



# Evaluating how Swedish hunters determine which species belong in nature

M. Nils Peterson<sup>1</sup> · Alyssa Chen<sup>1</sup> · Erica von Essen<sup>1</sup> · Hans Peter Hansen<sup>1</sup>

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## Abstract

Understanding whether people view non-native species as belonging in a place will help guide important conservation efforts ranging from eradications of exotics to re-introduction of extirpated species. In this manuscript we describe the degree to which Swedish hunters perceive key wildlife species as belonging in Swedish nature. We surveyed 2014 Swedish hunters randomly selected from a database of all registered hunters with a 47.5% response rate. We measured hunters' perceptions of the belonging of 10 key species on the Swedish landscape, compared them with confidence intervals for proportions, and predicted them using regression models. Construct validity was assessed through pretesting and focus groups. Our results suggest Swedish hunters consider species introduced wholly by humans as less likely to belong in Sweden compared with species that evolved in situ, species with negative socio-economic impact as less likely to belong in Sweden compared with species with no impact or positive economic impacts, and species with wide distributions to be seen as more likely to belong in Sweden compared with those with narrow distributions. Perceptions of wolves, fallow deer, and European rabbits differed from these broad trends potentially due to unique cultural constructions of belonging for the species and the duration since anthropogenic introductions for the latter species. Age was generally negatively related with considering species as belonging in Swedish nature, whereas few effects were detected for other demographic variables. This study suggests multiple drivers of perceived belonging for species exist, and may include where species evolved, socio-economic impacts of species, breadth of distribution, cultural naturalization, and age of stakeholders making assessments. These findings highlight the importance of managing invasive species before they become culturally naturalized or gain broad geographic distribution.

**Keywords** Belonging · Exotic · Hunters · Introduced species · Invasive · Native

## Introduction

Non-native invasive species receive extensive policy and research attention because they pose a primary threat to biodiversity. The introduction of non-native species can alter

existing ecosystem processes and displace native species (Gordon 1998; Manchester and Bullock 2000; Mooney and Cleland 2001; Pimentel et al. 2005). The International Union for the Conservation of Nature's (IUCN) 2003 Red List database suggests invasive species' ecological impact caused most known animal extinctions (Clavero and García-Berthou 2005); European Union (EU) nations face legal obligations to manage invasive alien species (Regulation (EU) No 1143/2014). Invasive predators accounted for 58% of global bird, mammalian, and reptile species extinctions (Doherty et al. 2016). Invasive species in marine ecosystems also pose a threat to biodiversity (Molnar et al. 2008). In addition, increasing globalization (Hulme 2009) and secondary effects of climate change (Rahel et al. 2008) may promote more non-native species introductions in the future. Accordingly, various methods have been proposed to manage invasive species impacts, including risk assessment for biosecurity, proactive pathway management, rapid response to early detection,

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✉ M. Nils Peterson  
nils\_peterson@ncsu.edu

Alyssa Chen  
chen18alyssa@ncssm.edu

Erica von Essen  
erica.von.essen@nina.no

Hans Peter Hansen  
hph@bios.au.dk

<sup>1</sup> North Carolina State University, Box 7646, Raleigh, NC 27695, USA

invasive species eradication, restoration of habitats damaged by invasive species (Pyšek and Richardson 2010), and protection of at-risk native species in protected areas (Rahel et al. 2008). Preventative control is the most cost-effective measure for managing invasive species risk, although cooperation between control agencies is required for successful implementation (Schmitz and Simberloff 1997).

