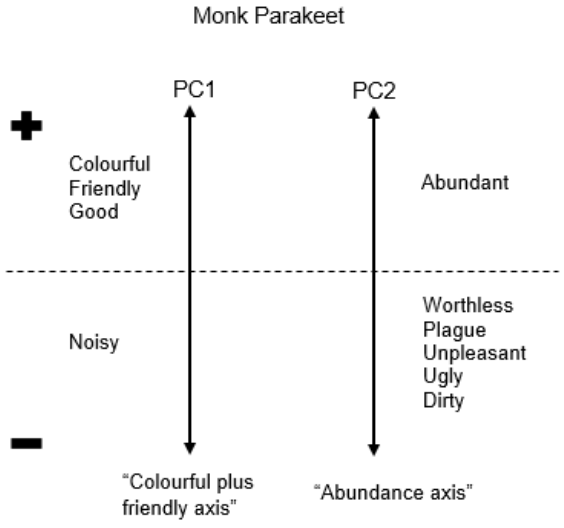

Figure 12 - Most important variables associated with each PCA axis. Variables presented in order of importance (-0.30<loadings>0.30).

respondents who considered this species to be: good, friendly and colourful versus those that consider it noisy (Figure 12). The second axis, henceforward the "abundance axis", represents the gradient between people who consider the Monk parakeet to be abundant versus those who think it is worthless, a plague, unpleasant and ugly. The first axis accounts for 21.83% of the variance while the second one accounts for 18.55% (see Table 13 and Figure 16 in Appendix 4).

The results of the GLM fitted with the PCA scores of the colourful plus friendly axis, showed that: group, the answers to the questions "Do you know this species?" ($p=0.001$) and the answers to the question "Have you seen this species here?" ($p=0.029$) were the variables that influenced the results the most (percentage of explained deviance = 19.6%) (Appendix 5, Table 16). Looking at the coefficients (Table 4), we can infer that, visitors of parks with parakeets and visitors of parks without parakeets tend to give lower scores to the variables forming this axis. People who answered positively to the question "Do you know this species?" gave higher scores than those who answered negatively. On the contrary, those who answered positively to the question "Have you seen this species here?" tended to give lower scores to this axis' variables.

Regarding the GLM fitted with the PCA scores of the abundance axis, the variables place where currently lives ($p=0.012$), place where lived before the age of 16 ($p=0.003$), plate colour ($p=0.09$), the answer to the question "have you seen this species here?" ($p=0.011$) and age ($p=0.022$) were the variables who had the biggest effect on the results (percentage of deviance explained= 13.97%) (Appendix 5, Table 17). However, the variable "plate colour" seems to only have marginal influence ($p>0.05$). The coefficients (Table 4) suggest that people who lived in cities bigger than Porto, and people who were given darker coloured plates, tended to give higher scores to the variable abundant and lower scores to the categories represented on the negative end of this axis, while people who currently live in cities bigger than Porto tend to give lower scores to the variables that form this abundance axis. Also, people who had already seen the species tended to give higher scores to this axis variables. Age wise, older people tended to have worse opinion on this axis variables.

Table 4 - GLM results for all GLMs fitted with PCA scores as a dependent variable and the social variables as an independent variable.

Model	Variables	Coefficient	Standard error	t value	Pr (>|z|)	% of deviance explained
GLM PCA scores (axis1) for RRP attitude vs social variables	Gender	-1.079	0.626	-1.722	0.089	15.6
	Last diploma achieved	-0.742	0.272	-2.728	0.008	
	Plate colour	-0.691	0.384	-1.801	0.075	
GLM PCA scores (axis2) for RRP attitude vs social variables	Last diploma achieved	0.364	0.211	1.730	0.088	6.65
	Have you seen this species here?	1.367	0.782	1.748	0.084	
GLM PCA scores (axis1) for MP attitude vs social variables	Visitors of parks with parakeets	-1.608	0.66	-2.680	0.008	19.6
	Visitors of parks without parakeets	-2.426	0.676	-3.588	0.0005	
	Do you know this species?	2.029	0.619	3.280	0.001	
	Have you seen this species here?	-1.481	0.67	-2.209	0.029	
GLM PCA scores (axis2) for MP attitude vs social variables	Place where lived before the age of 16	1.524	0.509	2.996	0.003	13.97
	Place where lives now	-1.269	0.503	-2.525	0.013	
	Plate colour	0.424	0.253	1.676	0.096	
	Have you seen this species here?	1.178	0.456	2.583	0.011	
	Age	-0.031	0.013	-2.327	0.022	

