The role of species charisma in biological invasions

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Abstract

Species charisma, understood as a set of species characteristics and their perception that affect people's attitudes and behaviors, is a highly relevant concept for invasion science, with implications across all stages of the invasion process. However, the concept of invasive alien species (IAS) charisma has not yet been systematically investigated. Here, we discuss this concept, provide a set of recommendations for further research and highlight management implications. We review how charisma affects the processes associated with biological invasions and IAS management, including: effects on species introductions and spread, media portrayals, public perceptions of species management, research attention, and active public involvement in research and management. Explicit consideration of IAS charisma is critical to improve understanding of the drivers of people's attitudes towards particular IAS and planned management measures and strategies, and to implement programs aiming to influence stakeholder perceptions and behavior and to strengthen public engagement.

In a nutshell

- We discuss the concept of charismatic invasive alien species (IAS), highlight management implications and provide a set of recommendations for further research.
- The charisma of IAS might influence all stages of the invasion process, and both charisma and its influence can vary over time and space.
- It is a potential hindrance to management actions by affecting public support and contributing to conflicts.
- We explore the concept of IAS charisma and its effects on biological invasions and management, including species introductions, media portrayal, public perceptions, opposition to management, research effort and public participation in research and management.

Introduction

The concept of charismatic species – which is commonly used in the literature to refer to the "attractiveness", "appeal" or "beauty" of species (Panel 1) – has recently garnered attention in conservation science due to its potential to stimulate public awareness and support, especially through the use of flagship species (Veríssimo *et al*. 2011; Courchamp *et al*. 2018). The charisma of any introduced species, and invasive alien species (IAS) in particular, can affect people's perceptions of the species and their attitudes towards management (McNeely 2001; Veitch and Clout 2001; Shackleton *et al*. 2019). There is ample evidence in the literature of IAS charisma influencing the invasion process across a wide range of taxa spanning different taxonomic groups and regions (WebTables 1-3; Figure 1). As opposed to a positive effect of charisma in the management of threatened species, IAS charisma most often represents a hindrance to management actions (Genovesi and Bertolino 2001; Bertolino and Genovesi 2003). It can reduce public support for management attempts and contribute to conflicts, and ultimately impede management efforts, for example by delaying or preventing control implementation (Estévez *et al*. 2015; Novoa *et al*. 2018). However, the issue of species charisma in relation to IAS has not yet been systematically explored.

Here we discuss the concept of species charisma in the context of IAS, exploring how it can affect actions and processes, such as species introductions, media portrayal, public perception, opposition to management, research effort and public participation in research and management (Figure 1). In addition to clarifying the concept of charismatic IAS (Panel 1), we illustrate how the perception of charisma is highly context-dependent and varies over space and time. Identifying these issues enables us to provide a set of recommendations for further research and to highlight both management implications and measures that can be taken to address this issue.

Effects of charisma on introductions and establishment success

It is likely that charisma has an effect on introduction and establishment rates, especially in certain taxonomic groups and introduction pathways, such as the ornamental plant, aquarium and pet trade (Padilla and Williams 2004; van Kleunen *et al*. 2018). For example, aquarium releases are recognized as a key contemporary introduction pathway for invasive aquatic species, and are responsible for the introduction of as much as one third of the world's ecologically and economically most damaging aquatic IAS (Padilla and Williams 2004). Such aquatic ornamental species, as well as terrestrial ones, are not randomly selected, but chosen for specific, appealing traits, resulting in higher demand for charismatic species in the pet and horticultural trades (Chucholl and Wendler 2017; van Kleunen *et al*. 2018; Kutlvašr *et al.* 2019). Although this remains to be quantified, it is likely that the increased prominence of such charismatic species within the pool of traded and reared species can lead to increased prominence in the introduced species pool and, hence, to a higher propagule pressure. While charisma probably has negligible effects on inadvertent introductions (e.g. by ballast water or seed contamination) or those mainly driven by perceived utility (e.g. crop species), all else being equal, we hypothesize that charismatic species should have a comparatively higher overall chance of being introduced than non-charismatic species. Species charisma could thus potentially shape the composition of the introduced species pool, and charismatic species could consequently also be more likely to become established than non-charismatic species. In fact, some of the best-known IAS introductions were likely influenced by their charisma. The raccoon (*Procyon lotor*) is a good example: raccoons are very charismatic due to their "cute" appearance with their facial color patterns resembling a bandit's mask across their eyes, their behavior that is perceived as comical and their endearing habit of dousing, supposed washing of food prior to eating. The raccoon became popular as a pet animal in Japan, where it is an alien species, and many individuals were imported, allegedly due to the popularity of the animated cartoon 'Rascal Raccoon' on TV in 1977; it has since become invasive across the