Despite this attention, nativeness is a disputed concept for several reasons (Boonman-Berson et al. 2014). Species ranges naturally move over time (Holt 2003), so a given species may be considered native or non-native to a location, based on time of reference. Some species are considered naturalized after extended periods of time in a region. Ultimately, political processes use somewhat arbitrary definitions for native status. Boonman-Berson et al. (2014) suggested impacts of the species on nature and society determine native classifications in policymaking contexts. Qvenild (2014) highlighted the ambiguous and value-laden process through which policy makers established the year 1800 as a temporal threshold for establishing native status of plants in Norway for the 2010 Red List and 2012 Black List. The term non-native poses different meanings between different expert groups, including contexts such as biogeographic barriers, mode of entry, spread and colonization, biosecurity, habitat management, and human-nature relationships (Humair et al. 2014). Similarly, the definition of invasive varies depending on whether it focused exclusively on ecological and biogeographic criteria (e.g., location, reproducing, spreading) (Richardson et al. 2000; Colautti and MacIsaac 2004), or included socio-economic criteria (e.g., weedy, pest, noxious) (Binggeli 1994).

Consensus on what constitutes a native species among experts may have less impact than pragmatically more important public perceptions of whether specific species belong in specific places. As human intervention is necessary for effective wildlife management, public attitudes about whether species belong in a specific area place major constraint on wildlife management activities (Peterson et al. 2012; Wald et al. 2016). This is clear for controversial contexts of lethally managing feral cats in protected areas and on islands (Longcore et al. 2009; Duffy and Capece 2012). Public attitudes can support wildlife conservation when stakeholders view threatened native species as belonging in a place and even defining place, and thus support their conservation (Gillespie 1998; Bremner and Park 2007). For example, an investigation into public views of Scotland's native flora found laypeople-associated species nativeness with their own national identity (Selge et al. 2011). Conversely, non-native species such as feral pigs and rats can act as a replacement for native species and be highly valued among local people, rendering eradication efforts politically problematic (Gillespie 1998; Jean Desbiez et al. 2011; Carvalho et al. 2015; Shapiro et al. 2017), which may indicate potential resistance toward removal programs targeting non-native species. Coates (2006) notes

that such species may become either permanent residents, tolerated while still not considered to truly belong, or naturalized citizens, who gain both *jus soli* (right of territory) and *jus sanguinis* (right of blood/descent) in the country given sufficient time. Further, perceptions of native species not belonging can threaten conservation by encouraging poaching, as is often noted in high profile cases of wolf conservation (Williams et al. 2002; Liberg et al. 2012).

Consequently, this study aims to ascertain how one important wildlife conservation stakeholder group, recreational hunters, perceive key Swedish wildlife species as belonging or not belonging in Sweden. Given the aforementioned conflict over this terminology, we do not attempt to settle the debate; rather we focus on an array of species which lie in diverse locations along continuums of means of introduction (i.e., evolved in situ to introduced wholly by people), biogeographic patterns (i.e., small areas of persistence to geographically widespread), and socio-economic impacts (i.e., positive to extensive economic and ecological damage). In the discussion, we trace hunter designations of native and non-native to theoretical perspectives, arguing that socially constructed traditions and ideal types of landscape often predict hunters' present preferences for game composition (Miller 2006). Finally, we emphasize the importance of ownership of the wild fauna, showing how symbolic appropriations of animals by hunters as "mine" and "theirs" (referring to the state) reflect their relative nativeness (von Essen et al. 2017).

Swedish hunters' perceptions provide a valuable case study for several reasons. First, where a species belongs shapes one fundamental component of hunting, searching for the hunted animal (Peterson et al. 2011). This renders the subject area salient to potential respondents. Second, recreational hunting is popular in Sweden (Ericsson et al. 2004) and approximately 290,000 people engage in the activity (The European Federation of Associations for Hunting and Conservation 2010). Third, hunters' opinions are important as they are one of the groups most directly impacted and likely to influence wildlife management politics and policy (Heffelfinger et al. 2013; Cooper et al. 2015). Since the establishment of the Swedish Hunting Association in 1830, hunters hold a government mandate to steward ecosystems, including ensuring the protection of vulnerable species. Fourth, hunters' decisions about whether to kill individuals from a given species can impact both managers' ability to control overabundant wildlife (Koval and Mertig 2004; Messmer 2009; Williams et al. 2013) and ability to protect threatened wildlife (Ericsson et al. 2004; Loveridge et al. 2007). Our primary objectives were to describe perceptions of species belonging among species with diverse characteristics in terms of introduction, biogeographic distribution, and socio-economic impact, and identify potential relationships between hunters' perspectives and key demographic variables including gender, age, and education level.