3.2.7 Is parakeet's selection intimately related with the respondent's opinion about the species?

The Pearson correlation results suggest that, regarding the Rose-ringed parakeet, the selection of this species was related to people's scores given to the categories that formed the Friendly axis (p=0.0012), which means that people who have a good opinion about this species, in those categories, tend to select it more. The variables expressed in the Colourful axis did not seem to be correlated with people's choice (p=0.2) (Table 5).

The Pearson correlation test, regarding the Monk parakeet selection, suggests that the selection of this species is not correlated with the attitude people have towards this species. (p= 0.10 and p=0.13) (Table 5).

Table 5 - Results for the Pearson correlation test between the selection of the parakeet and the PCA scores.

	t	df	p value	95% confidence interval	r
Selection of RRP vs. Axis 1 scores	3.35	83	0.0012	0.14 – 0.52	0.35
Selection of RRP vs. Axis 2 scores	-1.3	83	0.2	-0.34 – 0.074	-0.14
Selection of MP vs. Axis 1 scores	1.65	136	0.1	-0.028 – 0.30	0.14
Selection of MP vs. Axis 2 scores	-1.53	136	0.13	-0.29 – 0.038	-0.13

3.3 Discussion

Parrot's incredible intelligence, potential for tameness, visual attractiveness and the ability of many species for mimicking of the human voice, has made them extremely popular pet bird species across the globe (Juniper and Parr 1998). Thus, as a result of accidental or intentional escapes from captivity, several species have successfully established breeding populations outside their natural distribution range (e.g., Europe and North America), being now present throughout the world (Carrete and Tella 2008; DAISIE 2009). In fact, Psittacidae represent almost 18% of Europe's established alien avifauna (Strubbe and Matthysen 2009a). Avian invasions can have devastating impacts in the ecology of the local habitat, by disseminating diseases, direct and indirect competition with native fauna and potential damages to the agriculture (Cramp and Brooks 1992; Pruett-Jones and Tarvin 1998; Pruett-Jones et al. 2005; Fletcher and Askew 2007; Hernández-Brito et al. 2014; Menchetti and Mori 2014). Additionally, IAS may also have strong detrimental economic and socio-cultural impacts (McNeely, 2001; Pimentel et al., 2005). Thus, better awareness and management of the issue of IAS is critical and should be prioritized.

Presently, nature and wildlife management heavily depend on public support for the success of its actions (Vaske, Jacobs, and Sijtsma 2011; Sijtsma, Vaske, and Jacobs 2012). So, it is critical to have a good insight about public's views, opinions and attitude about the topic (Teel and Manfredo 2010). Public attitudes can have a great influence in invasive species management as it can have big implications on prevention, early detection and eradication success (Cohen, Mirotchnick, and Leung 2007; Crall et al. 2010; Burt et al. 2007) so, public's understanding, involvement and support for IAS prevention and management actions must be encouraged (Witmer et al. 2009).

Out of all Psittacidae, the Rose-ringed parakeet and the Monk parakeet are the most successful invaders, having established 65 and 31 European populations respectively (Strubbe and Matthysen 2009a), most of which are currently established in urbanized areas (Butler 2003; Santo et al. 2013). In those urbanized areas, where parakeets are a well-known and constant presence among the native avifauna, people tend to have a rather unfound opinion about them, mainly because of the noise pollution, falling nests and aggressiveness (Davis 1974; Bucher and Bedano 1976; Long 1981; Temple 1992; Stafford 2003; Chapman 2005; Ham, Genovesi, and Scalera 2013; Fernández 2014). However, in Porto, where these species are still in the initial stage of a possible establishment, little to nothing was known about Porto resident's attitudes towards the presence of this alien species in the city's parks and gardens.

