



# Towards a societal discourse on invasive species management: A case study of public perceptions of mink and beavers in Cape Horn

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## ABSTRACT

The management of biological invasions is a complex and often controversial issue reflecting a diversity of values. Research and public policy on invasive species have concentrated on their ecological and economic impact, most frequently overlooking the social component. In this paper we examined the public perceptions of invasive species of high conservation concern in the Cape Horn Biosphere Reserve, Chile, for which management plans are forming: the American mink (*Neovison vison*); and, the North American beaver (*Castor canadensis*). Two native species served as counter-examples, the guanaco (*Lama guanicoe*) and the upland goose (*Chloephaga picta*). Qualitative semi-structured interviews covered three areas: conceptualisation and knowledge of invasive species; values associated with invasive and native species; and acceptance of control measures. We found differentiated knowledge and high awareness of invasive species among the public. Interviewees attributed utilitarian, aesthetic, and humanistic values to all four species; however, negativistic values were attributed only to invasive species, and moralistic values only to native species. Our results further revealed key issues explaining tolerance towards invasive species, and different positions of acceptance for management. To include a broader public participation in the design and management of responses to biological invasions we suggest: (1) considering local knowledge as a source of information, and vice versa, providing the public with scientific information; (2) evaluating the tolerance level towards invasive species and negotiating conflicting values; (3) clarifying the perspectives of economic income through invasive species management; and, (4) employing compromises on the basis of suggestions from the public.

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## 1. Introduction

There is widespread concern among nature conservationists and policy institutions about invasive species “progressively replacing biodiversity with biosimilarity” (Warren 2007, p. 428). Biological invasions are not only considered as one of the major threats to the Earth’s biota (Sala et al. 2000), but some are also detrimental to human health and wealth (McMichael & Bouma 2000; Pimentel, Lach, Zuniga, & Morrison 2000). As a consequence of such well-documented impacts, “native only” policies (Kendle & Rose 2000, p. 19) have widely been promoted and implemented (e.g., Krajik 2005; McNeely et al. 2001). Yet, the construction of native species as more ‘natural’ elements of ecosystems – as compared to invasive species – implies a specific set of underlying values (Foster

& Sandberg 2004). Those values change according to the different stakeholders involved in the debate: scientists; policy makers; the commercial sector; journalists; and, different groups of the general public (e.g., Lodge & Shrader-Frechette 2003). Indeed, invasive species can be viewed from different perspectives, and responses to them will depend on the lens through which we are looking. In this paper we argue that a better understanding of the public’s perceptions of invasive species and their participation in a discourse on their management is needed.

Generally, decision-making through societal discourse is widely urged in the environmental management agenda (UNEP/CBD 2000). Today, scientists are also promoting the consideration of different perspectives, values and relationships with nature as a critical step for reducing conflicts in biodiversity policy (e.g., Berghöfer et al. 2010; Fischer & Young 2007; Jax & Rozzi 2004). However, with respect to invasive species, to date, the literature has focused predominantly on their ecological impacts (e.g., Parker et al. 1999). While there are some influential studies on their economic costs (see especially Pimentel et al. 2000, updated Pimentel, Zuniga, & Morrison 2005), comparatively little attention has been

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given to the social relevance of invasive species and their management.

The social components of invasion biology represent an emerging and diverse field of investigation; an increasing number of studies address criticisms to invasion biology, including, for example, the dubiety of the conceptual foundations of the native/non-native framework (e.g., Warren 2007; Woods & Moriarty 2001) or the use of a fear-based, e.g., “threat”, “crisis”, “disaster” (cited in Gobster 2005, p. 263) and war-like, e.g., “enemy release”, “battling invaders”, “novel weapons” (cited in Larson 2005, p. 495) language in communications about invasive species. Other authors have focused on ethical perspectives of control and eradication (Haider & Jax 2007; Lockwood & Latchinsky 2008; Meech 2005) or on the beneficial traits of invasive species. For example, Shackleton et al. (2007) have shown that rural communities in southern Africa would even prefer higher densities of an invasive cactus species whose fruits they used. Other studies, in turn, emphasised the importance of values in the formation of attitudes towards biodiversity management (e.g., Fischer & van der Wal 2007). Thereafter a variety of studies were concerned with the positions of institutional stakeholders towards invasive species (e.g., Binimelis, Monterroso, & Rodríguez-Labajos 2007; Stokes et al. 2006) and those of stakeholders not formally associated with interest groups (e.g., Evans, Wilkie, & Burkhardt 2008; Robinson, Smyth, & Whitehead 2004). Often quantitative questionnaires are used for these assessments (e.g., Andreu, Vila, & Hulme 2009; Bremner & Park 2007; García-Llorente, Martín-López, González, Alcorlo, & Montes 2008).

Before explaining how our case study provides an example of a qualitative approach to gather in-depth information on such perceptions, it is necessary to first define some important terms. The fact that concepts about invasive species are diverse and lack common agreement among invasion ecologists (Coulatti & MacIsaac 2004) reflects the challenge this complex issue poses even to experts. Among the proposed classification schemes, authors often distinguish between the range of spread and impacts (e.g., Davis & Thompson 2000; Heger 2004). Here we use a definition that minimizes value judgement by referring to an ‘invasive’ species as a non-native species spreading in a new area outside of its area of origin, no matter whether it exerts any negative effects on native ecosystems or not (adapted from Heger 2004).