## Methods

The Swedish Environmental Protection Agency maintains an official national database of registered hunters, and we randomly selected 2014 hunters from that database to sample. We obtained hunters' names and mailing addresses from the agency following a formal IRB approval. We mailed a paper questionnaire along with a pre-stamped return envelope to each address on May 16, 2016. A postcard reminder was sent a week after the mailing date, and a letter reminder including an additional paper questionnaire and return envelope was sent three weeks after the mailing date. A logon code was provided on all correspondence allowing participants to respond online if they chose to do so. Only 11 questionnaires were undeliverable, and we received 957 answered and 18 unanswered questionnaires, yielding a 47.5% response rate.

We tested the questionnaire for construct validity by conducting pretesting with focus groups consisting of officials from Svenska Jägareförbundet and Jägarnas Riksförbund, the two major national hunters' associations in Sweden. We asked the focus groups for feedback regarding wording and clarity of questions. We also selected 33 hunters from the Uppland region to participate in a pilot survey, and the 17 willing to participate were asked to mark items on the questionnaire they had difficulty understanding, and provide suggestions for improvement in item wording and clarity. We conducted phone interviews with all 17 pilot survey respondents within a week of the pilot surveys to ask each respondent about the clarity, terminology, and layout used in the questionnaire.

In the questionnaire, we asked for hunters' perceptions of the belonging of 10 key species on the Swedish landscape. The question asked: "Is there any game you consider don't belong to the Swedish nature?" and directed respondents to check boxes for the species that did not belong. The species listed varied in means of introduction, biogeographic locations, and socioeconomic impacts, and were as follows: the raccoon dog (*Nyctereutes procyonoides*), wolf (*Canis lupus*), lynx (*Lynx lynx*), wild boar (*Sus scrofa*), gray seal (*Halichoerus grypus*), greylag goose (*Anser anser*), mouflon (*Ovis orientalis*), European rabbit (*Oryctolagus cuniculus*), fallow deer (*Dama dama*), and raccoon (*Procyon lotor*).

Raccoon dogs are non-native and listed as an invasive species in the European Union (EU) and were introduced to Sweden in 1945 (Notini 1948). Raccoons were introduced to Europe as early as 1934 (Lutz 1995), and have no formal range in Sweden but have been reported in multiple areas. Their ecological impact on native habitats is disputed and not very well documented scientifically. They are known as vectors for parasites and other diseases including rabies (*Lyssavirus*) (Kauhala and Kowalczyk 2011). They are also known for a high reproductive capacity and being difficult to contain from spreading. As good swimmers, they are believed to pose a particular threat to waterfowl nests and to threaten native

species through competition for denning sites (Bartoszewicz et al. 2008). Being on the EU list of invasive species, member states are obliged to fight them and in some member states national radical culling programs have been initiated involving the hunting community. In some countries, including Sweden, hunters have been instructed to capture raccoon dogs for scientists to sterilize and return to the wild—as so-called Judas Animal—for eradication purposes (URL: [https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n\\_proj\\_id=3784&docType=pdf](https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3784&docType=pdf)).

The mouflon, fallow deer, and European rabbit are also non-native species in Sweden. Mouflon originate in Asia and were introduced to Europe in the twentieth century. Their range includes southeastern Sweden, and they are hunted for sport with a yearly harvest of 500 individuals (Svenska Jägareförbundet 2014). Although we focused on introduced Asian Mouflon, there are some introduced European mouflon (*Ovis aries musimon*) in Sweden, and the latter has long historical roots in continental Europe and is subject to controversy regarding its origins deriving from feral sheep or being a native species.

Fallow deer were introduced to Sweden during the sixteenth century (Gibb 1990), can be found throughout the country, and may compete with native cervids for forage. Fallow deer also damage crops, and cause additional economic damage through vehicle collisions (Jensz and Finley 2013). Fallow deer have a yearly harvest of 31,000 individuals (Svenska Jägareförbundet 2014). Fallow deer did exist as a native species in Sweden prior to the Weichselian glaciation (> 100,000 BP).