The strategy adopted in our survey, which included a visual approach enquire, followed by a question based survey, to investigate people's perception towards two species of IAS, proved to be very successful. People felt compelled and interested in participating in the survey because of its shortness, easy filling and visual attractiveness, thus lowering the rejection rate. The employed approach was also effective in capturing the attention of groups of people that tend to be less responsive to inquiries, such as older people, people with less schooling or people without any interest in environmental issues (White et al. 2003). Also, the lack of information about the goal of the study or the target species meant that the answers provided were unbiased. Most people recognized that the species indicated in the plate was a parakeet or similar, so the information we obtained is relevant for the species of interest. The different images chosen for the different versions of the plates (bright, medium or dark) could have influenced the results, but we did not find evidence of that in our analysis. Therefore, it is safe to say that the decision of including the parakeets in the ten chosen species was done conscientiously and not simply because of the particular appearance of a picture.

In the first part of the survey, where respondents were asked to select ten species they would like to see in the given environment, we expected that, if people perceived the parakeets positively, it would be more likely included in the list of ten chosen species. Indeed, the parakeets where a very popular choice, with over half of respondents choosing a parakeet, and almost half of respondents choosing both species. Even though the percentage of deviance explained was very weak, we found that some demographic groups are more likely to choose a parakeet species, such as younger people and people who lived in smaller cities before the age of 16. Indeed, in other studies, authors found that older people are more concerned about the problem of invasive species (Fitzgerald, Fitzgerald, and Davidson 2007), which is in accordance with our results, as older people were less inclined to choose the parakeet to be a part of our avifauna.

The level of knowledge proved to be quite high, with over half the inquired population saying they knew the parakeets. However, the Monk parakeet had a higher percentage of positive answers, especially the groups who had more interactions with the parakeets, as the recreational fishermen, workers and visitors of parks with parakeets, as predicted. The same did not happen for the Rose-ringed parakeet. Likewise, when considering the results obtained from the analysis of the answers to the question "Have you seen this species here?" there was a very noticeable difference between the two species, with the Monk parakeet having been seen almost five times more than the Rose-ringed parakeet. As expected, fishermen were the group with the highest rate of positive answers for the Monk parakeets, and workers for the Rose-ringed

parakeet. The differences between the answers given to the two species may be due to the higher numbers of Monk parakeet, thus making it more conspicuous. As described in other studies, we also found that Rose-ringed parakeets were harder to observe, as they often perched higher in the trees, did not build conspicuous nests and rarely landed on the ground, which diminishes detectability (Senar, Carrillo-Ortiz, and Arroyo 2012). Furthermore, the Rose-ringed parakeet has a much bigger home range, being frequently observed at a distance of 5 km from the roost, while the Monk parakeet has a home range of only about 500 m to 1 km maximum, which means it spends more time near the roost, making it easier to detect by amateur bird watchers and the general public (Batllori and Nos 1985; Eberhard 1998).

Only in the case of the Common waxbill did we find a significant difference between the plates with or without the information non-native, yet the percentage of explained deviance was very low. In Porto, it seems that most people chose the species independently of the presence of information emphasizing the origin of the species. This could be due to people's unfamiliarity with the term "non-native" or people's unawareness of the implications the presence of invasive species may have when introduced into new environment (Fraser 2001; McKinney 2006; Ham, Genovesi, and Scalera 2013). This results indicates the urgent need for awareness campaigns and public education actions about the alien and invasive species and their possible impacts (Glowka et al. 1994; García-Llorente et al. 2008).

In the second part of the survey, where people's opinion about our target species was inquired, we found that overall Porto's residents have a very good opinion about both parakeet species. This seems to be particularly true in the case of Rose-ringed parakeet. Once again, the difference between the two species can be due to their different presence in the city, with the Monk parakeet being more conspicuous than the Rose-ringed parakeet. As such, people have a more informed opinion of the Monk parakeet as a feral bird, while, for the Rose-ringed parakeet, they may tend to answer considering it as a pet. Indeed, the answers to the question "have you seen this species here?" proved to be important when analyzing the attitude towards the Monk parakeets. Various studies support the idea that public attitudes towards different species of animals is based on people's emotional connections with those species, where animals capable of being or are companion animals are considered more favorably (Fox 1990; Fitzgerald, Fitzgerald, and Davidson 2007), as it might have been the case, in our study, with the Rose-ringed parakeet. Other factors that seemed to influence overall attitude towards this species was education, with people with lower levels of schooling and older people having a more positive overall attitude when it came to the Monk parakeet. Gender also seems to be an important factor, with men having a better opinion about the Rose-ringed

parakeet. Men and women often have fundamentally different values and attitudes on subjects such as wildlife management and ecological issues (Lauber, Anthony, and Knuth 2001; Dougherty, Fulton, and Anderson 2003), and some studies have proven that men are more likely to consider invasive animals as a serious problem and want more severe measures taken against them (Bremner and Park 2007). However, this trend was not apparent in our results, having males shown a better opinion about the parakeets than females.