126 country (Ikeda *et al*. 2004). Other examples feature in Figure 2 and WebTables 1-3. However, what
127 constitutes charisma is dynamic, changing over time and differing among cultures. This limits the
128 predictive power of analyses of future charisma-driven invasions or their management based on
129 historic events.
130 Charisma can also have a strong effect on the establishment success of introduced species,
131 through public support and active provisioning of resources. Typical examples include winter-food
132 provisioning for charismatic alien parakeets via bird feeders (Crowley *et al*. 2019) and feeding of
133 feral cats (*Felis catus*) and dogs (*Canis familiaris*; Allen 2018).
134 Interestingly, some species traits contribute to both the establishment potential of a species
135 and the likelihood that it will be perceived as charismatic, which makes them especially relevant for
136 invasion risk assessments. For example, long flowering periods or multiple flowering events and
137 plant height are particularly desirable in ornamental plants, and are also traits that are positively
138 associated with establishment success and invasiveness (Pyšek and Richardson 2008; van Kleunen
139 *et al*. 2018). Similarly, many alien bird species that were successfully introduced by acclimatization
140 societies in the 19th and 20th centuries were commonly characterized by a combination of appealing
141 features and traits that facilitated their establishment and spread.
142
143 **Effects of IAS charisma on media and communication**
144 Beside direct experience with IAS impacts, public awareness and perception of IAS can
145 stem largely from indirect sources of information such as the media, and charisma is expected to
146 affect the style and tone of language used by media outlets (Veitch and Clout 2001; Larson 2005).
147 These media portrayals are more likely to feature either charismatic species or those with serious
148 environmental or economic impacts (Veitch and Clout 2001; Wilson *et al*. 2007; Jarić *et al*. 2019).
149 The public perception of species charisma can therefore be influenced (both positively and
150 negatively) by the way species are portrayed, via increased media exposure, or by emphasizing

specific points of view (Figure 3; Veitch and Clout 2001; Crowley *et al*. 2017; Shackleton *et al*. 2019). For example, public perception and the stance of official bodies towards the Nootka lupine (*Lupinus nootkatensis*) in Iceland shifted from positive to largely negative because of an ongoing public debate in the media (Petursdottir *et al.* 2013; Benediktsson 2015). Effects of IAS charisma and their media representation and communication are essentially inter-related, they affect each other, and the way species will be ultimately perceived.

Messages emphasized with emotive language may result in partial reporting and public misinformation (Crowley *et al*. 2019). For example, reports of the planned control program for invasive eastern grey squirrels (*Sciurus carolinensis*; Figure 2b) in Italy by newspapers and animal rights groups used emotive messages by associating them with cute cartoon characters, which greatly affected public perception and attitude towards the species (Genovesi and Bertolino 2001). This led to protracted legal proceedings, a withdrawal of funding and thus contributed to the failure of the eradication campaign (Genovesi and Bertolino 2001; Shackleton *et al*. 2019). Management of some IAS can be associated with intense conflicts where various stakeholders (e.g. journalists, scientists, resource managers, governmental institutions, non-governmental organizations) have frequently resorted to militaristic language and combative, war-like metaphors to pursue and advocate desired research and management activities (Larson 2005; Wallach *et al*. 2018). While the way such conflicts emerge or escalate might be affected by stakeholders' perceptions of IAS charisma, the manner in which their perceptions are communicated might in turn also affect perceived charisma (eg by referring to a plant species as a weed, or to an animal species as a pest). A good example is *Echium plantagineum*, a European herb introduced to Australia, where it is called ‘Salvation Jane’ in South Australia and ‘Patterson's curse’ elsewhere in the country (Kueffer and Kull 2017). While the name reflects how the species is perceived regionally (ie as either a useful crop or a noxious weed), the choice of the name in turn also affects perception of the plant by the public.

Effects of IAS charisma on their societal acceptance

Perceptions of the natural state of the environment are to a large extent socially constructed and context-dependent (Backstrom *et al*. 2018). Public attitudes towards species can be influenced by their origin, but other factors are usually more important, such as economic value and impact (van der Wal *et al*. 2015), or charisma (Gobster 2011; WebTables 1-3). For example, big trees are often valued by the public regardless of their origin (Gobster 2011).