European rabbits were introduced to Sweden during the Roman period (509 BCE–14 CE) (Gibb 1990) and have a yearly harvest of 30,100 individuals (Svenska Jägareförbundet 2014). Farmers consider them an economic liability due to crop damage (Ward 2005).

Lynx, gray seals, greylag geese, wolves, and boars are native species to Sweden (Nowak 1999). Lynx persist throughout Sweden but are more common in central Sweden (Andrén et al. 2011). Although lynx are protected, they are hunted under yearly quotas determined by the Swedish Environmental Protection Agency (e.g., 200 individuals in 2010). Gray seals can be found in northeastern, southeastern, and southern coastal areas of Sweden. Hunting gray seals was legalized in 2011, with a yearly quota of 300 individuals (Härkönen 2016), but this quota is rarely even halfway filled (Holma 2010). Gray seals may hurt the fishing industry by damaging trapnets (Lehtonen and Suuronen 2004). Greylag geese are found across Sweden, but their distribution is concentrated in southern regions and along the coast (Birdlife International 2016). Greylag geese may damage crops (Patterson et al. 1989), and are impacted by hunting pressure and harvest by farmers in response to crop depredation (Birdlife International 2016).

Wolves were extirpated from Sweden by 1966 and began recolonizing in 1978 (Wabakken et al. 2001; Kvastegård 2013). Their range includes central and southwest Sweden. Wolves negatively impact reindeer (*Rangifer tarandus*) husbandry, sheep farmers, and hunters (e.g., killing hunting dogs, reducing the number of moose hunters are able to harvest) (Olsson et al. 1997; Skonhoft 2006). Wolf depredation, and concerns about it, was linked to livestock breeders abandoning livelihoods, and wolves are distinct among the species in this study because they likely have negative effects on hunting interests (Kvastegård 2013). For instance, registration for hunting declined in areas with wolves during the 2005–2012 period.

Boars were extirpated by the end of the eighteenth century and reintroduced in the 1970s (Oliver and Leus 2008). Boars are distributed over southern and central Sweden (Magnussen 2010) and may cause economic problems through crop damage and vehicle collisions. The boar has an increasing yearly harvest that was 97,300 individuals in the 2012–2013 hunting season, a 100% increase from the previous year (Svenska Jägareförbundet 2014).

In addition, we collected information about respondents' education level, home city size, age, importance of dogs for hunting, and days hunting in the previous year. For education level, we asked respondents to select their highest education, from "primary school" to "university or college for 3 years or more". For home city size, we asked respondents to identify where they live, with options ranging from "In an area with less than 200 inhabitants" to "In an area with more than 300,000 inhabitants." We measured the importance of dogs for hunting by asking respondents about the degree to which they agreed with the statement "I hunt so I can work/train with my dog" (5-point scale ranging from absolutely agree to do not agree at all). We asked respondents for days spent hunting in the 2014–2015 hunting season to gather a reasonable measure of dedication to hunting in this region (Hansen et al. 2012).

To analyze how accurately our respondents represented the larger sample, and population of Swedish hunters, we compared responses between waves of respondents. In this continuum of resistance approach (Kypril et al. 2004), later respondents are considered more like non-respondents than earlier respondents are. We analyzed three groupings of responses categorized by response time: early responses (after the first email;  $n = 210$ ), intermediate responses (after the first reminder and before the third reminder;  $n = 418$ ), and late responses (after the third reminder;  $n = 139$ ) using ordinal regression models. In each original regression model, we attempted to predict the grouping (i.e., wave 1, 2, or 3) using age ( $p = 0.212$ ), educational attainment ( $p = 0.657$ ), home city size ( $p = 0.708$ ), and perceptions of species belonging. No relationships were significant except perceptions of whether raccoons belonged in Swedish nature (raccoon,  $p = 0.0091$ ;

raccoon dog,  $p = 0.729$ ; wolf,  $p = 0.0679$ ; lynx,  $p = 0.117$ ; boar,  $p = 0.397$ ; gray seal,  $p = 0.308$ ; greylag goose,  $p = 0.673$ ; mouflon,  $p = 0.0637$ ; European rabbit,  $p = 0.154$ ; fallow deer,  $p = 0.407$ ). This indicated non-response bias was possible for perceptions of raccoons with non-respondents being less likely to perceived raccoons as part of Swedish nature. Because raccoons were the species considered least belonging to Swedish nature, weighting data for this variable would not change conclusions in the study.