We expected that the different groups, defined a priori by their different levels of interaction with the parakeets, would have different perceptions about the parakeets, as it has been shown in similar studies (García-Llorente et al. 2008; Fernández 2014). However, our results showed no significant differences on the overall perceptions of our different stakeholder groups. Indeed, the results for the GLM using the PCA scores from the "Colourful plus friendly axis" in the Monk parakeet analysis (Table 4), showed that both visitors from parks with and without parakeets displayed the same tendency to give low scores to the categories of that axis. It is possible that, even the groups with the highest level of interactions with the parakeets, the recreational fisherman and workers of parks with parakeets, still do not have a high enough level of interaction with these species to personally feel the impacts of their presence. Alternatively, it is possible that, even though this groups already experience some of the impacts of the presence of this species, such as the unignorably loud and constant noise, they still appreciate the presence of such conspicuous and attractive species in our gardens and parks (Avery et al. 2006).

3.3.1 Final remarks

This study tries to shed light upon the problem of overlooking people's views on the issue of invasive species and their involvement on the managing process. Our results raise two major concerns: first, the good opinion about parakeets in the city of Porto means that future actions to control or eradicate the populations of feral parakeets will likely be met with serious opposition from the public, making it impossible for a quick and effective response by managers and competent authorities (Bremner and Park 2007). Secondly, people have limited knowledge or concern about the ecological impacts that the presence of an potential invasive bird, such as the parakeet, may have in our parks and gardens (García-Llorente et al. 2008), which may lead to more intentional releases of exotic birds and worsen the already growing problem. These situations show the vital

role that awareness and education have in terms of increasing public support for invasive species management initiatives (Bremner and Park 2007; Ellis and Elphick 2007).

4 Conclusion

Humans bear the brunt of responsibility when it comes to presence of IAS across the world. Invasive pets are a classic example of how human activities directly contribute to the liberation of alien animals into new environments (McNeely 2001). However, humans are also essential to solving the problem of IAS (Poorter 2001). For IAS management to be effective, it needs full support from citizens. This will greatly improve its chances of success in all stages of implementation, such eradication, prevention, early detection and lowering rates of introduction (Burt et al. 2007; Cohen, Mirotchnick, and Leung 2007; Crall et al. 2010). As such, it is important to know how familiar and aware people are about the presence and seriousness of the IAS issue in our cities. In Porto, the Rose-ringed parakeet and Monk parakeet population are at early establishment/invasion stages, with only a few dozens of birds present in the main colonies of the city. This is however changing quickly, and both populations are starting to spread into other parts of the city where previously absent.

This study presents a novel approach for evaluating people's opinion and knowledge about specific invasive species. The visual approach proved to be quite successful and liked by respondents, thus lowering the rejection rate. With this approach, we were able to conclude that majority of respondents successfully recognized our target species and where able to identify them as Psittacines. Monk parakeet did have a higher percentage of recognition and sightings, probably due to its greater conspicuousness and higher density.

We also found individuals from specific social groups were more likely to choose the parakeets to be a part of the local avifauna, and have a better opinion about them. Regarding the sensibility to the non-native species, in Porto, people seemed to be unbothered about the source of the species they chose to be in our gardens and parks. The second part of the survey showed that, most Porto's residents interviewed had a positive opinion of the alien parakeet populations present in the city, especially in the case of the Rose-ringed parakeet. Finally, we found no evidence that groups of people with different levels of interactions with parakeets had different perceptions, as has been suggested in other studies (García-Llorente et al. 2008; Fernández 2014).