IAS may become accepted by the public as desirable elements of local fauna and flora, often as an instance of the shifting baseline syndrome, which represents a gradual change in the accepted norms due to a lack of experience, memory or knowledge (Soga and Gaston 2018; Beever *et al.* 2019). Over time, expectations of what is a truly original and desirable state of the natural environment change (Soga and Gaston 2018), and the ability of people to recognize a species as alien decreases with the time that has passed since introduction (Garcia-Llorente *et al*. 2008).

The readiness of the public to accept an alien species as the "new normal" likely increases with perceived charisma, especially if a species has become associated with cultural practices or perceptions of the place (Nuñez and Simberloff 2005; Verbrugge *et al*. 2013). For example, after being introduced in southeast Spain for different economic reasons, *Agave* and *Opuntia* species have invaded large arid areas where they built charisma over time and became iconic symbols of the landscape that has been depicted in stamps and postmarks (Figure 2c). *Jacaranda* trees also became iconic in South Africa and a symbol of Pretoria, nicknamed the "Jacaranda City" (Dickie *et al*. 2014). Alien species can become integrated into cultural identities through positive interactions and emotional and material attachments, and such processes can occur rather quickly in the case of charismatic species (Crowley *et al*. 2017, 2018). For example, monk parakeets (*Myiopsitta monachus*) in Chicago became an iconic species for the city in less than 50 years since their introduction (Crowley *et al*. 2017). The ruddy duck (*Oxyura jamaicensis*) was adopted as the

emblem of the birdwatchers' club in the region of the UK where it was first introduced. Many alien species are nowadays considered desirable and might even be subject to protection or restoration measures in case of threats or population declines (Clavero 2014; Crowley *et al*. 2018). In some cases, IAS charisma can be a relevant source for economy, for example through tourism, which will further promote their societal acceptance (Panel 2).

Effects of charisma on the likelihood of public opposition to IAS management

A lack of public support for IAS management, or even opposition against IAS removal, is not uncommon (Crowley *et al*. 2017; Novoa *et al*. 2018), and can also be affected by IAS charisma (Fischer *et al*. 2014). Plans to control species perceived as charismatic have often faced opposition, while no such resistance is the norm for species that are not perceived as charismatic, except those with economic value (Liordos *et al*. 2017). Some well-known instances where public opposition hindered IAS control due to perceived charisma include invasive populations of monk parakeets and mute swans (*Cygnus olor*) in the United States, and hippopotamuses (*Hippopotamus amphibius*) in Colombia (Panel 2; Ellis and Elphick 2007; Dembitzer 2017; Crowley *et al*. 2019). Conflicts also frequently arise surrounding attempts to control feral populations of charismatic pets and domestic animals, such as cats, dogs and horses (*Equus caballus*; Veitch and Clout 2001; Estévez *et al*. 2015; Allen 2018). Due to a strong taxonomic bias in perceptions of charisma, public opposition against control of invasive mammal or bird species is more likely to occur than against invertebrates or plants (Shackleton *et al*. 2019). However, attempts to control charismatic alien plants, such as large pines (*Pinus* spp.) or eucalypti (*Eucalyptus spp.*), have also faced some opposition (Nuñez and Simberloff 2005; Dickie et al. 2014; Estévez *et al*. 2015).

There also seems to be a relationship between species charisma and a public consensus on acceptability of particular control measures – for more charismatic species, there is often less acceptance of direct and lethal control methods (Verbrugge *et al*. 2013; Fischer *et al*. 2014).

Opposition by some vocal sections of the public has sometimes forced management authorities to use alternative, non-lethal, and often more expensive methods such as reproduction control or relocation, even though they may be less effective (Bertolino and Genovesi 2003; Verbrugge *et al*. 2013; Panel 2).

Effects of IAS charisma on research efforts and funding availability

Invasion science is taxonomically biased, and only a minority of IAS are studied in detail (Wilson *et al*. 2007; Pyšek *et al*. 2008). While the taxonomic focus is largely determined by their impacts (Pyšek *et al*. 2008), there is also greater focus on invasive vertebrates than invertebrates, as well as greater focus on large and charismatic species (Wilson *et al*. 2007). Research biases can lead to knowledge gaps, and may negatively affect conservation prioritization, management effectiveness, international decision-making and policy development (Donaldson et al. 2016).