This study aims to improve our understanding of public perceptions on invasive mammals on a continent where little research of this kind has been carried out before, South America. It is based on the analysis of two cases which allow the comparison of distinct invasion processes and their implications on people’s attitudes: the recently arrived (a decade ago) carnivorous American mink (*Neovison vison* Schreber, 1777) and the long established (more than five decades ago) herbivorous North American beaver (*Castor canadensis* Kuhl, 1820). Having invaded one of the most remote and pristine areas remaining on the planet, the UNESCO Cape Horn Biosphere Reserve (CHBR) in southern Chile (Rozzi et al. 2006), these species are considered of high conservation concern. Yet, so far, management plans in the past (Soto & Cabello 2007) and a planned eradication campaign (“the beavers must die”, Choi 2008, p. 968; see also Menvielle et al. 2010) have given little attention to attitudes of the local community. As examples of terrestrial native species to be used as counterparts in the analysis, we chose two conspicuous species of which we expected people had personal experiences and different types of relationships the upland goose (*Chloephaga picta* Gmelin, 1789), a representative of the rich avifauna of the region, and an abundant and culturally important bird species in coastal and frequented habitats, and the guanaco (*Lama guanicoe* Müller, 1776), the only striking terrestrial mammal on Navarino Island, an island where the other mammals include two species of bats and

two species of mice that were considered as rather inconspicuous and therefore not suitable for the study.

We present results from 37 qualitative face-to-face interviews on the four selected species with members of different socio-cultural groups residing in the CHBR, exploring (1) the conceptualisation and knowledge of invasive species, as well as their perceived impacts, (2) the range of values regarding native and invasive species, and (3) the attitudes towards controlling invasive species. This case study will provide information useful to conservation managers in the Cape Horn Biosphere Reserve, and beyond, by providing a basis for management decisions that consider the diversity of perspectives among those whose environments and lives are affected by those decisions.

## 2. The local setting

The study focused on a significant conservation problem taking place in the CHBR: the alteration of natural ecosystems by an ensemble of invasive mammal species in one of the Earth’s 24 most pristine wilderness ecoregions (Mittermeier et al. 2003). American mink and North American beavers are the two invasive species of highest conservation concern (Anderson, Rozzi, et al. 2006). As a consequence, a regional control program residing with the Ministry of Agriculture, specifically the Agriculture and Livestock Service (SAG), has promoted the hunting of beavers and mink in the Magallanes and Chilean Antarctic Region from 2004 to 2007, resulting in 234 dead mink and 11,700 dead beavers (Soto & Cabello 2007).

The mink is a North American semi-aquatic mustelid, which was introduced to Argentine Tierra del Fuego Island for fur farming in the 1940s and 1950s (Jaksic, Iriarte, Jiménez, & Martínez 2002). Recently, in 2001, escaped farm animals had reached Navarino Island (55°S), part of the CHBR (Rozzi & Sherriffs 2003), where our study was conducted (Fig. 1). Here the mink represents a new guild of terrestrial mammalian predators with negative impacts on ground-nesting waterbirds, such as ducks and geese endemic to Patagonia (Ibarra, Fasola, MacDonald, Rozzi, & Bonacic 2009; Schüttler, Klenke, McGehee, Rozzi, & Jax 2009), and on poultry farming (Soto & Cabello 2007). Impacts of wild populations of mink are well known in Europe, where they have been shown to reduce populations of waterbirds, rodents, amphibians, and mustelids (reviews in Bonesi & Palazon 2007; Macdonald & Harrington 2003).

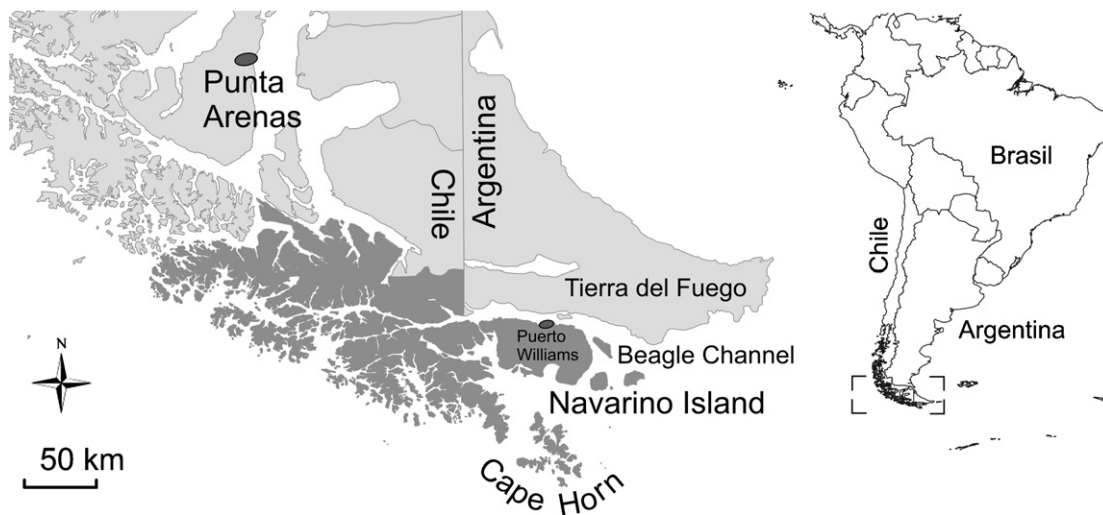
Already in 1962 beavers had reached Navarino Island after having been released as furbearers into Argentine Tierra del Fuego Island in 1946 (Sielfeld & Venegas 1980). Today, beavers have colonised the archipelago of Tierra del Fuego, parts of the CHBR and of the Chilean mainland (e.g., Anderson et al. 2009; Wallem, Jones, Marquet, & Jaksic 2007). As ecosystem engineers, beavers have caused the largest alteration to the sub-Antarctic forests since the recession of the last ice age (Anderson et al. 2009). The main ecological consequences are the removal of over storey trees and the alteration of the riparian community structure (Anderson, Griffith, et al. 2006). Social and economic effects include impacts on forestry and livestock management, and damage to the infrastructure (Skewes & Olave 1999).