We calculated 95% confidence intervals for the proportions of Swedish hunters who considered each species as belonging in Swedish nature to facilitate the primary objective of quantifying the degree to which this key stakeholder group considered each species as native. We developed binomial generalized linear models to determine if demographic variables predicted whether Swedish hunters considered each species as belonging in Swedish nature, and provided AUC classification estimates as indicators of the degree to which models predicted better than random, and to allow comparison of models. All analyses were conducted using JMP 13.

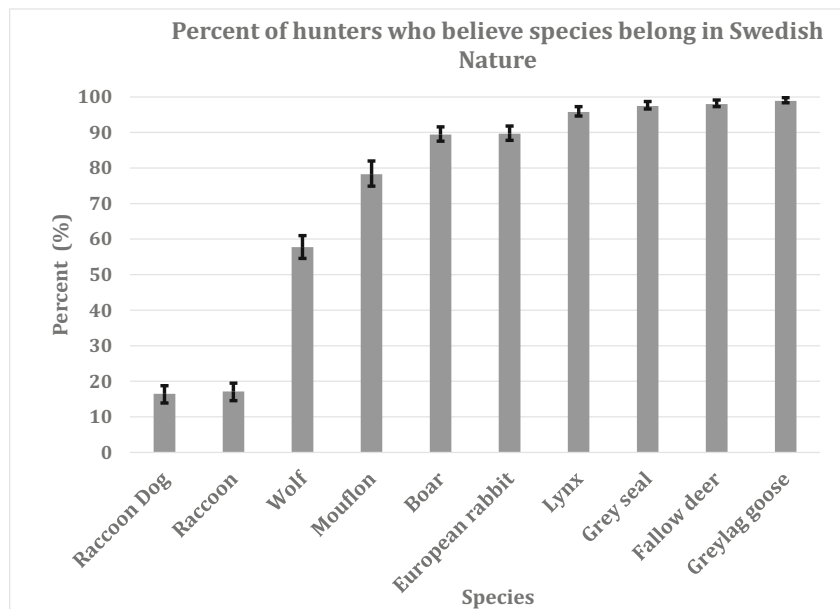
## Results

There were distinct species level differences for the degree to which species were considered belonging in Swedish nature by Swedish hunters (Fig. 1). Raccoon dogs and raccoons were considered the least belonging in Swedish nature (raccoon dog = 16.5% belonging [95% CI = 14.2–19.1%], raccoon = 17.2% belonging [95% CI = 14.8–17.2%]). More than half of Swedish hunters considered wolves as belonging in nature (57.7% belonging [95% CI = 54.5–60.9%]). A strong majority of respondents thought mouflon belonged in Swedish nature (78.3% belonging [95% CI = 74.5–81.6%]). Around 90% of Swedish hunters considered boars (89.4% belonging [95% CI = 87.2–91.3%]) and European rabbits (89.6% belonging [95% CI = 87.5–91.5%]) as belonging in Swedish nature. Almost all respondents considered lynx (95.8% belonging [95% CI = 94.2–97.0%]), gray seals (97.4% belonging [95% CI = 96.2–98.3%]), fallow deer (98% belonging [95% CI = 96.9–98.7%]), and greylag geese (98.9% belonging [95% CI = 98.0–100%]) as belonging (Fig. 1).

