

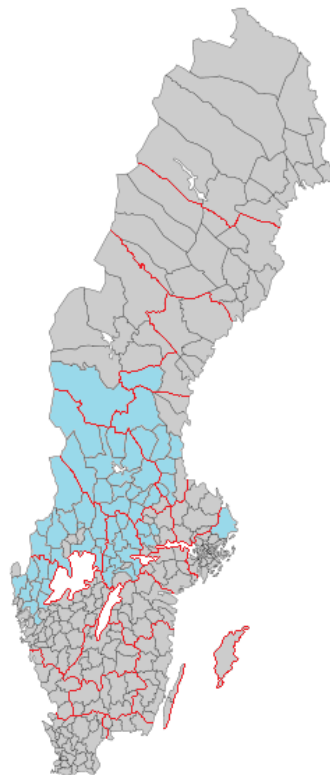


Examensarbete i ämnet biologi

2013:8

Social and economic consequences of wolf (*Canis lupus*) establishments in Sweden

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Socioekonomiska konsekvenser av vargetablering i Sverige

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Abstract

Wildlife contributes with many benefits to humans but also brings economic costs. From being eradicated in Scandinavia the grey wolf (*Canis lupus*) is returning to South-Western Sweden and people are not used to its presence. In Scandinavia carnivores have to co-occur with humans in a landscape used for many different interests. Consequences of wolf establishments are e.g. competition for moose, depredation on sheep and attacks on hunting dogs. Wolf related issues are commonly highlighted in different media. People are expressing fears regarding wolves' impact on e.g. the sheep industry, forest holding prices, house prices and the hunting activity. Fundamentally the conflict regarding wolf re-establishment might not concern the wolves per se, but rather how the local landscape is perceived (e.g. a scene for preserving cultural heritage or the conservation of species). There is an increasing urbanization trend in many parts of Europe and the intensity of a human-wildlife conflict is affected by social factors, e.g. low income affect people's perception of vulnerability and therefore also increases resistance to acknowledged consequences pertaining to wildlife presence. Parts of Sweden's countryside have poor opportunities for social development. This study investigated the potential impact of wolf occurrence on a number of economic interests and recreational and cultural values visible in the wolf debate in Sweden and also examined the development of socioeconomic factors that have the potential to influence the wolf debate. The study included all municipalities in Sweden divided in a wolf area and a wolf-free area. This study do not support the general magnitude of fears expressed in the recent wolf debate. However wolves probably enhance the already negative trend of number of sold hunting licenses which should be considered since the wildlife management in Sweden is based on hunters' participation. Due to the strong symbol value of wolves, the negative socioeconomic development in the wolf area, and the underlying social factors affecting the intensity of conflict; wolves become a structural symbol of negative socioeconomic development, and thereby also enhancing the intensity of the wolf debate in Sweden. Since hunters participation is negatively affected by weak rural development and probably also wolves, it is needed to promote rural development and make wolves valuable to hunters. This study has also pointed out areas which are subjected to poor socioeconomic development and should therefore be prioritized for conflict mitigation measures in the future if wolves will spread to those areas. Thus, in Sweden with todays limited number of predation events, is social factors a more important driver of the wolf conflict than the actual direct consequences?

Sammanfattning

Djurlivet bidrar med många fördelar för människor men medför också ekonomiska kostnader. Från att ha varit utrotad i Skandinavien har vargen (*Canis lupus*) återvänt till Sydvästra Sverige och människor är inte vana med artens närvaro. Rovdjur i Skandinavien måste samexistera med människor i ett landskap utnyttjat av många olika intressen. Konsekvenser av vargetablering är t.ex. konkurrens om älg, predation på får och attacker på jakthundar. Det är vanligt att vargrelaterade frågor är framhävda i olika media. Människor uttrycker rädslor angående vargens påverkan på t.ex. fårskötsel, skogsmarksfastighetspriser, huspriser och jakt. Fundamentalt angår möjligtvis konflikten kring återkomsten av vargen inte arten i sig utan snarare hur det lokala landskapet upplevs t.ex. som en plats för att bevara kulturarv eller för bevarandet av arter. Det är en ökande urbaniseringstrend i många delar av Europa och intensiteten av en människa-vilt konflikt påverkas av sociala faktorer t.ex. låg inkomst påverkar människors uppfattning om utsatthet och ökar därför också motstånd mot erkända konsekvenser som en effekt av närvaron av vilt. Delar av Sveriges landsbygd har dåliga möjligheter för social utveckling. Denna studie undersöker den potentiella påverkan av vargförekomst på ett antal ekonomiska intressen och rekreations- samt kulturella värden synliga i vargdebatten i Sverige samt utvecklingen av socioekonomiska faktorer som har potential att influera vargdebatten. Studien inkluderar alla kommuner i Sverige uppdelat i ett varg- och vargfritt område. Denna studie stödjer inte den generella magnitud av rädslor som uttrycks i dagens vargdebatt. Däremot ökar antagligen vargen hastigheten på den redan negativa trenden av antal sålda jaktkort vilket borde tas i hänsyn eftersom viltvården i Sverige baseras på jägarnas deltagande. På grund av vargens starka symbolvärde, den negativa socioekonomiska utvecklingen i vargområdet och de underliggande sociala faktorerna som påverkar konfliktintensitet har vargen blivit en strukturell symbol för negativ socioekonomisk utveckling, och ökar därigenom också intensiteten i vargdebatten i Sverige. Eftersom jägarnas deltagande påverkas negativt av en svag rural utveckling och troligtvis också av vargförekomst är det nödvändigt att främja rural utveckling och göra vargen värdefull för jägare. Denna studie har även pekat ut områden som är utsatta för dålig socioekonomisk utveckling och borde därför vara prioriterade för konflikthantering i framtiden om vargen sprider sig till dessa områden. Således, i Sverige med dagens begränsade predation, är sociala faktorer en viktigare drivkraft i vargkonflikten än de faktiska direkta konsekvenserna?

Introduction

Wildlife contributes with many benefits to humans but also brings economic costs (Skonhøft 2006). In present time, large carnivores are returning to their former ranges prior to extirpation (Linnell et al. 1996; Breitenmoser 1998; Skogen & Kränge 2003) in Europe (Breitenmoser 1998) and North America (Linnell et al. 1996). The historic approach of persecuting large carnivores due to depredation, competition and fear (Bradley et al. 2005) has thus changed in the last decades to attempts of conservation (Bruskotter & Shelby 2010) and this animal group is legally protected in the main part of Europe (Breitenmoser 1998). Large carnivore protection has consequences for natural ecosystems (e.g. Ripple & Beschta 2003; Hebblewhite et al. 2005), human economy (e.g. Miller et al. 1998; Bostedt & Grahn 2008; Sommers et al. 2010) and peoples' way of life (Breitenmoser 1998; Skogen 2003; Sjölander-Lindqvist 2006; Skogen & Thrane 2008). This implies that the conservation of carnivores is a complicated and controversial policy matter in the western part of the world (Bostedt et al. 2008). For many people the carnivores return are viewed as a conservational success while others have an opposing view to their current presence (Skogen & Kränge 2003). The conflicts concerning carnivores include both human-animal and human-human aspects; concerning for example economic interests, recreation activities (Skogen & Kränge 2003), urban-rural tensions and processes (economic and cultural) of urban growth (Skogen 2001). Allowing carnivores to increase in numbers have in some places resulted in increasing conflicts (Skogen 2001; Treves & Karanth 2003) and in such places the conflicts can be long lasting (Graham et al. 2005) and have a substantial economic impact (Bradley et al. 2005; Graham et al. 2005).