We hypothesize that IAS charisma can also affect research effort, with charismatic IAS receiving more research interest, ~~ie~~ e.g.~~?~~ through personal researcher preferences or potentially greater funding availabilities. Although this is not yet tested within the field of invasion science, there is a well-established effect of charisma in conservation science (Clark and May 2002; Fleming and Bateman 2016; Jarić *et al*. 2019). Furthermore, social sciences and humanities are interested in personal and societal discourses, changes and events (eg cognitive changes, personal attitudes and behaviors, and conflict processes; Schüttler *et al*. 2011). Such societal dynamics are more likely to arise from charismatic IAS and therefore more likely to lead to comparatively greater research effort focused on socio-cultural aspects of charismatic IAS, with more funding allocated. On the other hand, applied research can also be hindered by reduced funding support and public opposition to management. Such was the case for an eastern grey squirrel population in Italy, where public opposition obstructed a pilot research project on its eradication (Genovesi and Bertolino 2001).

Effects of IAS charisma on active public involvement in research and management

Volunteer initiatives are increasingly recognized as an affordable tool to manage biological invasions (Pagès *et al*. 2018). However, public involvement in controlling highly charismatic species may in some cases be limited (Crowley *et al*. 2018). Unappealing features and negative perception of a species can be more beneficial for control efforts, as it is the case for cane toad (*Rhinella marina*) invasions in Australia, where the strong aversion against this species attracted significant volunteer efforts for various management activities (Estévez *et al*. 2015).

Nevertheless, IAS charisma can also have potentially positive effects in some cases, for example by motivating the public to actively engage in hunting, fishing, or other public initiatives directed at invaders perceived as attractive game species (Green *et al*. 2017). For example, annual hunting derbies directed at charismatic invasive Indo-Pacific lionfish (*Pterois volitans*/*miles*) in the Western Atlantic have attracted substantial volunteer effort and proved to be effective for local population suppression (Green *et al*. 2017). Some of the traits that contribute to species charisma may simultaneously make them easier to detect (e.g. bright colors, large body size, unique morphology), thus increasing the efficiency of monitoring programs and citizen science initiatives. However, any management initiative based on public promotion of IAS charisma needs to be evaluated against the associated risks, such as promoting further invasions, incorporation of such species into local cultures (Nuñez *et al*. 2012), and promoting public engagement that may also target threatened native species.

IAS charisma can also motivate the active involvement of specific groups, such as aquarium hobbyists, to contribute to scientific research, education and awareness raising, as well as to campaigns on IAS trade and introduction control (Maceda-Veiga *et al*. 2016). In some cases, it can also stimulate public involvement through the use of the flagship species concept (Panel 3).

Concluding remarks and ways forward

We argue that it is crucial to recognize explicitly the importance of charisma surrounding IAS if we want to fully understand the extent of human contributions to biological invasions, and management successes and failures (WebFigure 1). Interventions to change attitudes and behaviors towards charismatic IAS, as well as to raise awareness of their potential impacts, can reduce risks arising from trade and cultivation of high-risk invaders and their introductions. It can also bolster support for control measures and volunteer participation in management initiatives. Perception of species charisma is highly context- and culture-dependent (Lorimer 2007), and can be affected and modified through targeted activities (Veríssimo *et al*. 2017; Panel 1). Some conservationists have advocated behavior change interventions, a set of techniques aimed at influencing people's choices in ways that will positively affect the environment (Byerly *et al*. 2018). In addition to behavioral changes, these types of strategies are also able to affect attitudes towards IAS and charisma perception.

Open communication, improved collaboration and engagement among scientists, managers and key stakeholders can considerably reduce the risk of conflicts, and foster establishment of joint management goals and initiatives (Fischer *et al*. 2014; Crowley *et al*. 2017; Novoa *et al*. 2018). Conflicts, especially when involving charismatic IAS, can sometimes stem from the apparent incompatibility of two different ethical perspectives, between those prioritizing ecosystem health or species conservation on one hand, and those concerned for the welfare of individuals of the alien species in question on the other (Genovesi and Bertolino 2001; Wallach *et al*. 2018).