Results from our surveys indicate that this positive perception towards the parakeets may hamper future actions to eradicate or manage these invasive populations. Furthermore, our results show that respondents had limited knowledge about the negative aspect of IAS and showed little to no concern about the potential risks of having

alien birds flying freely in our parks and gardens. Thus, our results emphasize the urgent need for IAS awareness and education projects targeting the general public.

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6 Appendixes

6.1 Appendix 1. Survey

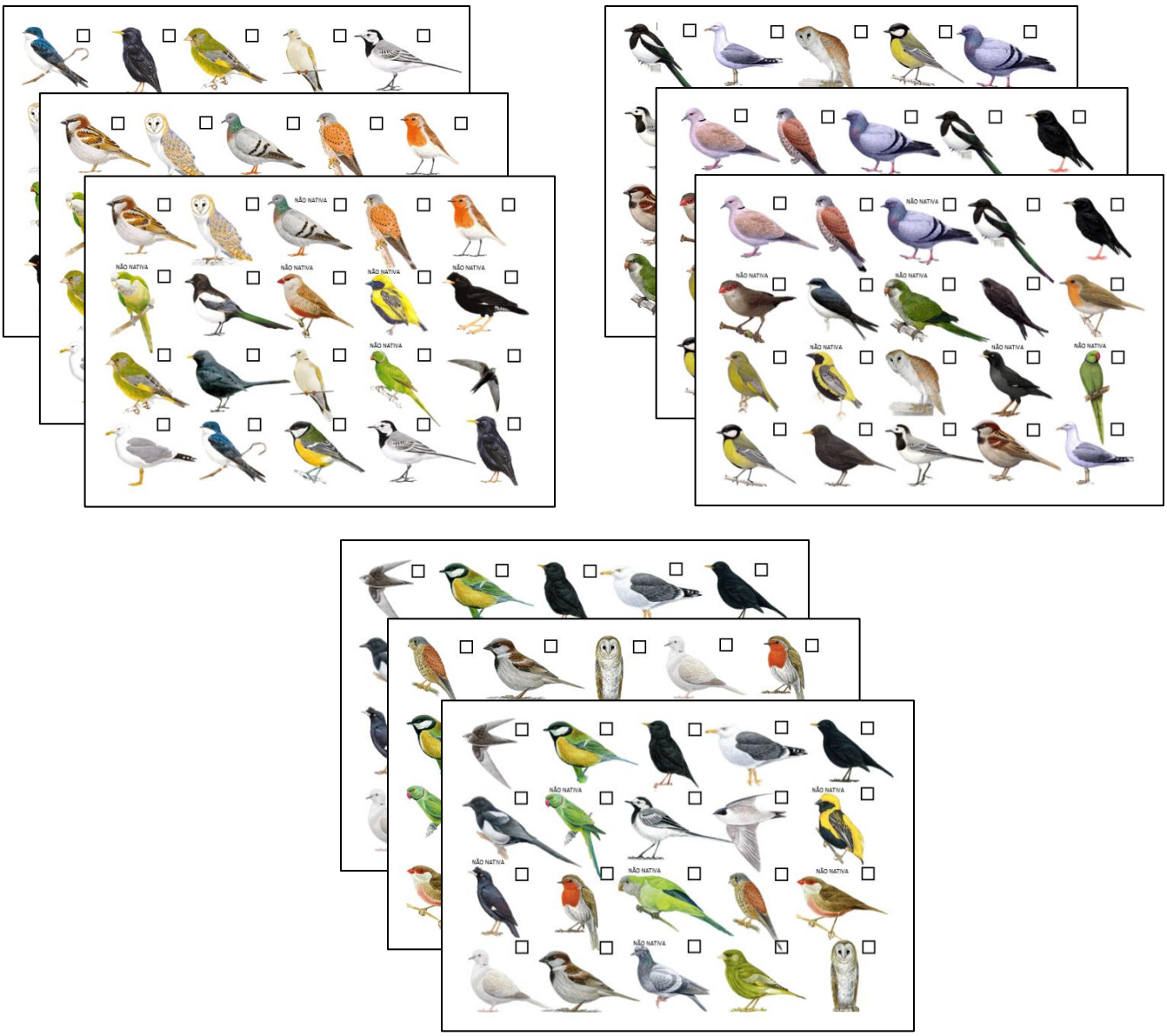

Figure 13 - Plates for the first part of the survey where people had to choose ten out of the twenty presented species to be part of the given environment; Bright version on the top right corner; Dark version on the top left corner; Medium version on the bottom. Species included (NOT IN ANY PARTICULAR ORDER): Common house martin (*Delichon urbicum*) Common swift (*Apus apus*) White wagtail (*Motacilla alba*) Common waxbill (*Estrilda astrild*) Yellow-crowned bishop (*Euplectes afer*) Great tit (*Parus major*) Western barn owl (*Tyto alba*) Spotless starling (*Sturnus unicolor*) yellow-legged gull (Larus michahellis) Common blackbird (*Turdus merula*) House sparrow (*Passer domesticus*) Common magpie *(Pica pica*) Crested myna (*Acridotheres cristatellus*) Common kestrel (*Falco tinnunculus*) Rose-ringed parakeet (*Psittacula krameri*) Monk parakeet (*Myiopsitta monachus*) European robin (*Erithacus rubecula*) Rock dove (*Columba livia*) Eurasian collared dove (*Streptopelia decaocto*) European greenfinch (*Carduelis chloris*) Sources: http://www.avibirds.com/; http://zoologia2013.blogspot.pt/2015/03/periquito-monge-myiopsitta-monachus.html; http://pet-cockatiel.com/Dboard/viewtopic.php?t=1788;https://www.birdguides.com/species/species.asp?sp=164089; http://www.triplov.org/matias/index.html;http://www.boldaslove.co.uk/blog/uploads/parakeet.jpg; *http://www.hbw.com/species/crested-myna-acridotheres-cristatellus*; *http://www.hbw.com/species/yellow-crowned-bishop-euplectes-afer*; *http://images.sou.com/i?src=rel&q=%E6%B5%B7%E5%8D%97%E5%85%AB%E5%93%A5%E4%*B8%8E%E6%9E%97%E5%85%AB%E5%93%A5; (Mejías and Barrag 2005; Barros and Ríos 2002).