From being extirpated from large portions of its historical distribution range the last two hundred years (Wabakken et al. 2001); the grey wolf (*Canis lupus*) is in recent times returning to many areas in Europe and the northern U.S. (Mech et al. 2005). This species is subjected to controversy through all of its distribution range (Skogen 2003; Skogen & Thrane 2008) and many different interest groups are engaged in wolf related issues (Skogen 2003). From being functionally extinct in Scandinavia (i.e. Sweden and Norway) in the mid 1960's, at the same time as it was first protected, the species started to recolonize Sweden in the late 1970's (Wabakken et al. 2001). The wolves' core area is in South Western Sweden, on the border to Norway, and from this area the population has both increased in size and distribution range in subsequent years (Wabakken et al. 2001). The Scandinavian wolf population has increased with on average 14 % annually in the time period 1998-2011 and during winter 2011/2012 the population estimate was 200-270 wolves in Sweden (Svensson et al. 2012). The population is small in the sense that they are, according to Lande et al. (2003) not close to carrying capacity, and also when considering issues with the population's genetics (e.g. Liberg et al. 2005; Chapron et al. 2012). At present the species is considered as endangered (IUCN Red List: EN) in Sweden, which implies that the species is protected by law (Franzén 2010). The return of the species initiated an intensive debate with most focus and interest from people in the wolves' core area in the rural parts of South Western Sweden (Ericsson & Heberlein 2003). Wolves have returned fast and people in general are not used to having them present (Kleiven et al. 2004). In Scandinavia carnivores have to co-occur with humans in a landscape

used for many different interests (May et al. 2008). Well known direct consequences that may accompany the presence of carnivores are depredation on livestock (e.g. Mech 1995; Graham et al. 2005; Bostedt & Grahn 2008; Sommers et al. 2010) wild game, and attacks on hunting dogs (Skogen & Krange 2003; Bostedt & Grahn 2008), all of which are relevant of the wolf occurrence in Sweden. More specifically the most commonly attacked domesticated animal in Sweden is sheep (*Ovis aries*) (Karlsson et al. 2012), and the main game species as prey is moose (*Alces alces*) (Sand et al. 2005). Sweden is thus an example of a country where the wolf has returned and where their occurrence and related consequences are highly controversial topics among groups of people with differing interests. Wolf related issues are commonly highlighted in different media, especially within or in close proximity to the wolf area.

Local concerns to an alien threat- The wolf debate

When local communities have to face a new phenomenon that will alter their local surroundings it can trigger a social mobilization to highlight local perspectives on values that are perceived as threatened and therefore needs to be protected (Sjölander-Lindqvist 2006). This is caused by lack of trust in political decisions and authorities if the locals do not feel as their concerns are thoroughly observed and respected, example scenarios are for example when constructing wind power stations, nuclear power stations or tunnels (Sjölander-Lindqvist 2006). This problematic can be applied to the Swedish wolf issue as well (Sjölander-Lindqvist 2006) since the wolf is a returning species, and therefore can be seen as a relatively new phenomenon that also has the capacity to affect local values through for example predation. People living in rural areas may see the wolf as a symbol of urban dominance in the sense that urban areas force the wolf reintroduction on rural inhabitants (Williams et al. 2002; Ericsson & Heberlein 2003). This implies a basis of a greater conflict due to the positive attitudes toward wolves in the urban society forced upon the countryside (Williams et al. 2002). People living close to wolves say that they do not have any support from e.g. authorities and urbanites concerning wolf issues that have had negative impact on their quality of life (Ericsson & Heberlein 2003). The majority of people in Sweden are positive toward wolves, although hunters and people living in wolf areas are less positive than the general public, and this negativity have probably increased along with the returning wolves (Ericsson & Heberlein 2003). People inside or close to a wolf territory are to a higher degree exposed to predation events and negative information concerning wolves than people living further away (Karlsson & Sjöström 2007). Even though the debate is polarized, many still have neutral attitudes toward wolves (Williams et al. 2002; Ericsson & Heberlein 2003) and according to Ericsson & Heberlein (2003) Swedes in general have weak attitudes which imply that these attitudes may sway either way through highlighted public events. In general, the debate comprises two main sides; people who are either positive or negative to wolf occurrence (Sjölander-Lindqvist 2006). The different perspectives of wolf occurrence, such as wolves as a threat to people and their activities or wolves as a positive addition to the Swedish fauna and that are threatened by people; are based on various cultural and social factors (Sjölander-Lindqvist 2006). Fundamentally the conflict regarding wolf re-establishment might not concern the wolves per se, but rather about how the local landscape is perceived

(Sjölander-Lindqvist 2008, 2009). It may be viewed either as a scene where cultural values are passed along to future generations or, in the context of conservation, as a location of species preservation (Sjölander-Lindqvist 2008, 2009). Wolves are by some seen as a natural part of the environment; and by others as unfamiliar (Sjölander-Lindqvist 2008) and interrupting or destroying peoples relationship with their nature surroundings in the sense of farming, hunting and other rural outdoor activities, namely local people's way of life (Skogen & Kränge 2003; Sjölander-Lindqvist 2008, 2009). Local communities fear that the occurrence of wolves in their surroundings is threatening the future welfare of the community and its local practices (Skogen & Kränge 2003; Sjölander-Lindqvist 2006, 2009).