It is critical to improve understanding and anticipation of public perceptions towards particular IAS, and to consider the power of charisma in management planning and its role in particular management scenarios. Moreover, any effects of IAS charisma on different facets of human well-being should also be defined and integrated within established frameworks for socioeconomic impact classification (Bacher *et al*. 2018). While quantifying the effect of species charisma on the invasion process is challenging due to subjectivity and instability of societal

charisma perceptions (Panel 1), future studies should try to address this issue. Improved understanding of IAS charisma will require careful consideration of values, perceptions and cultural background of different stakeholders, as well as of cultural trends and variability (Garcia-Llorente *et al*. 2008; Crowley *et al*. 2017). Research based on social scientific methods will be key to provide a better understanding of IAS characteristics, societal values and other factors that give rise to IAS charisma. Digital approaches, involving analysis of large bodies of text and other media, could represent valuable additional research tools to explore human culture, identify key traits and drivers of IAS charisma, and understand and monitor public perceptions of IAS and their trends over space and time (Ladle *et al*. 2016).

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Panel 1. Invasive alien species (IAS) charisma

Species charisma is a highly complex concept, and there is currently no consensus on definitions (Lorimer 2007; Albert *et al*. 2018). It is used in the literature to refer to "attractiveness", "appeal" or "beauty" of species but, except for the seminal work by Lorimer (2007), very few studies actually state what the term signifies or what its properties are (Albert *et al*. 2018; Crowley *et al*. 2019). Lorimer (2007) refers to it as "non-human charisma" and defines it as a concept that lies somewhere between inherent species characteristics on the one hand and subjective perceptions and values assigned by humans on the other; the latter are generated through direct or indirect human interactions with the species (Crowley *et al*. 2019). Being highly subjective, perceptions around charisma can change over time or even be enhanced or constructed (Lorimer 2007). Lorimer identifies that charisma is not always unambiguously positive; for example, species can be both charismatic and perceived as frightening (e. g. sharks, anacondas). In wider use, however, and particularly in conservation, the term is applied to those species whose characteristics and behavior tend to inspire positive responses in humans. In conservation science and practice, charisma is closely associated with the flagship species concept, and used for scientific communication and attracting funds (Albert *et al*. 2018).

Our definition of charismatic species, and of charismatic IAS in particular, therefore relates to species whose characteristics affect people's perceptions, attitudes and behaviors surrounding them. We refer here to the behavior of both management activities by institutions and reactions of the general society. Characteristics that are driving species charisma can be visual (e.g. unique morphology), acoustic (e.g. particular sounds produced, such as bird calls), olfactory (e.g. emission of pleasant smells, fragrances of flowering plants), behavioral (e.g. complex or anthropomorphic behavior), or symbolic (e.g. abstract characteristics embedded in the general culture). However, it is important to bear in mind that species charisma is highly context-dependent, that it varies over

551 space and time, and that it is influenced by regional, social and cultural factors, as well as individual
552 value systems (Shackleton et al. 2019). For example, people can have strikingly differing
553 perceptions of squirrels, either considering them charismatic due to their features, such as large eyes
554 or bushy tails, or disliking them due to their rodent-like characteristics (Shackleton *et al*. 2019). A
555 detailed overview of factors driving human perceptions of IAS was provided by Shackleton *et al*.
556 (2019).

557 Although the definition of species charisma is elusive, some animal traits are known to
558 contribute to charisma, such as body size, distinctive coloration patterns, furry coat, peculiar
559 appearance, neotenic features and sentience (Gobster 2011; Shackleton *et al*. 2019; Beever *et al.*
560 2019). Feral populations of domestic animals are especially likely to be charismatic (Veitch and
561 Clout 2001). Charisma is also a feature attached to some plants, where it is strongly driven by traits
562 such as flower colors, size and fragrance, and foliage shape (Mack 2001; Veitch and Clout 2001;
563 Gobster 2011; Shackleton *et al*. 2019).

564

565 **Panel 2. The case of feral hippos in Colombia**

566 A small population of feral hippopotamuses (*Hippopotamus amphibius*) currently lives in
567 the Rio Magdalena valley in Northeastern Colombia, and represents an outstanding case of a
568 charismatic IAS (Figure 4). Drug cartel leader Pablo Escobar illegally imported four hippos for the
569 establishment of a private zoo on his estate in the early 1980s, but after his death in 1993 and
570 subsequent forfeiture of his estate, they turned to roaming the surrounding countryside and have
571 been reproducing successfully ever since, with potential negative impacts on native communities
572 (Dembitzer 2017). There have been several unsuccessful attempts to control the growth of the
573 population that is currently estimated to consist of up to 70 individuals. Culling initiatives were
574 abandoned due to strong public opposition in 2009, and sterilization plans have been stopped due to
575 high costs and risk for both hippos and humans during the procedure. Hippos are considered as one

of the most charismatic animal species, mainly based on their impressive body size and appearance (Albert *et al*. 2018). They are appreciated by the local communities, perceived as an important tourism factor and increasingly featured as decorative motifs in public spaces and commercial enterprises.