Some obvious patterns emerge in these perspectives held by Swedish hunters. First, species that evolved in situ were considered as belonging in Swedish nature more than species introduced by people (Fig. 1). The two most notable exceptions to this pattern were wolves and fallow deer, and these discrepancies may be explained by wolves being viewed as causing economic damages among many hunters (Kvastegård 2013), and fallow deer being valuable to hunters (i.e., included in the Swedish hunters' association Svenska Jägareförbundet's compilation of key harvests for the 2012–2013 hunting season). Further, fallow deer were introduced in



**Fig. 1** Percent of hunters who believe each species belongs in Swedish nature. Each error bar is constructed using 95% confidence intervals for the percent



1500s, before any other introduced species except the European rabbit. Species that were important for hunting were perceived as belonging by most respondents, with the gray seal being the only species that was not a valuable hunted species for hunters among the species considered as highly belonging in Swedish nature (Fig. 1). Species with the narrowest distributions (raccoon dogs and raccoons) were seen as least likely to belong in Swedish nature. Finally, hunters appeared divided over wolves, as only slightly more than half of respondents considered wolves as belonging (Fig. 1).

Perceptions of species belonging among Swedish hunters were robust to demographic differences among hunters (Table 1). Respondents were 94% male, averaged 56.7 years old (SD = 15.06), and had an average education level (mean =

2.89, SD 1.50) corresponding to 3–4 years of high school, and the average sized city they lived in (mean = 3.49, SD = 2.11) was rural corresponding to 3000 residents. Age was consistently related to whether hunters considered species as belonging in Swedish nature (Table 1). Older hunters were more likely to consider wolves as belonging in Swedish nature than younger hunters, and less likely to consider raccoon dogs, raccoons, mouflon, boar, and European rabbits as belonging in Swedish nature. Education level was positively related with considering wolves as belonging in Swedish nature and negatively related with considering raccoons as belonging in Swedish nature. Female hunters were more likely to consider boar as belonging in Swedish nature, and urban residency was positively related to considering wolves as belonging in Swedish nature (Table 1).

**Table 1** Results of binomial generalized linear models predicting whether Swedish hunters consider species as belonging in Swedish Nature

Variable	Species model									
	Raccoon dog	Raccoon	Wolf	Mouflon	Boar	European rabbit	Lynx	Gray seal	Fallow deer	Greylag goose
Intercept	0.9045	-0.6522	-1.4094***	3.4163***	2.7907***	4.0368***	2.2527*	5.1815*	4.2214**	16.3726
Sex <sup>a</sup>	-0.2559	0.1080	0.1017115	0.0163	0.4630*	-0.0403	0.0047	0.0248	-0.1248	-9.3205
Age	-0.0380**	-0.0079	0.0145**	-0.0320***	-0.0207*	-0.0308***	-0.0001	-0.0319	-0.005	-0.0486
Education level	-0.0528	-0.2389***	0.2008***	-0.1203*	0.0393	0.1209	0.1283	0.1271	-0.1866	-0.0195
City size	-0.0348	0.0269	0.0734*	0.0221	0.0265	-0.0880	0.1825	0.0379	0.1804	0.1566
Pearson goodness of fit (P)	855.766 (0.419)	851.920 (0.456)	853.430 (0.441)	837.578 (0.594)	858.322 (0.395)	896.580 (0.120)	845.810 (0.514)	933.338 (0.022*)	857.177 (0.406)	754.079 (0.991)
AUC	0.658	0.595	0.604	0.616	0.622	0.656	0.628	0.647	0.606	0.701