Concerns for economic interests and recreational and cultural values

In all areas where both carnivores and livestock exist, some degree of predation occurs (Karlsson & Johansson 2010). Depredation on domesticated animals will become more common with the expansion of carnivores or when humans are closing in on their habitats (Naughton-Treves et al. 2003). A common reason for low tolerance of large carnivores in many places is the depredation on livestock (Karlsson & Johansson 2010). Conflicts with humans will highly increase when wolves come in contact with areas of agriculture because of increased predation on livestock and pets, which may lead to public hostility (Mech 1995). There are generally few people in Sweden who are directly affected by wolf predation (Karlsson & Sjöström 2007). In 2011 there were 455 sheep attacked by wolves in 62 predation events (Karlsson et al. 2012). Compared to the total number of sheep in Sweden in that same year 2011; 622,700 individual sheep in 9,400 sheep holdings (Grönvall 2012) this constitutes a small percentage (0.07 %) lost to predation. Therefore the wolves' impact on the total national sheep production is probably of small magnitude today with the current size of the wolf population. According to Graham et al. (2005) loss of livestock or game can have severe economic consequences for some on a local scale, even though the total percentage lost to predators is generally low. Moreover human-predator conflicts may in some cases be more of a psychological than an economic issue due to low number of predation events and also the existence of compensation schemes of livestock losses in many countries, one of which is Sweden (Graham et al. 2005). People living in the countryside say that the consequences of wolf occurrence have resulted in livestock breeders, landowners and farmers to quit their practice and move away, and that this will continue in the future if the wolf issue is too troublesome (Sjölander-Lindqvist 2008). Local concerns for the future of sheep farming when wolves are roaming the surroundings are framed in media and the following citations and similar ones can be found: "They can call me a wolf hater. But the wolf will only cause trouble for us farmers. We have enough problems to make it profitable." (Samuelson 2012) and "The establishment is namely a threat to the Swedish locally produced organic sheep production. It is also a threat to open pastures and the biological diversity." (Söderberg 2011). Thus people are expressing their fears regarding wolves' negative effects on sheep farming in Sweden and that it adds to other already existing problems accompanying this kind of practice.

Hunting is often an important activity in rural areas and also of cultural value (Heberlein & Willebrand 1998; Heberlein & Ericsson 2005; Milner et al. 2005; Skonhøft 2006). Major parts

of Sweden are rural areas with low population densities and hunting is considered as an important tradition (Heberlein & Willebrand 1998). In Scandinavia the hunting rights are based on land ownership, acquired through either owning or renting a piece of land (Wabakken et al. 2001). Since moose is the main prey species for wolves in Scandinavia (Sand et al. 2005) and also the most dominant game species for Swedish hunters (Mattson 1990; Skonhøft 2006; Mattson et al. 2008), humans and wolves are sharing the same available moose resource, which in some places creates a human-carnivore conflict due to limitations in this shared resource. In Sweden, hunters constitute 3 % of the total population and the activity of hunting is of great symbolic value (Heberlein & Ericsson 2008). Each year all hunters have to pay a hunting license fee to be legitimated to hunt, this is a part in funding management and research of wildlife in Sweden (Anonymous 2013B). In many rural areas of Sweden the autumn moose hunt could be the most valued cultural and social happening that is occurring (Skonhøft 2006). A common method of monitoring moose populations in Sweden is hunter's observations of moose during the annual moose hunt, and since the moose hunt is such a big event the observation effort is enormous (Ericsson & Wallin 1999). The way of hunting moose has not changed much over time (Boman et al. 2011); however, a common subject for discussion in the hunter community is the impact of the wolf presence on hunting activities (Ericsson & Heberlein 2003). The predation by wolves on moose is not a general problem in all rural areas although it still causes significant concern since it is the most popular game species in Sweden (Skonhøft 2006). Moose is hunted with dogs in Sweden and the dog is a symbol of effectiveness (Heberlein 2000). Wolves pose a potentially lethal threat to these dogs, and this causes great concern amongst hunters (Skogen & Kränge 2003; Bisi et al. 2007). This threat to the dogs may affect the general moose hunting interest since the dog is a traditional companion in the moose hunting activity (Skogen & Kränge 2003). Concerns regarding wolf occurrence and its impact on moose hunting are thus both that they decrease the number of available moose to hunt and threatening the hunting dogs. Therefore, the hunter community is an important interest group in the wolf debate since they are directly affected by this species and also because they have national influence in politics (Heberlein & Ericsson 2008). Concerns regarding wolves effects on the moose hunt are commonly expressed similar to the following citation: "The absolute greatest impact is on the people that lives in the countryside and on the hunting as such. It makes it very difficult, sometimes impossible to release dogs, and that obstructs the moose hunt very much." (Smedslund 2012).

The price development of real estates' partly reflects people's willingness to pay to live in a certain location (Bjerke et al. 2012). This could mean that wolves potentially are affecting the development of prices in forest holdings and houses through the perceived effect on the hunting activity through (as explained earlier) decreasing the available amount of game and threatening hunting dogs and/or other recreational activities like berry-picking or hiking inside the wolf area. Hunting rights and the recreation value are some factors that affect the total purchase price of the forest holding (others are e.g. timber prices and interest rate), nearly half of all forest holding owners view the soft values like hunting, recreation and the feeling of owning a holding as the most important factors in owning a forest holding Anonymous (2012). Moreover, the importance of these soft values for the total price of a forest holding is increasing (Anonymous 2012). Especially relevant to house prices is the

actual level of fear for family and pet safety that may influence the location where a person chooses to buy a house. As can be seen in the recent debate regarding the subject: "Anyone who wants to buy a farm with the purpose of hunting is probably not prepared to pay any larger amounts of money if it is situated inside a wolf territory. The desire to move to the countryside may also be lower when one knows the trouble it entails." (Karlsson 2009) and "A forest property yields many values. First and foremost is the timber. The estate also commonly includes berries and mushrooms, a benefit all can provide from. The second largest yield comes from hunting. Wolves and lynx have the capacity to affect the yield from the forest property through affecting the hunting activity." (Lindevall 2011).

Socioeconomic development and the wolf as a symbol

The controversy around the Northern Spotted Owl (*Strix occidentalis caurina*) is a widely known example where environmental protection is set against job opportunities, a controversy which in many cases follows conservation attempts (Kirschner 2010). Since some of the socioeconomic factors that are affecting humans' well-being and life satisfaction are income, employment and education (through its effect on income) (Watson et al. 2010) it is a sensitive matter when jobs are at stake. Moreover, according to Dickman (2010) the intensity of a human-wildlife conflict is affected by social factors, e.g. low income affect people's perception of vulnerability and therefore also increases resistance to acknowledged consequences pertaining to wildlife presence. Protecting areas harboring the owl species was claimed to affect timber-dependent communities negatively and this gave rise to an angry debate (Kirschner 2010). However, other structural factors in the timber industry were affecting the employment, and these changes had already begun prior to the protection of the owl (Kirschner 2010). According to Freudenburg et al. (1998) the protection of the owl had no significant effect on the number of available jobs. In this way the Northern Spotted Owl became an unambiguous symbol of a negative development of employment as a cost for conservation efforts, even though the protection of the species in fact did not affect the employment significantly. Something similar could possibly also be seen in Sweden. The urbanization is an ongoing process in most European countries (including Sweden) which means that people are moving from rural to more urban areas (Antrop 2004); the population development is therefore generally positive in urban areas whilst negative in rural areas (Antrop 2004; Kolmodin et al. 2009). In urban areas there is in general a higher level of education, more job opportunities and a stronger development of salaries than on the countryside (Bjerke et al. 2012). A positive economic growth in an area creates job opportunities and therefore also a population increase through people moving in from other areas which adds to the positive socioeconomic development of those areas (Bjerke et al. 2012). This means that there is both a weaker economic and social development in small communities far away from large urban areas (Johansson 2012). There are thus parts of Sweden's countryside with poor opportunities for employment and social developmental conditions (Anonymous 2013A). As previously mentioned, the core area of the returning wolves' population is in rural areas of South Western Sweden (Wabakken 2001), and these particular areas could be subjected to poor social and economic development which could be affecting people's general well-being and therefore also the intensity of the debate specifically

concerning the occurrence of wolves in the Swedish countryside. People will naturally use a powerful and unequivocal symbol like a carnivore to express strong opposition against rural policies and/or if they are concerned about economic difficulties in the future, even though the single question of pro or con wolf occurrence is a minor part of the problem (Kleiven et al. 2004). Thus the wolf might not only be a symbol of urban dominance (as mentioned earlier) but also a symbol of negative socioeconomic development per se, although the species itself is not causing this development.