As a basis for the nomenclature of taxa we used the Integrated Taxonomic Information System.

## 3. Methods

### 3.1. Data collection

We used a qualitative approach to explore the spectrum of perceptions on invasive and native species. By sampling representative information-rich cases, qualitative research allows for description of the perspective of the social actors themselves,



**Fig. 1.** Overview of the study area. Navarino Island with Puerto Williams as the capital of the Chilean Antarctic Province is located within the Cape Horn Biosphere Reserve (54–56° S, shaded in dark gray) in southern South America.

while the researcher's conceptualisation of the topic stays in the background (Denzin & Lincoln 2005). Methods including, for example, qualitative interviews, focus group discussions, or participant observation, are increasingly applied to explore environmental phenomena in-depth (e.g., Berghöfer et al. 2010; Fischer & Young 2007). We adopted a qualitative design here, because we assumed that our understanding of invasive species might differ from those of our participants. Such an explorative methodology allows perceptions to emerge that, to some extent, go beyond our own sets of beliefs. Between 2005 and 2007 the first author performed 37 semi-structured qualitative face-to-face interviews in the town of Puerto Williams on Navarino Island. This is the capital of the Chilean Antarctic Province, and with approximately 2,300 residents, it is the largest human settlement in the CHBR. The participants were selected on the basis of belonging to the main distinct sections of the population on Navarino Island, representative of their socio-cultural background or principal economic activity (Rozzi et al. 2006). In addition, we contacted members of a specific interest group, namely nature conservationists. This classification served to include a broad range of responses given by the heterogeneous groups present in the region rather than to analyse differences among those socio-cultural groups; therefore uneven numbers of interviewees in each group do not represent a limitation. The 37 participants belonged to six pre-defined groups of participants: *Chilean Navy members* (8 interviewees), whose residence on Navarino Island was less than four years; *Yaghan indigenous people* (5), mostly raised on the island; *fishermen* (7), two of them being also Yaghan, *public service employees* (3); *civilian residents* (10), performing a variety of economic activities; and *nature conservationists* (4), partly academic, partly administrative professionals of which two were foreigners. A bias towards male participants (67.6%), particularly among fishermen and public service employees, might have influenced the results to some extent as there is evidence of gender differences in concern about specific local environmental risks (e.g., Zinn & Pierce 2002) and the actions willing to take in response (e.g., Ozanne, Humphrey, & Smith 1999).

Only participants who were adults and had lived at least one year on Navarino Island were selected. We used a snowballing procedure to recruit the participants during which we identified initial interviewees of each group who provided contact information for subsequent participants from their circle (e.g., Marshall, White, & Fischer 2007). The interviews were conducted in Spanish and were between 30 and 90 min long (on average 48 min). Although the fact that the interviewer was a foreigner might have motivated the par-

ticipants to employ a more simplified language, we believe that these effects were not so great as to change the implications of our findings. The semi-structured interview schedule had three main sections, dealing with (1) the conceptualisation of invasive species, knowledge and impacts of mink and beavers; (2) the evaluation of invasive versus native species, and values related to mink and beavers, and guanacos and upland geese; (3) the attitudes towards control of invasive species (see Table 1). In the interviews we used the term 'exotic' and 'invasive' synonymously although some authors make a distinction here (e.g., Heger 2004). All interviewees were asked all questions, but the order was adapted to the course of conversation; and we allowed other related topics to be raised during the interview. Nevertheless, in face-to-face interviews, the context provided by subsequent questions may influence responses to preceding questions (e.g., Schwarz & Hippler 1995). These "order effects" might have emerged when first talking about knowledge and impact of invasive species (Theme 1), and then moving on to their evaluation (Theme 2), potentially leading to more negatively shaped answers. We tried to reduce the potential effect of social

**Table 1**

Themes covered in the interview schedule using semi-structured open-ended questions.

Theme 1: Conceptualisation, knowledge and impact of mink and beavers

*Which animals are typical for you on Navarino Island?*  
*Which native and exotic animal species do you know on Navarino Island?*  
*What do you know about the mink and beaver? (arrival, ecology, impacts on the island and on inhabitants, and reasons for their survival on Navarino Island)*  
*How do you estimate the quantities of mink/beaver (today and in ten years)?*  
*Which personal experiences do you have with the mink/beaver?*  
*How did you acquire your knowledge about the animals on the island?*  
*What is an exotic species for you?*

Theme 2: Evaluation of invasive and native species

*Is there an important animal for you on Navarino Island? Why?*  
*Is there an animal you don't like on Navarino Island? Why?*  
*What does the mink/beaver mean to you? Do you like it?*  
*What does the guanaco/upland goose mean to you? Do you like it?*

Theme 3: Attitudes towards controlling invasive species

*Does nature need human aid with respect to exotic species?*  
*What does the term 'control program of exotic species' mean to you?*  
*What do you think about a control program of exotic species on Navarino Island?*  
*What should this control program contain?*  
*Do you think that the mink/beaver could be used? How?*  
*Would you personally participate in a control program of exotic species on Navarino Island?*

desirability bias (where the participants wish to appear socially or morally worthy, Maccoby & Maccoby 1954) as a consequence of the interviewer's identity (natural scientist) through providing the least information possible on the researcher's identity and affiliation during the recruiting, and through a neutral position during the interviews.