Panel 3. Potential of the flagship species concept in IAS management

The concept of flagship species was developed to focus conservation marketing campaigns on species with traits that are perceived as charismatic, and thus to attract public support and funding for conservation efforts, e.g. giant panda (*Ailuropoda melanoleuca*; Veríssimo *et al*. 2011). However, while charisma is one of the key parameters that determine the flagship potential of a species, IAS charisma can constrain management by diminishing support for control measures. In practice, IAS charisma is often taken into account during promotion campaigns, by either excluding charismatic invaders from promotional material when control measures are advocated, as was the case for the invasive brush-tailed possum (*Trichosurus vulpecula*) in New Zealand, or conversely by promoting the charismatic perspective of IAS in case of campaigns that oppose control measures (McNeely 2001).

Use of charismatic IAS as flagship species can be beneficial for monitoring programs and citizen science initiatives, where they can help motivate volunteers to become engaged in sampling or monitoring activities. For example, guppies (*Poecilia reticulata*) were promoted as flagship species of a citizen science project directed at monitoring alien fish species in thermal waters in Germany (Figure 2d; Lukas *et al*. 2017).

The most promising way to apply the flagship species concept in IAS management is arguably to focus on the charismatic species that are impacted by IAS. Such conservation marketing campaigns can be focused either on the species threatened by IAS, or on selected species pairs, represented by the IAS and its charismatic victim. The “flagship victim” charisma can potentially

mitigate effects of IAS charisma on public support for management, and this concept is already used for some local IAS management actions. Examples include the endangered southern cassowary (*Casuarius casuarius*) promoted as a flagship victim of feral pigs (*Sus scrofa*) in Queensland, Australia (McNeely 2001); the "SOS Puffin" project with Atlantic puffin (*Fratercula arctica*) as a flagship victim of the invasive mallow tree (*Lavatera arborea*) in the Firth of Forth islands in Scotland (Pagès *et al*. 2018); and the water vole (*Arvicola amphibius*) as a flagship victim of American mink (*Neovison vison*) in Scotland (Melero 2017).

Figure captions

Figure 1. Overview of different mechanisms through which invasive alien species (IAS) charisma affects different invasion stages and management measures. Invasion stages are based on the framework by Blackburn *et al*. (2011). Red fields and arrows – charisma effects that tend to hinder IAS management; green fields and arrows – charisma effects that tend to facilitate IAS management; bicolored fields and arrows – charisma effects that can either hinder or facilitate IAS management, depending on circumstances.

Figure 2. Examples of invasive alien species (IAS) charisma effects on biological invasions and management measures: (a) introduction rates – introduction of pontic rhododendron (*Rhododendron ponticum*) was to a great extent driven by its charisma (Mack 2001; photo by Kenneth Cox); (b) IAS charisma gives rise to public opposition to control measures – proposed control measures for introduced eastern grey squirrel (*Sciurus carolinensis*) populations in Italy were delayed and made ineffective by strong public opposition (Bertolino and Genovesi 2003; photo by Jonathan Jeschke); (c) IAS charisma contributes to the acceptance of IAS by the society – *Opuntia* species in Spain became an iconic symbol in the landscape, depicted even in stamps and postmarks (photo by Pablo

González-Moreno); (d) IAS charisma can contribute to volunteer involvement in citizen science projects – guppies (*Poecilia reticulata*) were promoted as flagship species of a citizen science project directed at monitoring alien fish species in thermal waters in Germany (Lukas *et al*. 2017; photo by David Bierbach).

Figure 3. The way IAS is presented in media can strongly affect how it is perceived by the public: (a) "Pikachu" possum (*Trichosurus vulpecula;* photo by Boronia Veterinary Clinic and Animal Hospital); (b) a possum and black rat (*Rattus rattus*) eating chicks from a song thrush (*Turdus philomelos*) nest (photo by Ngā Manu Images). All three species represent IAS in New Zealand.

Figure 4. Population of feral hippopotamuses (*Hippopotamus amphibius*) in the valley of the Rio Magdalena in Northeastern Colombia (photo by David Echeverri López).