Research questions and predictions

Based on the current concerns expressed in the debate regarding wolf issues, the known predation events and the general urbanization trend in Sweden; the main objectives of this study are to investigate the potential impact of wolf occurrence on a number of economic interests and recreational and cultural values in Sweden and also to examine the development of socioeconomic factors that have the potential to influence the intensity of the wolf debate. More specifically, and as explained earlier, the variables connected to the impact of wolf occurrence are related to sheep farming, hunting and price development of forest holdings and houses. To detect the potential impact of wolves on the included variables and also differences in the socioeconomic development; I divided the study area (i.e. Sweden) into a wolf area (i.e. all municipalities and counties with wolf territories) and a wolf-free area (i.e. all municipalities and counties without wolf territories). Due to the negative effects of wolf establishments highlighted in the media I expect to find negative effects of the growing wolf population on the studied variables over time. I predict that (A) there will be a slower and less positive development of number of sheep holdings in the wolf area compared to the wolf-free area, (B) the development of number of sold hunting licenses will be more negative and also decrease faster in the wolf area compared to the wolf-free area, (C) the number of harvested moose (i.e. moose bag) will increase slower and be less positive in the wolf area compared to the wolf-free area and (D) the development of purchase prices of forest holdings and houses will be slower and less positive in the wolf area compared to the wolf-free area. Moreover I also expect to find differences in the development of socioeconomic factors between the wolf area and the wolf-free area because, as previously mentioned, the wolf area is mostly rural areas with potentially less positive socioeconomic development. Since social factors have the ability to affect conflict intensity (Dickman 2010) I expect to find a worse socioeconomic situation in the wolf area which may amplify the fierceness in the wolf debate. Note however that I do not assume wolves as the underlying cause of a potentially weaker socioeconomic development in the wolf area compared to the wolf-free area. I predict that (E) the socioeconomic factors of population density, income and education level will be at a lower level and have lesser positive development, that there will be a higher age, and a higher percentage of unemployment; over time in the wolf area compared to the wolf-free area.

Material and Methods

Study area

The study comprises all of Sweden (from 69° N, 20° E to 55° N, 13° E) including 21 counties with in total 290 municipalities which I divided into a wolf area (9 counties and 59 municipalities) and a wolf-free area (12 counties and 231 municipalities). A wolf county is defined by containing at least one wolf municipality (i.e. a municipality containing at least one wolf territory for three consecutive years), a wolf municipality is always included in a wolf county whereas a municipality in a wolf county that do not have wolf territories is included in the wolf-free area (when looking at the municipality level). Sweden is mostly covered by coniferous boreal forest; however deciduous trees are dominating in the southernmost parts of the country. The reindeer husbandry area comprises nearly half of Sweden and includes parts of the northernmost counties (Anonymous 2013D) within which wolves are not allowed to establish (Anonymous 2008A). The wolf area is currently situated approximately from 62° N, 15° E to 58° N, 12° E, and the rest of Sweden is in this study considered as the wolf-free area (*Figure 1*). The wolf area (on the municipality level) is not including any of Sweden's major cities (i.e. Gothenburg, Stockholm and Malmö).

In general the human population density is low in Sweden; in 2012 it was 23 persons per km² and ranged from 3-326 persons per km² on a county level (Statistics Sweden 2013 [SCB; Statistiska Centralbyrån]). Population density is highest in the southern part of the country whereas the lowest population densities are found in the north (Statistics Sweden 2013A). The average population density in the wolf area in 2012 was 21 persons per km² and the same for the wolf-free area is 172 persons per km², (Statistics Sweden 2013) however there is a great variation within the areas, especially in the wolf-free area. In the wolf area 68 % of the municipalities have population densities lower than the national average of 23 persons per km² whereas in the wolf-free area 39 % municipalities have population densities lower than this national average.

The nature and land use differs among different parts of the country; the largest amount of productive forest land is found in the northern parts (Anonymous 2013E) while the largest amount of agricultural land is found in the more southern parts (Olsson 2012). Moreover the forestry is dominated by large companies in the northern parts and shifts toward more private landowners in the southern parts of the country. The number of sheep and sheep holdings are highest in the southern parts of the country (Thorstensson 2012). The highest number of moose harvested in the wolf-free area is in the northernmost counties (Västerbotten and Norrbotten; *Figure 2*). However when only considering the wolf area the counties of Jämtland, Västernorrland, Värmland and Dalarna are on top of the list of where most moose are harvested. In the more southern counties other game species (e.g. red deer *Cervus elaphus*, fallow deer *Dama dama* and wild boar *Sus scrofa*) are due to higher densities (compared to more northern parts) also hunted besides moose.

Outdoor activities like berry-picking, hiking and hunting are common among the Swedish people and are by many considered as important activities which should be available for all.

This is to some degree reflected by Sweden's traditional law; the right of public access, which is considered as both a cultural heritage as well as a national symbol that can be traced far back in Sweden's history (Anonymous 2013C).