### 3.2. Interview coding and analysis

The interviews were digitally recorded and subsequently transcribed verbatim by native Spanish speakers. Our text analysis was guided by the qualitative content analysis strategy following Mayring (2000). The performance of this process is theory-driven following analytical rules (generalisation and reduction of paraphrases). However, content analysis does not aim at developing or verifying theories; rather it is a descriptive method to interpret systematically textual data. Step by step, we deduced categories from the text material, revised them and reduced them to main categories (inductive category development, Mayring 2000). We included information from across the whole interview into the coding procedure of our three main themes (Table 1). We will keep this classification throughout our results section, although the topics strongly intersect. After the exploration of the data, we searched for theories that matched our categories. The value categories attributed to wildlife defined by Kellert (1996) fit the data well and were therefore used as an umbrella for Theme 2, the evaluation of invasive and native species. We understand 'value' here as 'subjectivistic' concept (Ott 2003, p. 32), i.e., values necessarily depend on a valuing subject, a valuer. There have been different approaches to classify values in an environmental context (e.g., Kellert 1996; Minter & Collins 2005; Norton 1987; Ott 2003; Rolston 1988). Although these classification efforts are partly based on different ontological assumptions, their resulting categories are to a large degree similar. In this study, we make use of Kellert's empirically derived categories, because they also include negative values (*dominionistic*, *negativistic*) in contrast to, for example, the philosophically more sophisticated typologies of values presented by Norton (1987) or Ott (2003). This is of special relevance with respect to evaluating species that some people view as undesirable.

Kellert's taxonomy of values (1996) includes: the (1) *utilitarian* value (practical and material benefit from nature); (2) *naturalistic* value (direct experience of nature and wildlife); (3) *ecological-scientific* value (systematic study of structure, function, and relationship in nature); (4) *aesthetic* value (physical appeal and beauty of nature); (5) *symbolic* value (use of nature for communication and thought); (6) *humanistic* value (strong emotional attachment and 'love' for aspects of nature); (7) *moralistic* value (spiritual reverence and ethical concern for nature); (8) *dominionistic* value (mastery, physical control, dominance of nature); and (9) *negativistic* value (fear, aversion, alienation from nature).

## 4. Results

### 4.1. Theme 1: conceptualisation, knowledge and impacts of mink and beavers

#### 4.1.1. Conceptualisation

In order to explore the conceptualisation people had of invasive animals, we asked them about their own definitions of invasive species. Here, descriptive and evaluative aspects were already intensely interwoven. Most interviewees agreed that invasive species were species introduced to a place they did not originally belong to. For some it made a difference whether those species arrived with human aid or on their own. With respect to time scales, the beaver was regarded as "already belonging to us" by five

interviewees. A Yaghan woman used her life time experience as a reference: "I was accustomed to seeing those animals that I have seen since my childhood, and suddenly seeing a new animal is a novelty." Interestingly, interviewees among fishermen and civil residents attributed to invasive animals a settler's spirit: the "new neighbours" emigrated in search of new habitats, adapting themselves to their new harsh environment "like us". Two interviewees were not convinced of the native/non-native concept. One Navy member would not make a difference between animals, and one civil resident criticised this concept as xenophobic. Finally, interviewees from all groups assigned invasive species a negative impact on their new environment. Invasive species were threatening the "equilibrium" of the invaded ecosystem. "An animal that is not from here can mix up the cycle of the ecosystem, the way they [the native animals] are in peace among themselves" (a fisherman).

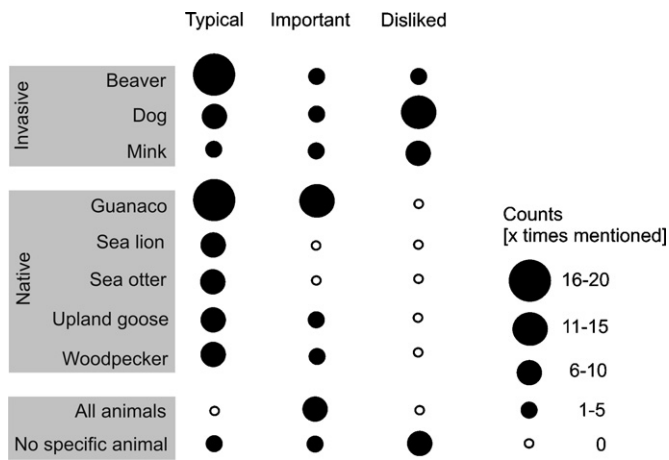
#### 4.1.2. Knowledge and impacts of mink and beavers

To get the conversation about mink and beavers started, we first asked a general question on the participants' knowledge and experience of these species. Most interviewees classified them as introduced animals, although almost half of the participants stated that they did not know much about the mink. In contrast, beavers were well known and people often had experienced these animals.

The participants associated a broad spectrum of ecological, social, and economic impacts to invasive mink and beavers. Regarding the mink, there was little direct experience of its impacts; it appeared as an invisible predator. Most interviewees worried that mink had caused the perceived decline of birds during the last number of years (with the possibility of species becoming extinct) and feared negative consequences for tourism. Other concerns raised by the interviewees were attacks on poultry, the destruction of fishing nets, the possible invasion of settlements including attacks on humans, and the risk of losing the local people's identity and rootedness as a consequence of bird species extinctions. Only five participants thought that mink were not a pest. Several interviewees, however, acknowledged a limited knowledge of the mink and its impacts, as well as an indifference towards it: "...there is no effect [of mink], because the people don't know it...they don't talk a lot about the mink" (civil resident).