<sup>a</sup> Coded 0 = male, 1 = female

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$

## Discussion

This study suggests hunters share scientists' focus on origin when determining whether species belong in a given place. Thus, hunters, and particularly older hunters, may present key allies in management efforts aimed at removing non-native species using lethal removal methods. Although this study did not determine whether Swedish hunters supported lethal management of species perceived as not belonging in Sweden, it seems likely since hunters by definition support lethal management of species they perceive as belonging in Sweden (i.e., the game species they hunt). Indeed hunters and wildlife managers (Olszańska et al. 2016) generally support killing non-native species, whereas other stakeholder groups may question lethal management (Shelton 2004). Generational amnesia and invention of tradition may help explain the obvious cases where Swedish hunters departed from an origin-based assessment of species belonging. Studies on environmental esthetics suggest perceptions of ideal species composition may follow a logic of generational amnesia (Miller 2006) and allow for the invention of tradition—consciously or unconsciously (Hobsbawm and Ranger 1992). This perspective suggests people tend to take for “natural” the landscape and animals they grew up with, and reproduce this perspective through appeal to tradition. Research suggests ancestral configurations like this are mostly fantasies and may be harmful for conservation (Wallach et al. 2015). This may explain why almost half of Swedish hunters viewed wolves as not belonging in Sweden despite wolves being biologically native, and why younger hunters were less likely than older hunters to consider wolves as belonging in Swedish nature. Wolves in Sweden have a long history, but few hunters are likely to have had this species as part of their landscape during their formative years, and hence many may exclude wolves from being considered native. Further, cultural construction of the Swedish hunter in previous generations made them masculine protectors from the risks posed to other community members by wolves. More recently, wolf hunters were described as doers, not content to be pushed around by government regulation or willing to let their livestock-owning neighbors suffer from wolf attacks (von Essen 2016). These same relationships likely explain how fallow deer and European rabbits are viewed as belonging in Swedish nature. These species have persisted in the Swedish landscape and existed as part of Swedish culture for centuries.

The cultural construction of belonging may help explain relatively low levels of considering wolves as belonging in Swedish nature. Indeed, wolves appear to be afforded neither *jus soli* (right of territory) nor *jus sanguinis* (right of blood/descent) in Coates' (2006) terms. To some extent, research finds that parts of the hunting community struggle to accept species when they are seen as illegal immigrants: wolves in Sweden are said to be out of place because they originate from Finland (Bergström et al. 2015); in Finland, the same critique is said of Russian

immigrating wolves; in Denmark, wolves are painted as illegal immigrants from across the German border, and in Germany, eastern wolves from Poland may be seen as out of place. These views may have been particularly potent given ethno-nationalism, and anti-immigrant narratives were emerging globally during this study, and those movements can expand into violent exclusion of some animals (Gillespie and Narayanan 2020). Here, nativism, referring to “an extreme, defensive-aggressive form of nationalism based on a perception of immigrant menace” (Coates 2006, p. 15) may originate in anxieties about socio-economic and political changes, but become displaced onto non-human animals (Skogen and Krange 2020). Problematically, this entails hunters making a moral economy of species arbitrarily distinguishing those who belong from those who do not (Shelton 2004), and indeed adding a “moral element to the description of wolves” (Hermans 2015, p. 268). Simberloff (2013) calls this the xenophobic dimension to the nativity debate.

Geographic distribution may interact with the duration an introduced species has persisted in a place to influence perceptions of species belonging with important implications for conservation. Specifically, non-native species with wide distribution in Sweden tended to be seen as more likely to belong in Sweden by hunters. This potential for cultural naturalization of species with non-native origins in association with their temporal and spatial distribution highlights potential management problems associated with non-native species becoming common. If raccoon dogs and raccoons expand to be seen as common in wider areas, Swedish hunters may eventually begin to view them more as belonging to Swedish nature. There are multiple cases of non-native species becoming common to a region, becoming accepted by locals, and impacting conservation outcomes. For example, locals in the Brazilian Pantanal support the existence of feral pigs because the feral pigs act as a replacement hunting target for native species, and having an alternative to hunting threatened native species may provide a beneficial outcome for wildlife conservation (Jean Desbiez et al. 2011). Similarly, local hunters on the island of Saõ Tomé, in the Gulf of Guinea, hunt non-native monkeys and feral pigs, which reduces hunting pressures on native species and provides culturally acceptable sources of income and meat (Carvalho et al. 2015). Conversely, island children in the Bahamas showed greater preference for non-native invasive species, including dogs, cats, and wild hogs, than for many native species (Shapiro et al. 2017), and Maori people often value Polynesian rats (*Rattus exulans*) and the Maori name for the species refers to them as a treasure (Shelton and Tucker 2007). These positive perceptions of non-native species which are accepted as belonging complicate efforts to manage such species.