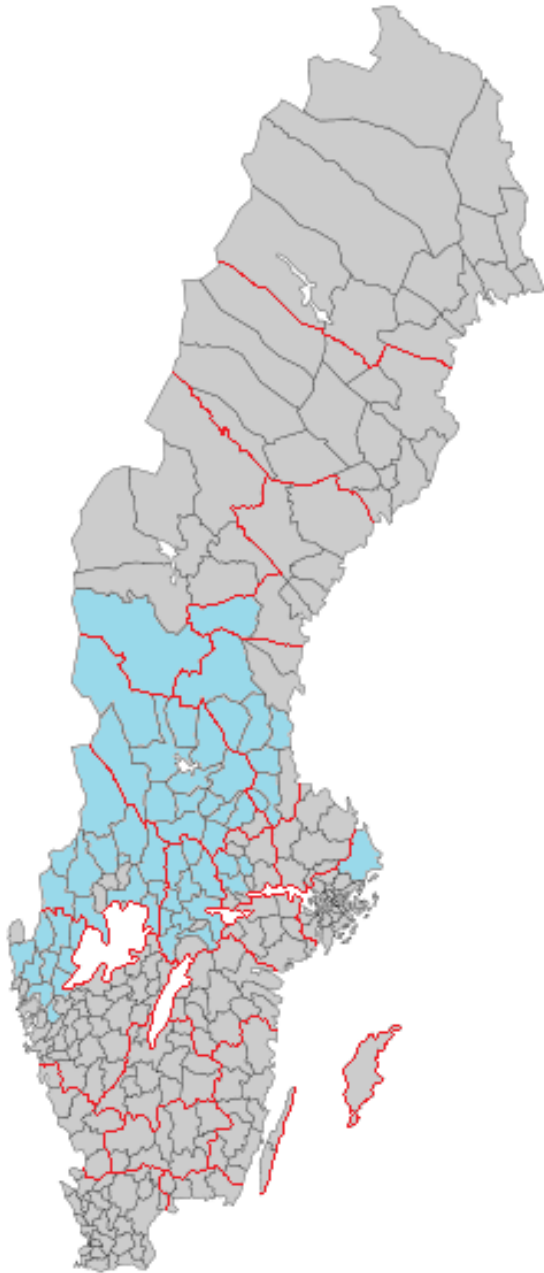


Figure 1. Map of Sweden with county and municipality borders highlighted in red and dark grey respectively. Municipalities with wolf occurrence are shaded in blue whereas municipalities without wolves are shaded in light grey. Counties are classified as wolf counties if at least one of its municipalities are shaded in blue (i.e. having wolf occurrence).

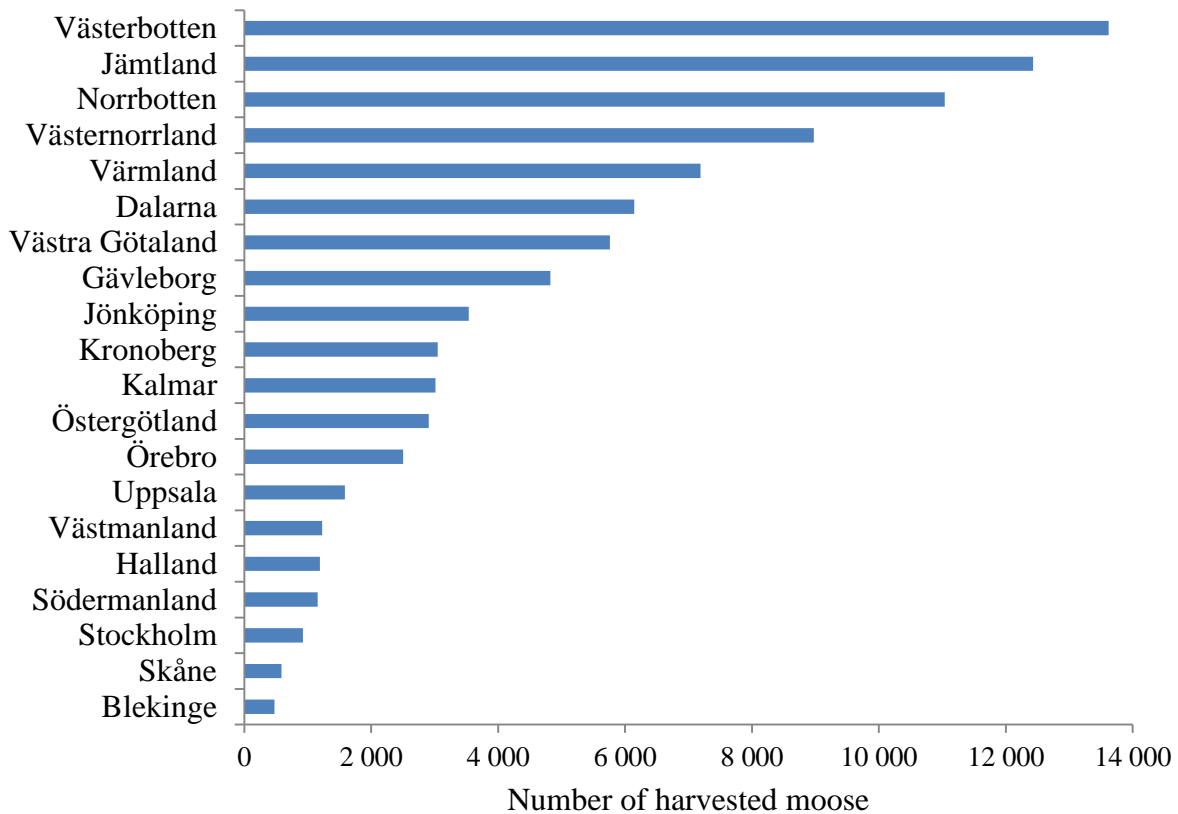


Figure 2. Number of harvested moose per county in 2011. All counties in Sweden (except for Gotland with no moose hunt) are included in the figure. Each bar is representing the number of harvested moose per county in 2011. (Data: Swedish Association for Hunting and Wildlife Management 2011).

Data collection

Wolf territory data

To define the wolf area I used ESRI ArcMap (10.1) to determine which municipalities in Sweden that were overlapped by one or more wolf territories. The wolf monitoring data in the form of territory minimum convex polygons are from the time period 1998/1999 to 2011/2012 and was provided by the Wildlife Damage Center (Viltskadecenter), Swedish University of Agricultural Sciences (SLU). Note however that the wolf territory polygons do not give the total size of each territory, in most cases approximately 1/3 of territories' total area is monitored (an average wolf territory in Sweden is approximately 1000 km²; Svensson et al. 2012) however less coverage do also occur (Svensson, L. pers. comm. 2012). My definition of wolf occurrence in a certain municipality is if the border of a monitored wolf territory crosses the border of a municipality, however to be included in the wolf area municipalities with wolf occurrence must also have had an overlap with wolf territories for a minimum of three consecutive years. Consequently the wolf-free area encompasses all municipalities which have not met the two criteria considering wolf occurrence. Given that only 1/3 of the total territory sizes are known, the size of the wolf area as I define it in this study is likely to be an underestimation and there are probably more municipalities harboring wolf territories than

presented here, this is especially likely for the municipalities neighboring the ones I include in the wolf area.