Bonita								Feia
Hostil								Amigável
Silenciosa								Barulhenta
Inofensiva								Perigoso
Valiosa								Sem valor / Insignificante
Desagradável								Agradável
Asseada								Suja
Má								Boa
Útil								Praga
Com cores suaves								Colorida
Abundante								Rara

Figure 14 - Second part of the survey: table where people were asked to place an x on the square that best suited their opinion.

6.2 Appendix 2. Variable codification

Table 6 - Variables codification for statistical analysis.

Variable	Codification	
Plate colour	Bright	1
	Medium	2
	Dark	3
Last diploma achieved	Primary school (1st cycle)	1
	Middle School (2nd and 3rd cycle)	2
	High school	3
	Bachelor degree	4
	Master degree	5
	PhD	6
Place where lived/s	City < Porto	1
	Porto	2
	City > Porto	3
Gender	Male	0
	Female	1
Do you know? Have you seen? Presence of information native	Yes	1
	No	0

Table 7 - Opinion table score codification for statistical analysis.

Bonita/Pretty	7	6	5	4	3	2	1	Feia/Ugly
Hostil/Unfriendly	1	2	3	4	5	6	7	Amigável/Friendly
Silenciosa/Silent	7	6	5	4	3	2	1	Barulhenta/Noisy
Inofensiva/Harmless	7	6	5	4	3	2	1	Perigoso/Harmful
Valiosa/valuable	7	6	5	4	3	2	1	Sem valor / Insignificante/Worthless
Desagradável/Unpleasant	1	2	3	4	5	6	7	Agradável/Pleasant
Asseada/Clean	7	6	5	4	3	2	1	Suja/Dirty
Má/Bad	1	2	3	4	5	6	7	Boa/Good
Útil/useful	7	6	5	4	3	2	1	Praga/Plague
Com cores suaves/Muted coloured	1	2	3	4	5	6	7	Colorida/Colourful
Abundante/abundant	7	6	5	4	3	2	1	Rara/Rare

6.3 Appendix 3. Importance values

Table 8 - Importance values for variables used in the GLM for the selection of RRP.

Importance values GLM for the selection of RRP	
Variable	**Importance value**
Age	**0.75**
Last Diploma achieved	0.42
Place where lived before the age of 16	0.36
Place where lives now	0.33
Have you seen this species here?	0.27
Do you know this species?	0.27
Information native	0.27
Gender	0.27
Plate colour	0.26
Group	0.04

Table 9 - Importance values for variables used in the GLM for the selection of MP.