Concerning the beaver, the most frequently perceived impact was its damage to the forest, and in most cases this impact was directly experienced. Other frequently mentioned impacts included the contamination of potable water and the disturbance of hiking trails. Further impacts had an economic dimension: the destruction of bridges due to changed watercourses; the disturbance of grazing land and of the extraction of fire wood; the prevention of cultivating crops; and negative impacts for tourism. Some impacts were more specifically mentioned according to the perspectives of the particular group; for example, nature conservationists primarily perceived the ecological effects (e.g., changes in the ecological communities, disruption of nutrient cycles) and a Yaghan woman was concerned with the impacts on reed extraction for traditional handicrafts. About a third of the interviewees among all groups, except for nature conservationists, were less convinced of the severity of the beaver's impacts. They simply doubted that beavers were as destructive as people were telling: loggers were seen as more destructive than beavers, and some were pointing to the regeneration of the forest: "...they [the beavers] don't do big damage, more damage is done by the motor saws, twice that of the beavers. The beaver is eating what is good for him, never a whole area" (Yaghan). Many of the mentioned impacts of both animals, particularly economic and social, have not been addressed by scientists and public agencies (please refer to the references of Section 2).

Finally, we were interested in how the interviewees had acquired their knowledge about mink and beavers. We found that local knowledge about animals played a predominant role among



**Fig. 2.** Participant's most commonly mentioned typical, important, and disliked animals on Navarino Island expressed as ranges of counts (up to five per interviewee per category, only animals that at least five of the interviewees had named per category,  $n = 37$  interviewees). The woodpecker refers to *Campyphilus magellanicus* (King, 1827), the sea otter to *Lontra felina* (Molina, 1782), different species exist among sea lions.

all groups. This means that everyday life and professional experiences at the local level (as defined by Matthiesen 2005) played a predominant role in generating knowledge: people had learned from “settlers”, “the old”, locals and members of their own family. Personal experience acquired through work in nature, like fishing, farming, or hunting, was especially relevant for fishermen, Yaghan people and civil residents related to outdoor activities. On the other hand, nature conservationists, public service employees, civil residents and Navy members also used formal knowledge sources such as university, school, books, courses, or contact with scientists.

#### 4.2. Theme 2: evaluation of invasive and native species

To acquire an overall idea of which species were seen as typical for the island, which were important or disliked, we asked participants to name those animals that first came to their mind (see questions to start Themes 1 and 2, Table 1) and ordered their answers on a scale of most to least commonly mentioned animals (Fig. 2). This analysis results in a simple list of salient animals, while the subsequent paragraph on values treats the reasons behind this list, i.e., why the mentioned animal is important or disliked by the interviewee.

A total of 31 species were named plus eight generic groups of animals, e.g., petrels or gulls. The interviewees chose typical animals regardless of their origin. Over half of the interviewees found that beavers were a typical species for Navarino Island, along with the guanaco which was rather named by groups with a longer residence (Yaghan, fishermen, civil residents, public service employees). Interestingly, the ‘newcomer’ mink was already perceived as a quite typical species. Among the important animals chosen, native animals, particularly guanacos, figured prominently; vice versa, the participants overall disliked invasive species, particularly feral dogs. However, some interviewees would not make a decision regarding a particular animal important to them; they thought that all animals were important per se, irrespective of the native/non-native dichotomy. In the following, we give some background information for this list assigning the nine wildlife values defined by Kellert (1996) to invasive mink and beavers, and, as a comparison, to two exemplary native species, the guanaco and the upland goose (see Table 2 for a summary).

##### 4.2.1. Utilitarian value

The majority of interviewed groups assigned consumptive uses to all four species. While in the case of mink direct use was seen as limited (unsuitable meat) and only acknowledged in the course of a control program that generated incomes from furs, the participants mentioned a variety of direct uses for beavers: meat; fur; provision of firewood; touristic appeal; and extraction of oils. Different uses were also provided by guanacos (meat, wool, tourism, traditional uses in Yaghan culture) and upland geese (meat, eggs, hunting as a sports activity). Yet in this context, the interviewees referred to past times, because hunting of these two species has been restricted by law.

##### 4.2.2. Naturalistic value

All interviewed groups mentioned satisfaction through direct experiences with beavers: “. . . you see a beaver and suddenly you feel happy. . . especially in winter times when there is an ice cap, and you see them swimming underneath” (Navy member). Although directly asking about upland geese, birds in general often arose in the interviews. Contact with birds was of importance for recreation. Mink were generally perceived as cryptic animals and thus a naturalistic value could not be attributed to it; neither to guanacos which are locally rare.

##### 4.2.3. Ecological-scientific value

This type of value was found to be important among most groups, but it was rather mentioned for nature in general like “first of all knowing, knowing nature to be responsible, nobody loves what he or she does not know” (public service employee), and with respect to studying the impacts and, notably, the benefits of invasive species.

##### 4.2.4. Aesthetic value

All four species had responses that valued them aesthetically. This was particularly the case for birds and the guanaco. Most groups conceived beavers as physically appealing, but only few interviewees believed mink to be attractive.