Organizations and socioeconomic data

I collected all the data and sorted it according to the classification of the wolf area and wolf-free area and their corresponding counties and municipalities. The Wildlife Damage Center provided wolf territory polygon data for 1998/1999-2011/2012 and I used status reports of wolf in Scandinavia to calculate the average number of wolves in Sweden each year (Aronsson et al. 1999, 2000, 2001, 2003; Wabakken et al. 2004A, 2004B; Anonymous 2005, 2006; Aronson & Svensson 2007, 2008, 2009; Svensson & Hedmark 2010; Aronson & Svensson, 2011; Svensson et al. 2012). I obtained data on number of sold hunting licenses (the period 2005-2012) from the Swedish Environmental Protection Agency (SwedishEPA; Naturvårdsverket). I collected statistics of the annual moose hunting bag (a time series ranging from 1998 to 2012) from the moose database at the national web-based portal VILTDATA where hunters report hunting bag of different game species including moose. Data of purchase prices of forest holdings was provided by LRF konsult (LRF konsult), Sweden's largest agriculture and forest holding agent, and the available time series was 1997-2012. The forest holding dataset included holdings containing forest land to different degrees, however since the actual amount of forest was only given in the latest 7 years in the time series all holdings were included, despite of the differences of type of holding (i.e. amount of forest and agricultural land in the holding). I collected statistics of average purchase prices on houses from Statistics Sweden (2013) and the available time series that I used was 1990-2011 (it was not possible to compare statistics prior to 1990 due to poorer statistical quality at that time; Statistics Sweden 2013). The Swedish Association for Hunting and Wildlife Management provided data on hunters' observations of moose. I collected statistics on the number of sheep (ewes and rams, not lambs) holdings over time from the statistical database at the Swedish Board of Agriculture (Jordbruksverket) (Swedish Board of Agriculture 2010, 2012). The available time series on the municipality and county level was 2003-2010 and 2001-2012 respectively. I acquired the socioeconomic data i.e. (income [1991-2011], education level [2000-2011], population density [1991-2012] and age [1998-2011]) from Statistics Sweden [2013]) and unemployment statistics (1996-2012) from Arbetsförmedlingen ([2013]; the largest work placement service in Sweden).

Data analysis

Concerns for economic interests and recreational and cultural values

In the data analysis in general I aggregated the data into two data sets according to the definition of a wolf area and wolf-free area based on municipalities in all cases except in the regression analysis for hunting licenses and moose bag where I also tested the relationship based on counties. I chose to test differences in the development of different variables between the areas using the average relative change over time (i.e. the studied time period) and a 95 % confidence interval (CI) of slopes.

Study limitations

This study initially aimed at including more variables (i.e. subsidies for carnivore-proof fences and compensation for killed sheep, number of attacks on sheep and dogs and the tendency to use hunters' observations of moose) than what is currently reported in this paper. However a number of variables were excluded due to different reasons concerning data quality and availability. Data of the magnitude of subsidies for carnivore-proof fences and paid out compensation for killed sheep in each municipality/county in the wolf area over time was not available and therefore not included in this study. The number of wolf attacks on sheep and hunting dog's data over time is generally of poor quality (especially in earlier years) and hard to access and therefore not included in this study. Due to these reasons I did not start analyzing the hereunto mentioned variables and they will henceforth not be considered in this paper. However, I was able to start analyzing the tendency to use hunters' observations of moose (i.e. number of man hours spent on observing moose during the moose hunt). I predicted that the tendency to use hunters' observations of moose will decrease faster over time and be lower in the wolf area compared to the wolf-free area due to hunters' perceiving observing the moose population as not needed anymore due to extensive predation pressure of wolves. In order to investigate if the tendency to use hunters observations of moose differed between the wolf area and wolf-free area and thus find a relationship between the number of man hours spent on hunters' observations of moose and the average number of wolves over time I used a linear regression analysis. I used the total man hours in the hunters' observation of moose as dependent variable and the average number of wolves as independent variable in the time series 1997-2012. The analysis was carried out in the same way as explained below for the number of sold hunting licenses and moose bag. This analysis did not result in any general trends or differences when I had analyzed data from the counties (and included municipalities) of Dalarna and Värmland, and due to this lack of general trend and time constraint I chose not to finish analyzing this variable and it will not be further included or discussed in this paper.

Sheep holdings

In order to investigate if wolf occurrence had an effect on the number of sheep holdings in Sweden I aggregated the data on a municipality level separately in two data sets according to the definition of the wolf area and wolf-free area. I calculated the average relative change (i.e. this average is based on the relative changes of all included municipalities in each area over the studied time period) of number of sheep holdings separately for the two areas through using the first year as a base year (2003) and dividing all subsequent years in the time series with the base year in each of the municipalities. More specifically I divided all years in the time series with their base year, creating either a relative increase or decrease of number of sheep holdings over time in relation to the base year; one average relative change for each of the two areas. I tested for differences in the average relative change in individual years and the total rate of change of the whole time series. This is to detect general trends and also trends that are not general for the whole time series. I used a 2-sample t-test when testing for differences in the means of the average relative change of number of sheep holdings each year between the wolf area and wolf-free area. When testing for differences in the total rate of

change in the whole time series I calculated a 95 % CI of the slopes and compared the slopes of the two areas. The general higher increase of number of sheep holdings from 2010 is not fully comparable with the statistics of previous years due to changes in the way the sheep holdings were counted (Grönvall 2012) which means that the visible increase does not reflect an actual higher increase in the number of sheep holdings compared to previous years. Note however that this change affect both areas equally and that what is relevant here is not the actual number of sheep holdings but rather if the rate of change in the two areas diverge.

Hunting licenses

The same procedure to calculate the average relative change of number of sheep holdings is used to calculate the average relative changes of number of hunting licenses (i.e. based on included municipalities in each area). Furthermore the same way of testing the means with the 2-sample t-test is used with the means of the average relative change of this variable each year between the wolf area and wolf-free area. When testing for differences in the total rate of change in the whole time series I calculated a 95 % CI of the slopes (i.e. also in the same way as for the previous variable). The data on hunting licenses is based on where people live, not necessarily where they have hunting rights and actively hunt (Bladh, D. pers. comm. 2012). In order to analyze if the increasing number of wolves in Sweden had an effect on the already in general decreasing number of sold hunting licenses (*Figure 4*) I used a linear regression analysis. As the independent variable I used the average number of wolves and as the dependent variable I used the number of sold hunting licenses, in the time series 2005/2006-2011/2012, in total 7 data points. I ran the linear regression analysis for all municipalities; 59 in the wolf area and 231 in the wolf-free area to see if there were a general difference in the coefficient of determination (r^2) in the two areas on both county and municipality level.

Moose bag

The same procedure to calculate the average relative change of e.g. number of sheep holdings is used to calculate the average relative changes of moose bag (i.e. based on included municipalities in each area). Furthermore the same way of testing the means with the 2-sample t-test is used with the means of the average relative change of this variable each year between the wolf area and wolf-free area. When testing for differences in the total rate of change in the whole time series I calculated a 95 % CI of the slopes. To investigate if the growing number of wolves is affecting the number of moose harvested I used a linear regression analysis with the average number of wolves as independent variable and moose bag as the dependent variable, both in the time series 1998/1999-2011/2012. I ran the linear regression analysis for all available counties; 9 in the wolf area and 11 in the wolf-free area, and (districts) municipalities; 59 in the wolf area and 204 in the wolf-free area to examine general difference in the coefficient of determination (r^2) in the two areas on both the county and municipality level. The moose bag statistics were organized according to districts instead of municipalities in the VILTDATA database, however districts coincided with municipalities in most cases, therefore I could still gather the data according to municipalities included in the wolf area and the wolf-free area. However one county (Gotland) with no moose hunt, and 27

municipalities were excluded because in some cases more than one district were combined into municipalities, and in some cases, municipalities lacked data.