Importance values GLM for the selection of MP	
Variable	**Importance value**
Age	0.44
Last Diploma	0.29
Place where lived before the age of 16	**0.71**
Place where lives now	0.29
Have you seen this species here?	0.49
Do you know this species?	0.28
Information native	0.28
Gender	0.28
Plate colour	0.31
Group	0.1

Table 10 - Importance values for variables used in the GLM for the overall attitude towards RRP.

Importance values GLM for the attitude towards RRP	
Variable	**Importance value**
Age	0.27
Last Diploma achieved	**0.86**
Place where lived before the age of 16	0.31
Place where lives now	0.39
Have you seen this species here?	0.24
Do you know this species?	0.26
Information native	**0.53**
Gender	**0.71**
Plate colour	0.28
Group	0.21

Table 11 - Importance values for variables used in the GLM for the overall attitude towards the MP.

Importance values GLM for the attitude towards MP	
Variable	**Importance value**
Age	**0.84**
Last Diploma achieved	0.34
Place where lived before the age of 16	0.26
Place where lives now	0.34
Have you seen this species here?	0.39
Do you know this species?	0.48
Information native	0.25
Gender	0.35
Plate colour	0.25
Group	0.08

6.4 Appendix 4. PCA loadings and scatter plot

Table 12 - PCA loadings for attitude towards the RRP.

PCA loadings for Rose-ringed parakeet		
Category	**PC1**	**PC2**
Pretty vs. Ugly	0.059	-0.01
Friendly vs. Unfriendly	0.39	0.22
Silent vs. Noisy	0.2	-0.16
Harmless vs. Harmful	0.48	0.06
Valuable vs. Worthless	0.2	-0.00053
Pleasant vs. Unpleasant	0.4	0.16
Clean vs. Dirty	0.28	-0.13
Good vs. Bad	0.4	-0.014
Useful vs. Plague	0.34	-0.13
Colourful vs. Muted coloured	-0.056	0.92
Abundant vs. Rare	-0.094	0.07
Proportion of variance	**0.2873**	**0.16**

Table 13 - PCA loadings for attitude towards the MP.

PCA loadings for Monk parakeet		
Category	**PC1**	**PC2**
Pretty vs. Ugly	0.075	-0.31
Friendly vs. Unfriendly	0.43	-0.072
Silent vs. Noisy	-0.26	-0.19
Harmless vs. Harmful	0.16	-0.063
Valuable vs. Worthless	-0.0083	-0.48
Pleasant vs. Unpleasant	0.19	-0.32
Clean vs. Dirty	0.03	-0.29
Good vs. Bad	0.28	-0.24
Useful vs. Plague	0.11	-0.35
Colourful vs. Muted coloured	0.77	0.23
Abundant vs. Rare	-0.023	0.56
Proportion of variance	**0.2183**	**0.1855**

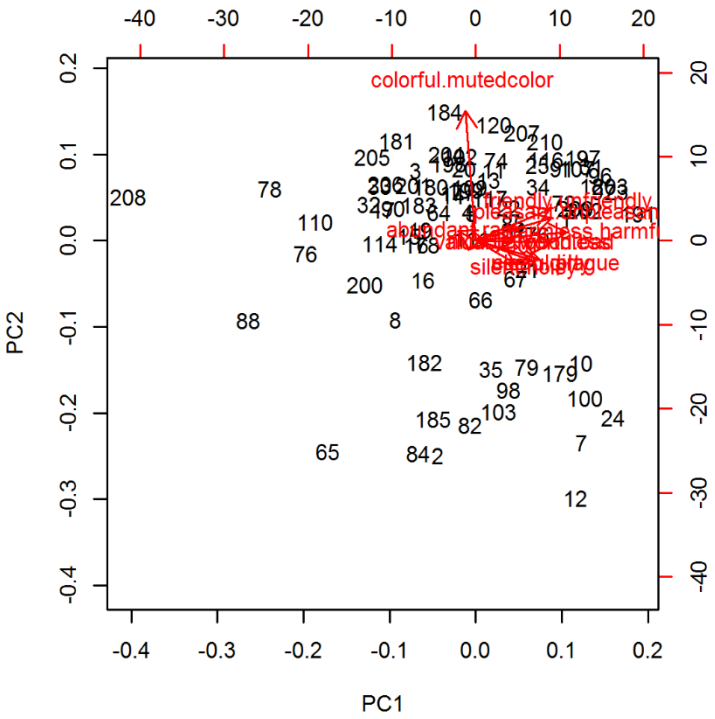

Figure 15 - PCA scatterplot for the attitude towards the Rose-ringed parakeet.