Our results also suggest hunters may strategically treat species belonging in ways predicted by classic economic theory. Behavioral models indicate humans faced with limited resources will optimize benefits and minimize individual costs (Becker 2013), which may stem from evolutionary tendencies

toward self-prioritization (Campbell 1986). Therefore, hunters may rationally associate species they benefit from (having higher utility) as having more value than species hunters do not hunt. Our results generally conform with predictions of rational choice theory because all but two species (lynx and gray seal) with high scores for belonging were popular game species. Possessive undertones for belonging may complicate these economic interpretations, however. Hunters, and other local communities, often develop a sense of ownership for animals they benefit from in some way or which they have stewarded for years (Peterson et al. 2002; Matilainen et al. 2017). For instance, Swedish hunters directly challenge, defend, or promote animals based on whom is seen as their proprietor (von Essen et al. 2017). Animals that do not belong are constructed not only as non-native and invasive but also as “property of the state,” whereas animals that may have been artificially introduced but have now naturalized into local use, are paternalistically embraced with possessive pronouns like our pheasants, my deer, and my boar (Peterson et al. 2002; Bell 2015). These differing perspectives of species belonging appear to influence acceptance of different killing tactics, with invasive, non-native and pest epithets commonly associated with more ruthless killing tactics (Clark 2015). Conversely, when hunters feel a sense of ownership over game animals, as in the case of wild boar, they may oppose killing methods for being inhumane or violating their conceptions of fair chase (von Essen 2018; Kowalewska 2019; Storie and Bell 2017).

Perhaps not surprisingly, perceptions of wolves belonging in Swedish nature were unique relative to other species in terms of having a native origin but being considered as not belonging by almost half of Swedish hunters. The debate over the belonging of wolves among hunters may in part reflect wolves’ negative impact on hunting interests, because wolves kill hunting dogs, are perceived as competing with hunters for game species, and lead to decreased hunting registrations in areas where wolves are common (Kvastegård 2013). Because wolves are native to Sweden, their recent recolonization has been accompanied by mixed concern for supporting their conservation and retaliation for wolves’ negative impact on hunters (Ericsson et al. 2008; Heberlein and Ericsson 2008). However, studies in the Nordic countries suggest hunters are also surprisingly positive—at a general or theoretical level—toward controversial species like wolves, declaring that their opposition toward conservation policy “is not the wolf itself” (von Essen and Allen 2020). Skogen and Kränge (2003) similarly found attitudes were ambivalent and nuanced, with some hunters conceding the wolf’s place in the national fauna.

## Conclusion

Perceptions of nativeness may operate along complex spectra that involve origin, behavior, and impact of species, and these

constructions may be informed by *type* of origin in terms of geography and how other human stakeholders are implicated in species establishment in a given place. We suggest hunters often designate proprietors of wildlife on the basis of to whom they seem to belong, and by whom they appear to have been introduced *for*. Further, hunters seemed to perceive non-native species as double others, in contrast to both humans and native species against which they compete. Future research may explore the social and political constitution of double others and case studies of such wildlife, including hybrid wolves as the “rabble” of the fauna (after Hegel’s rabble population), feral pigs as “animal sacrum” (after homo sacer, a kind of outlaw) (von Essen and Allen 2016), when these are seen to violate implicit spatial, behavioral or impact principles for species co-existence. Similarly, future research may explore how demographic changes associated with rapid human immigration to Sweden relate to conceptions of species nativeness among hunters. Such research may need to account for many immigrant groups having their own traditions of meat eating, including taboos around pork which seems especially relevant considering growing conflict around wild boar population management. Although invasive species literature is already multidisciplinary, it may benefit from examining nativeness along new nodes of being from sociology, social psychology, multispecies ethnography, and environmental esthetics (Crowley et al. 2018). These studies would be able to address the origins of outlier opinions about nativeness not easily assessed using quantitative studies. Finally, this study highlights the importance of eradicating invasive species before they become culturally naturalized or geographically widespread. This recommendation, however, may be difficult because determining invasive status (e.g., negative ecological and economic impacts) takes time and effort.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflicts of interest.

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