Forest holdings

In order to compare and find differences in the price development of forest holdings and houses I aggregated the data into two data sets, one for the wolf area and one for the wolf-free area based on the including municipalities in each area. For each individual year in the time series (1997-2012) I calculated the average price (SEK/ha) based on the prices of the total number of sales of the specific years (differed between approximately 1 and 30 sales per municipality and year). The number of total forest holding sales reached from approximately 300 in the earlier years to approximately 1,100 in the later years. The price I used for the real estates was (SEK/ha) because it is the total price of a forest holding that can be affected by the wolf occurrence (as explained in the introduction), not the specific price on the timber volume (SEK/m³forest), which is otherwise commonly used when comparing the price development of forest holdings in different geographical regions (LRF consult 2010). To test for differences in the average purchase prices (SEK/ha) each year in the time series between the wolf area and the wolf-free area I used a 2-sample t-test. When testing for differences in the development of purchase prices of forest holdings I calculated a moving average (i.e. to decrease the impact of sales of individual years, since great variations may be caused by chance in small sample sizes) with a 3-year interval, for each area. More specific, the moving average is based on an average of purchase prices of three years at a time, thus each year is based on the average purchase prices of a specific year and two years prior to that year. I tested the total rate of change of the average purchase price development (the moving average) through calculating and comparing a 95 % CI for the slopes of each area.

House sales

In order to test for differences in the average purchase prices of houses (1990-2012) I aggregated the data into two data sets, one for the wolf area and one for the wolf-free area based on the including municipalities in each area. The same procedure to calculate the average relative change of number of sheep holdings is used to calculate the average relative changes of purchase prices of houses. Furthermore the same way of testing the means with the 2-sample t-test is used with the means of the average relative change of this variable each year between the wolf area and wolf-free area. When testing for differences in the total rate of change in the whole time series I calculated a 95 % CI of the slopes.

Socioeconomic development and the wolf as a symbol

To test for differences in the socioeconomic development in the wolf area and wolf-free area I aggregated the data of population density (1991-2012), average income (1991-2012), proportion of people with higher education (2000-2011), age (1998-2011) and unemployment (1996-2012) over time in the same way into two data sets according to the municipalities included in the two areas. I calculated the descriptive statistics of these variables and compared the means between the two areas using a 2-sample t-test to test for significant differences in each time step in the time series. When testing for differences in the total rate of

change in the whole time series I calculated a 95 % CI of the slopes. The same procedure to calculate the average relative change of previous variables is used to calculate the average relative changes of population density, average income and proportion of people with higher education. Furthermore the same way of testing the difference in means each year between the wolf area and wolf-free area with the 2-sample t-test is used with the means of the average relative change of the previously mentioned variables. When testing for differences in the total rate of change in the whole time series I calculated a 95 % CI of the slopes.

Ranking system

The ranking system is based on the socioeconomic situation in nearly all municipalities in Sweden (two municipalities in the class unemployment level were removed due to missing data). The included socioeconomic factors were average income (2011), population density development (2012/1991), Age (2011), Unemployment level (2012), percentage of population per municipality (2011). The pressure score (0 [worst]-5 [best]) is based on individual ranking in all classes (socioeconomic factors) and the total pressure of all factors combined (summed), thus treating all factors as equally important for the socioeconomic situation. Low average income, low population density development, high age, high unemployment level and low percentage of population with higher education are here considered as negative socioeconomic development resulting in a low value in the pressure score.

Results

Concerns for economic interests and recreational and cultural values

Sheep holdings

There is no significant difference ($p > .3349$) in the average relative change in number of sheep holdings between the wolf area and wolf-free area for any of the years during the time period 2003-2010 (*Figure 3*). The same lack of significance is shown in the total rate of change (i.e. 95 % CI for the slopes), meaning that the development rate is equal in the two areas which indicates that the same overarching factors might be affecting both areas (e.g. subsidies and legislation) and a lack of a factor affecting one area but not the other. These results does not concur with prediction (A) which says that there will be a slower and less positive development in the number of sheep holdings in the wolf area compared to the wolf-free area, however I found no significant differences between the areas in either the yearly average relative change or the total rate of change.

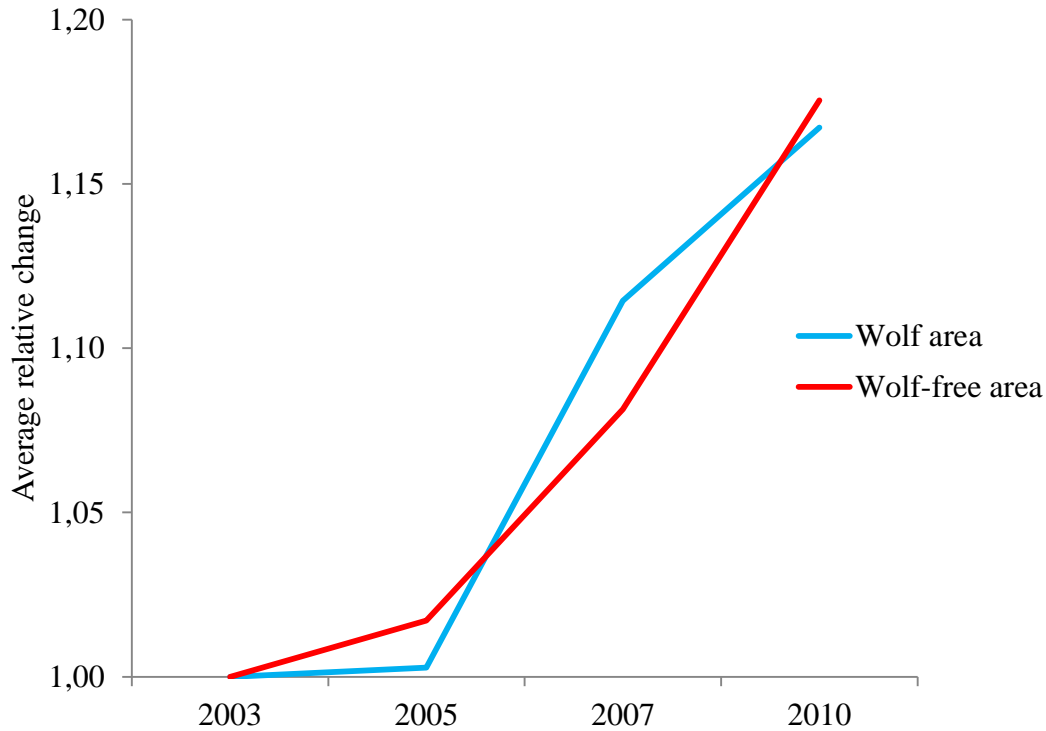


Figure 3. Average relative change in number of sheep holdings in the time series 2003-2010. Base year 2003; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

Hunting licenses

There is a significantly faster decrease ($p = .0005$) in the average relative change of number of sold hunting licenses in the wolf area compared to the wolf-free area from the year 2007/2008 and forward, and no significant difference ($p = .1969$) in 2006/2007 (*Figure 4*). Inferring that the average relative decrease in the number of sold hunting licenses is occurring at a significantly faster rate in the wolf area compared to the wolf-free area from the year 2006/2007 and forward. I found no significant difference in the total rate of change (i.e. 95% CI of slopes) between the areas. Even though the slopes of the total time series did not differ significantly, there is a significant difference from 2007/2008 which indicates that a factor, other than the overarching ones affecting both areas (e.g. factors affecting the general declining hunting interest), is having an effect in the wolf area but not the wolf-free area, resulting in a faster decrease in the number of sold hunting licenses compared to the wolf-free area. This partly coincide with prediction (B) the development of number of sold hunting licenses will be more negative and also decrease faster in the wolf area compared to the wolf-free area, indicating that wolves may actually be a factor affecting the rate of decrease in the number of sold hunting licenses.