##### 4.2.5. Symbolic value

Native guanacos and birds were often named as symbolic of the region. As “most ancient animal on the island” the guanaco played an important role in the identity of the Yaghan. The participants used birds also for communication, e.g., as indicators of seasons (upland goose). Interestingly, some civil residents saw invasive beavers as symbolic species for the island: “It is like our mascot”. Mink, however, were not mentioned in this context.

##### 4.2.6. Humanistic value

Emotional attachment and companionship played a role in all four species. Beavers had been kept as pets and some participants

**Table 2**

Summary of the values associated with two invasive species (mink, beaver) and two native species (guanaco, upland goose, i.e., birds in general).

Wildlife values according to Kellert (1996)	Mink	Beaver	Guanaco	Upland goose/birds
Positive values				
Utilitarian	✓	✓	✓	✓
Naturalistic		✓		✓
Ecological-scientific	✓	✓	✓	✓
Aesthetic	✓	✓	✓	✓
Symbolic		✓	✓	✓
Humanistic	✓	✓	✓	✓
Moralistic			✓	✓
Negative values				
Dominionistic	✓	✓	✓	
Negativistic	✓	✓		

**Table 3**  
Public acceptance of the management of invasive species on Navarino Island; main positions revealed from 37 qualitative interviews.

	Position	Quotes
In favour	Native species in danger	"...hunt them...or try to ensure that the invasives are not overpopulated, overwhelming the natives, because the natives can be lost and then we will have to look at them in a book."
	Creation of income	"[A control program] will make the local community work."
Ambivalent	Control yes, eradication no	"...the beaver should not be eliminated in its totality, but a certain number of the species should be respected, because it is also striking for touristic marketing."
	Control yes, other methods than killing	"It makes me sad to see them [the beavers] hanging <sup>a</sup> ...It would be good if they would find another way to extinguish them, not by killing them in such a crude way."
	Decisions from above	"...the voice of the local people doesn't really count. One thing is that they don't speak a lot, and the other thing is that all things are imposed."
Against	Species' right to exist	"They are talking of exterminating it [the beaver]. Something that also makes me concerned, because we will exterminate one more species."
	Invasives not responsible	"...we are charging the mink for a crime that basically is the responsibility of the human being."
	Invasives as scapegoats	"I would prefer that the mink would eat something different from the eggs of...the upland goose. But I also think there are people who are killing upland geese, because it's an exotic dish. So why don't we also talk about what humans do...?"
	Let nature take its course	"Nature is taking care of itself."

<sup>a</sup> Beavers are mostly killed by traps of the type 'Coniber' (Soto & Cabello, 2007), and then hung.

identified themselves with the beaver. "The beaver already belongs here. It is similar to us, one came from outside and got accustomed to here..." (civil resident). Guanacos were appreciated as free spirits and settlers of the region. Overall, birds were experienced as company: "...they [the gulls] are with you in the sea, they come to your boat, they always talk to you..." (fisherman). Finally, some participants found mink affectionate, playful, and intelligent.

#### 4.2.7. Moralistic value

Ethical concern in a narrow sense was solely expressed for the two native species. A great majority of the local community saw feral dogs as a reason for the declining population of guanacos. In addition, the perceived decline of birds worried many participants, who associated this decline almost exclusively with invasive mink.

#### 4.2.8. Dominionistic value

Both mink and beavers were referred to as "pest" animals which had to be controlled: "...the only adverse conditions we can impose on them [the mink and beaver] is the human predator" (public service employee). Negative values were only associated in one case with the guanaco. Its negative impact on the forest provoked mistrust in a nature conservationist.

#### 4.2.9. Negativistic value

The participants expressed negative feelings, which were evoked by mink (fear) and beavers (disgust), but were not by the two native species. A third of the interviewees (except for nature conservationists) perceived the "aggressive" mink as a personal threat. "The mink attacks you...I don't know whether this is true, because I haven't seen them. But now I am afraid when hiking in nature" (Yaghan).

### 4.3. Theme 3: attitudes towards the management of invasive species

When asked what the participants understood by the term 'control program of invasive species', the great majority of the interviewees clearly recognised that it was about reducing the population of mink and beavers. The responses from these persons were incorporated into the following subsections. Only three interviewees had other associations. For them, a control program meant, for example, counting the animals and vaccinating them (a Navy member), or, more in the sense of a closed hunting season, regulating their population numbers in order to ensure their survival (a fisherman, a civil resident, both elderly settlers).

#### 4.3.1. Acceptance of invasive species control

The interviews revealed a spectrum of different attitudes towards the management of invasive species (Table 3). All positions were present in almost all groups, but the general consensus was in favour of "doing something". However, interviewees were cautious to approve total eradication, especially regarding the beavers (an exception were nature conservationists). Rather, they proposed control; not only to maintain the versatile uses associated with beavers, but also because it seemed to be difficult to pass a definite judgement on such a complex issue: uncertainty prevailed about population numbers, impacts, moral issues, feasibility, and consequences of control.

#### 4.3.2. Suggestions for the management of invasive species

The participants had several suggestions to make the management of invasive species more acceptable to them. Civil residents and nature conservationists said that informing and raising awareness about invasive species in the local community were necessary assets for an effective control program. Many interviewees among Navy members and civil residents had ethical concerns with the killing of animals. Therefore they suggested applying humane methods of control, for example castration. The establishment of a fenced reserve for beavers was mentioned as a compromise between the necessity of reducing the population of beavers and not losing the benefits from them, e.g., meat or a tourist attraction. And, in a more general sense, some participants believed that ways should be found to better accept invasive species: "One should also search for the benefits of mink and beavers..." (Navy member) or "...finding another way to make them [the invasives] being liked," (fisherman).