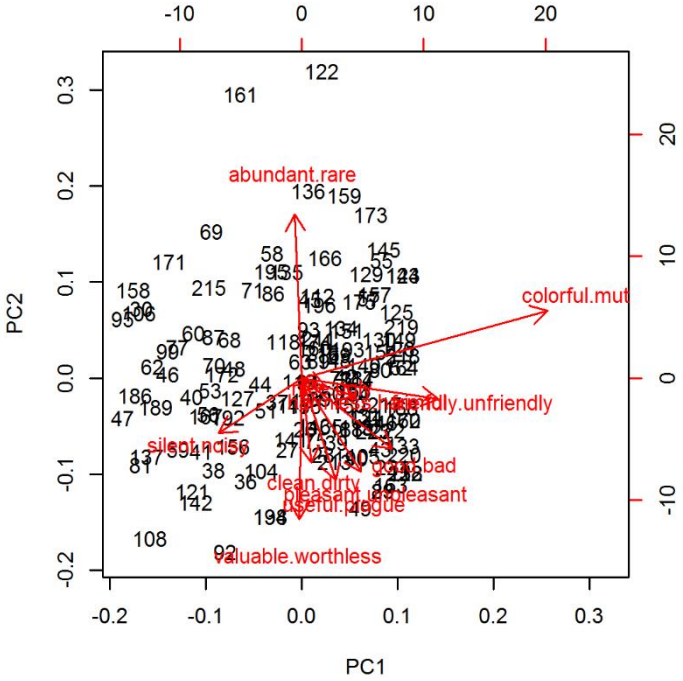

Figure 16 - PCA scatterplot for the attitude towards the Monk parakeet.

Table 14 - Importance values for variables used in the GLM with RRP

6.5 Appendix 5. Importance values for GLMs done with PCA scores

Table 14 - Importance values for variables used in the GLM with RRP PCA scores from axis 1.

Importance values	
RRP axis 1 vs. SOCIO VARIABLES	
Variable	**Importance value**
Age	0.32
Last Diploma achieved	**0.94**
Place where lived before the age of 16	0.29
Place where lives now	0.35
Have you seen this species here?	0.25
Do you know this species?	0.27
Information native	0.4
Gender	**0.63**
Plate colour	**0.64**
Group	0.26

Table 15 - Importance values for variables used in the GLM with RRP PCA scores from axis 2.

Importance values	
RRP axis 2 vs. SOCIO VARIABLES	
Variable	**Importance value**
Age	0.27
Last Diploma achieved	**0.6**
Place where lived before the age of 16	0.25
Place where lives now	0.24
Have you seen this species here?	**0.53**
Do you know this species?	0.29
Information native	0.24
Gender	0.25
Plate colour	0.29
Group	0.33

Table 16 - Importance values for variables used in the GLM with MP PCA scores from axis 1.

Importance values	
MP axis 1 vs. SOCIO VARIABLES	
Variable	**Importance value**
Age	0.26
Last diploma achieved	0.34
Place where lived before the age of 16	0.4
Place where lives now	0.29
Have you seen this species here?	**0.78**
Do you know this species?	**0.96**
Information native	0.3
Gender	**0.51**
Plate colour	0.46
Group	**0.96**

Table 17- Importance values for variables used in the GLM with MP PCA scores from axis 2.

Importance values	
MP axis 2 vs. SOCIO VARIABLES	
Variable	**Importance value**
Age	**0.8**
Last diploma achieved	0.36
Place where lived before the age of 16	**0.9**
Place where lives now	**0.8**
Have you seen this species here?	**0.67**
Do you know this species?	0.4
Information native	0.31
Gender	0.26
Plate colour	**0.61**
Group	0.36