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The role of species charisma in biological invasions

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51 **Abstract**

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

64

65 **In a nutshell**

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

75

76

77 **Introduction**

78 The concept of charismatic species – which is commonly used in the literature to refer to the
79 “attractiveness”, “appeal” or “beauty” of species (Panel 1) – has recently garnered attention in
80 conservation science due to its potential to stimulate public awareness and support, especially
81 through the use of flagship species (Veríssimo *et al.* 2011; Courchamp *et al.* 2018). The charisma of
82 any introduced species, and invasive alien species (IAS) in particular, can affect people's
83 perceptions of the species and their attitudes towards management (McNeely 2001; Veitch and
84 Clout 2001; Shackleton *et al.* 2019). There is ample evidence in the literature of IAS charisma
85 influencing the invasion process across a wide range of taxa spanning different taxonomic groups
86 and regions (WebTables 1-3; Figure 1). As opposed to a positive effect of charisma in the
87 management of threatened species, IAS charisma most often represents a hindrance to management
88 actions (Genovesi and Bertolino 2001; Bertolino and Genovesi 2003). It can reduce public support
89 for management attempts and contribute to conflicts, and ultimately impede management efforts,
90 for example by delaying or preventing control implementation (Estévez *et al.* 2015; Novoa *et al.*
91 2018). However, the issue of species charisma in relation to IAS has not yet been systematically
92 explored.

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

100

101 **Effects of charisma on introductions and establishment success**

102 It is likely that charisma has an effect on introduction and establishment rates, especially in
103 certain taxonomic groups and introduction pathways, such as the ornamental plant, aquarium and
104 pet trade (Padilla and Williams 2004; van Kleunen *et al.* 2018). For example, aquarium releases are
105 recognized as a key contemporary introduction pathway for invasive aquatic species, and are
106 responsible for the introduction of as much as one third of the world's ecologically and
107 economically most damaging aquatic IAS (Padilla and Williams 2004). Such aquatic ornamental
108 species, as well as terrestrial ones, are not randomly selected, but chosen for specific, appealing
109 traits, resulting in higher demand for charismatic species in the pet and horticultural trades
110 (Chucholl and Wendler 2017; van Kleunen *et al.* 2018; Kutlvašr *et al.* 2019). Although this remains
111 to be quantified, it is likely that the increased prominence of such charismatic species within the
112 pool of traded and reared species can lead to increased prominence in the introduced species pool
113 and, hence, to a higher propagule pressure. While charisma probably has negligible effects on
114 inadvertent introductions (e.g. by ballast water or seed contamination) or those mainly driven by
115 perceived utility (e.g. crop species), all else being equal, we hypothesize that charismatic species
116 should have a comparatively higher overall chance of being introduced than non-charismatic
117 species. Species charisma could thus potentially shape the composition of the introduced species
118 pool, and charismatic species could consequently also be more likely to become established than
119 non-charismatic species. In fact, some of the best-known IAS introductions were likely influenced
120 by their charisma. The raccoon (*Procyon lotor*) is a good example: raccoons are very charismatic
121 due to their “cute” appearance with their facial color patterns resembling a bandit's mask across
122 their eyes, their behavior that is perceived as comical and their endearing habit of dousing,
123 supposed washing of food prior to eating. The raccoon became popular as a pet animal in Japan,
124 where it is an alien species, and many individuals were imported, allegedly due to the popularity of
125 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

151 specific points of view (Figure 3; Veitch and Clout 2001; Crowley *et al.* 2017; Shackleton *et al.*
152 2019). For example, public perception and the stance of official bodies towards the Nootka lupine
153 (*Lupinus nootkatensis*) in Iceland shifted from positive to largely negative because of an ongoing
154 public debate in the media (Petursdottir *et al.* 2013; Benediktsson 2015). Effects of IAS charisma
155 and their media representation and communication are essentially inter-related, they affect each
156 other, and the way species will be ultimately perceived.

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

176

177 **Effects of IAS charisma on their societal acceptance**

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

183 IAS may become accepted by the public as desirable elements of local fauna and flora, often
184 as an instance of the shifting baseline syndrome, which represents a gradual change in the accepted
185 norms due to a lack of experience, memory or knowledge (Soga and Gaston 2018; Beever *et al.*
186 2019). Over time, expectations of what is a truly original and desirable state of the natural
187 environment change (Soga and Gaston 2018), and the ability of people to recognize a species as
188 alien decreases with the time that has passed since introduction (Garcia-Llorente *et al.* 2008).

189 The readiness of the public to accept an alien species as the “new normal” likely increases
190 with perceived charisma, especially if a species has become associated with cultural practices or
191 perceptions of the place (Nuñez and Simberloff 2005; Verbrugge *et al.* 2013). For example, after
192 being introduced in southeast Spain for different economic reasons, *Agave* and *Opuntia* species
193 have invaded large arid areas where they built charisma over time and became iconic symbols of the
194 landscape that has been depicted in stamps and postmarks (Figure 2c). *Jacaranda* trees also became
195 iconic in South Africa and a symbol of Pretoria, nicknamed the "Jacaranda City" (Dickie *et al.*
196 2014). Alien species can become integrated into cultural identities through positive interactions and
197 emotional and material attachments, and such processes can occur rather quickly in the case of
198 charismatic species (Crowley *et al.* 2017, 2018). For example, monk parakeets (*Myiopsitta*
199 *monachus*) in Chicago became an iconic species for the city in less than 50 years since their
200 introduction (Crowley *et al.* 2017). The ruddy duck (*Oxyura jamaicensis*) was adopted as the

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

206

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

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

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

226 Opposition by some vocal sections of the public has sometimes forced management authorities to
227 use alternative, non-lethal, and often more expensive methods such as reproduction control or
228 relocation, even though they may be less effective (Bertolino and Genovesi 2003; Verbrugge *et al.*
229 2013; Panel 2).

230

231 **Effects of IAS charisma on research efforts and funding availability**

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

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

250

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

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

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

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

274

275 **Concluding remarks and ways forward**

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

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

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

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

310

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525

526

527 **Panel 1. Invasive alien species (IAS) charisma**

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

543 Our definition of charismatic species, and of charismatic IAS in particular, therefore relates
544 to species whose characteristics affect people’s perceptions, attitudes and behaviors surrounding
545 them. We refer here to the behavior of both management activities by institutions and reactions of
546 the general society. Characteristics that are driving species charisma can be visual (e.g. unique
547 morphology), acoustic (e.g. particular sounds produced, such as bird calls), olfactory (e.g. emission
548 of pleasant smells, fragrances of flowering plants), behavioral (e.g. complex or anthropomorphic
549 behavior), or symbolic (e.g. abstract characteristics embedded in the general culture). However, it is
550 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

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

580

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

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

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

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

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

608

609 **Figure captions**

610

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

617

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

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

630

631 **Figure 3.** The way IAS is presented in media can strongly affect how it is perceived by the public:

632 (a) "Pikachu" possum (*Trichosurus vulpecula*; photo by Boronia Veterinary Clinic and Animal
633 Hospital); (b) a possum and black rat (*Rattus rattus*) eating chicks from a song thrush (*Turdus*
634 *philomelos*) nest (photo by Ngā Manu Images). All three species represent IAS in New Zealand.

635

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

638

639