Finally, when asking the interviewees whether they were personally interested in supporting a control program on Navarino Island, most of them spontaneously said yes. Some fishermen, Yaghan people, and civil residents wanted to actively hunt the animals. However, many interviewees could not imagine killing them, especially Navy members and the public service employees, but would consider support in monitoring, education or processing furs. Some participants disagreed with a management of mink and beavers and therefore refused to personally participate in a control program.

## 5. Discussion

A growing literature addresses the critical question of the social context of invasive species and their management (e.g.,

Evans et al. 2008; García-Llorente et al. 2008). We add to this debate by providing a view of public perceptions on invasive mammal species of conservation concern from a remote region of South America. We discuss our main findings, with the aim of providing some key issues important for engaging the public in the discourse on invasive species through a bottom-up approach and flexible, contextual policies. Our data shows that: (1) general public knowledge and awareness of invasive species are relevant, and deserve further efforts to be acknowledged; (2) an identification of the diversity of values attributed to invasive species can determine the tolerance level for these species; (3) an approach of ‘co-management’ in control programs of invasive species should consider the reasons behind acceptance or rejection and search for compromises.

### 5.1. Public knowledge and awareness

Regarding the interviewees’ understanding of the native/non-native concept, we found that many issues discussed by the scientific community, such as time scale of invasions, human influence, or critique of the concept, were also present in the answers. Yet in most cases, the participants’ definitions of invasive species were in concordance with the definitions guided by policy objectives, which emphasise their negative impacts (Binimelis et al. 2007; Heger & Trepl 2008). In addition, the scientifically contested concept of the “balance of nature” (or equilibrium notions of ecosystems, respectively; e.g., Botkin 1990; Wallington, Hobbs, & Moore 2005) was a predominant understanding of nature among the interviewees. Ideas allowing nature more dynamism and variability were less frequently expressed (see also Fischer & van der Wal 2007). Taking this into account, it seems that among the drivers, local policy institutions, natural scientists, or media that might have influenced the interviewees in their conceptualisation of invasive species, more critical and flexible perspectives were absent (e.g., Goulding & Roper 2002). For a better informed and balanced debate on the responses to invasive species, we thus think that the controversial character of the debate should be disclosed in media coverage, national and international conventions, policy directives and the general policy debate. Especially in settings with strong differences in power and education, as given on Navarino Island, the danger is great that an established dominant position will guide practice without any discussion, neglecting “silent voices”, not used to articulate themselves.

The participants perceived a broad array of ecological, economic, and social impacts of mink and beavers. Although the strength and significance of these impacts were subjects of discussion and uncertainty, the multi-faceted array of statements demonstrates awareness of the topic – keeping in mind that many interviewees (particularly fishermen, Yaghan people and civil residents) based their statements on local knowledge acquired in a non-formal way. Thus, the common critique that “members of the general public might have insufficient knowledge and motivation to contribute to environment-related decision making in a valid and meaningful way” (as summarised by Fischer & van der Wal 2007, p. 256) does not hold here.

In this context, local knowledge can be used as an indicator of gaps in scientific knowledge (see the lack of scientific studies on the social and economic dimensions in our case study) – and even as a source of information (UNEP/CBD 2000, p. 107). While doubtlessly in many cases a differentiated analysis of the impacts needs the input of science, e.g., mink are not threatening all birds per se, but rather specific species (Schüttler et al. 2009), ways to better accredit local knowledge have to be developed (Berghöfer et al. 2010; Hunter & Brehm 2003). Using local knowledge in policy can form an entry point for a more balanced discourse between social groups with different educational backgrounds, softening the

still prevalent dominance of scientific knowledge (see also Fischer 2000).

### 5.2. Tolerance towards invasive species

Values are generally understood as higher-order evaluative standards that guide people in their behaviour. As such, values are assumed to be determinants of preferences and attitudes, acceptance and rejection (Olson & Zanna 1993; Rokeach 1973). Here, we used the assessment of values to determine the public tolerance level of invasive species.

Our results indicate that the values were attributed species-specifically, and that the sets of values for native and invasive species overlapped to a high degree. The only difference between native and invasive species was that negative values were nearly absent in native species and moralistic values were missing in invasive species. Apparently, the fact that invasive species are impacting native species is a strong evaluation criterion, although this could look different for toxic native species or native weeds. In the following we have a closer look on the shared value categories. Here our results coincide with essential aspects of other studies. Firstly, invasive species with longer tenure as residents are likely to receive a broader spectrum of values, including positive values. For example, the symbolic dimension that clearly figured among the native species might be claimed for invasive species when time scales are long enough. This was the case of the beaver, which had noticeably become interconnected with the local community during its nearly five decades of presence, not only as a typical and symbolic species, but also with respect to its manifold uses. Other studies showed similar findings, i.e., species introduced in the past were not recognised as invasive species, while recent invasive species were indeed labelled as such (Fischer & van der Wal 2007; García-Llorente et al. 2008). These results support the idea that the native/non-native dualism is not valid as such, but rather a socially dynamic concept (Warren 2007). Secondly, invasive predators are likely to be less positively judged. The negative evaluation of the mink might not only be based on its recent appearance, but on its nature of being a predator. Negative attitudes towards carnivores typically figure among groups whose economic interests are threatened by these animals (e.g., Gusset, Swarner, Mponwane, Keletile, & McNutt 2009; Kaltenborn, Bjerke, & Strumse 1998). Thirdly, our results suggest that a limited possibility of natural experience with an invasive species might also contribute to its rejection. If this is the case, positive values like the satisfaction through observation (*naturalistic* value) cannot be enjoyed. The rather inconspicuous and “hidden” nature of the mink as compared to the beaver might also have provoked its negative perception.

Although our data fits well Kellert’s value system, we have found some value categories not to be represented in his system like diversity and naturalness (see also Haider & Jax 2007). However, those values were mostly referred to when talking about nature on Navarino Island in general, not about specific species. The interviews also contained a reference to indifference towards species, or the absence of any relation with respect to the new invasive species, a notion also absent in Kellert’s values, and worthy of future investigation.

Beyond these findings, other studies have already disclosed a variety of attributes shaping attitudes towards species like for example previous population change, harmlessness, ecological function or phylogenetic similarity to humans (Fischer, Langers, Bednar-Friedl, Geamana, & Skogen 2010; Montgomery 2002; Tisdell, Wilson, & Nantha 2006). Further investigation is therefore needed to determine the relative importance of the invasion criterion among the other attributes playing a role in public opinions of species.

While the above discussed results indicate that there are species-specific characteristics that help to determine the tolerance level of invasive species, most species probably raise mixed sentiments. Ambivalent positions have often been expressed for beavers: “*Although the beavers are detrimental, they are lovely*”. Future research could concentrate on the reasons behind contradictory relationships with a single species and the hierarchical order of values behind them. This can help to stimulate more differentiated approaches of management.

Given that an invasive species is most probably negatively and positively evaluated, management decisions must involve trade-offs. With respect to the ecological-economic dimension, Limburg, Luzadis, Ramsey, Schulz, and Mayer (2010) suggest to quantify and weigh ecosystem services against ecosystem disservices. However, no generally accepted rules for balancing conflicting non-quantifiable values exist, and actual negotiating of different values and goods affected will remain a matter of societal discourse, involving the full range of interests and value dimensions (e.g., Haider & Jax 2007). We thus support other authors who suggest that collaborative stakeholder workshops can identify conflicting values and their importance, and then make explicit trade-offs to preserve those values that are of highest priority through management interventions democratically agreed upon (e.g., Evans et al. 2008; Meech 2005; Shackleton et al. 2007).

### 5.3. Acceptance and compromises

Although the participants' positive attitudes towards control might have been affected by the social desirability bias, its extent can be considered as moderate as we obtained a diverse spectrum of perspectives (Table 3). The majority of the local community supported control strategies for two reasons: firstly, to reduce the perceived negative impacts of invasive species; and secondly, to create income. While the first point is in line with the interests of nature conservation, the second point might imply some sort of conflict. Benefits from the management of invasive species for the community can be either achieved by the employment of hunters, or by the profit from the products of hunted animals like furs, meat, oils, or handicrafts. As the control program of the Agriculture and Livestock Service (SAG) initially paid for animal products (Soto & Cabello 2007), most people referred to this type of benefit. However, nature conservationists in our interviews, and later the SAG control program itself, agreed that the creation of a market was a rather unsuccessful strategy, unprofitable in remote areas and contradicting in objectives (a successful market would avoid losing its product). Hence, if managers want to rely on the ‘support for income’ argument, policies should clearly communicate how benefit will be generated and who will benefit from the initiative, for example, local hunters or external hunters.

With respect to the control of invasive species in our case study, disagreement existed about its degree (control or eradication) and the specific methods used, e.g., killing or castration (see Fraser 2006 for a review of attitudes to pest control technologies in New Zealand). The objections towards extreme actions like eradication found here must be taken seriously if a more sensible approach of ‘co-management’ is sought (Robinson & Whitehead 2003). This approach should have three components. Firstly, scientists and managers should provide information on feasible methods of control and different scenarios for management as a basis for further discussions. Secondly, the process should start with issues where there is greatest agreement (Robinson et al. 2004). Perry and Perry (2008) have shown that even between wildlife managers and animal rights activists, common ground can be found. And thirdly, suggestions made by the local community could represent a means to achieve compromises in conflicting issues. In our case study,

this would mean, for example, taking up the idea of establishing a no-hunting area for beavers.

### 5.4. Conclusions

This paper adds to the small, but increasing body of literature that provides empirical support about the richness of perspectives on invasive species. From this we conclude the relevance of engaging stakeholders in decision making on their management, as argued by other authors (e.g., Evans et al. 2008; García-Llorente et al. 2008; Stokes et al. 2006). Our study showed a remarkable awareness of the topic and motivation for finding solutions among those who live in closest vicinity of invasive species. For the Cape Horn Biosphere Reserve this represents good conditions for a societal discourse on management plans for invasive species (see Choi 2008; Menvielle et al. 2010). Some general steps to include local communities in the design of management responses to biological invasions emerged from our study: (1) local knowledge should be used as a relevant form of information, and vice versa, the public should receive adequately presented information of scientific studies and management scenarios; (2) the tolerance level of an invasive species should be evaluated, and conflicting values be negotiated through a democratic process; (3) the acceptance of management options should be evaluated for each invasive species separately while the short- and long-term perspectives of economic income through invasive species management for the community must be clarified; and, (4) compromises when necessary can be employed on the basis of suggestions from the public. Although our paper offers some inputs helpful for questionnaire design for scientists and conservation managers, a major challenge still lies in the development and implementation of participatory approaches that allow decision making on the basis of a societal discourse.

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