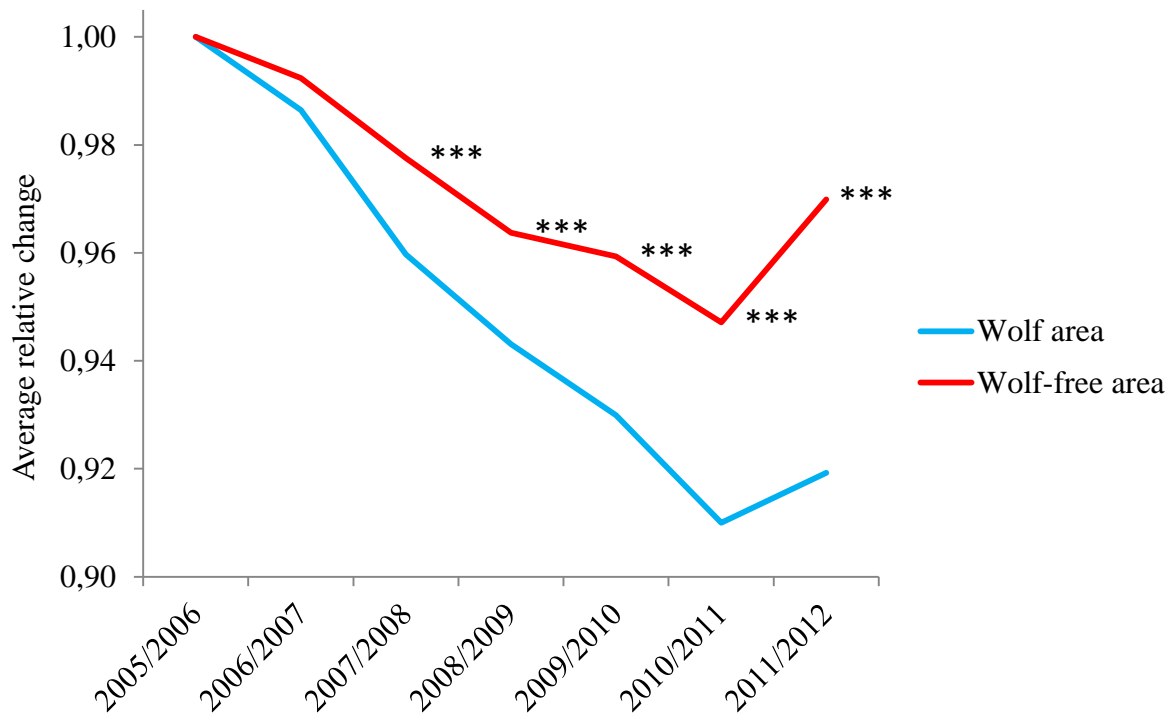


Figure 4. Average relative change in number of sold hunting licenses in the time series 2005-2012. Base year 2005/2006; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

The results of the linear regression analysis of number of wolves (independent variable) and number of sold hunting licenses (dependent variable) per county (*Table 1*) and per municipality (*Table 2*) shows that the relationship between the dependent and independent variable is stronger on both levels (i.e. county and municipality) in the wolf area compared to the wolf-free area. When considering the national level (i.e. Sweden, all counties aggregated; *Table 1*) there is no relationship between the variables. The highest r^2 -values (note: all r^2 -values showed in this section are based on negative r [correlation coefficient]-values) on the county-level is found in the wolf counties of Dalarna ($r^2 = 0.98$), Gävleborg ($r^2 = 0.95$) and Örebro ($r^2 = 0.94$) which means that there is a very strong relationship between the variables in these specific counties. The county of Stockholm in the wolf area are showing a positive relationship between the variables, this is probably because it is the only county with an increasing number of sold hunting licenses in the studied time period when comparing the last time step with the base year. The wolf-free counties of Blekinge ($r^2 = 0.81$), Uppsala ($r^2 = 0.86$), and Södermanland ($r^2 = 0.91$) are also showing high r^2 -values.

Table 1. Summary of results from the linear regression analysis of the relationship between number of wolves (independent variable) and number of sold hunting licenses (dependent variable) per county over the time period 2005/2006-2011/2012. The relationship (i.e. r = values) between the variables is denoted with (-) or (+) to show if it is negative or positive.

Wolf-free area (County)	Relationship (+/-)	r^2	Wolf area (County)	Relationship (+/-)	r^2
Uppsala	-	0.86	Dalarna	-	0.98
Södermanland	-	0.86	Gävleborg	-	0.95
Blekinge	-	0.81	Örebro	-	0.94
Kalmar	-	0.77	Värmland	-	0.91
Skåne	-	0.69	Västmanland	-	0.91
Östergötland	-	0.68	Västernorrland	-	0.91
Gotland	-	0.66	V. Götaland	-	0.83
Västerbotten	-	0.66	Jämtland	-	0.58
Jönköping	-	0.62	Stockholm	+	0.27
Halland	-	0.52			
Kronoberg	-	0.33			
Norrboten	-	0.21			
Sweden	+	0.03			

In *Table 2* it is shown that the variation in r^2 -values is greater in the wolf-free area than in the wolf area. The difference in r^2 -mean values (wolf area = 0.85 and wolf-free area = 0.58) suggests that there is a common social factor (e.g. age, population and density decline) related to the general hunting interest affecting the general decrease of number of sold hunting licenses in both areas, however it also indicates that a factor not common for both areas are causing the faster decrease in the wolf area. Thus overall, and especially when considering the municipality-level, this results concur with prediction (B) that the development of number of sold hunting licenses will be more negative and also decrease faster in the wolf area compared to the wolf-free area, indicating that wolves may actually be a factor affecting the rate of decrease in the number of sold hunting licenses.

Table 2. Summary of the mean, maximum and minimum r^2 - values (r = negative) from the linear regression analysis of the relationship between number of wolves (independent variable) and number of sold hunting licenses (dependent variable) per municipality in the time period 2005/2006-2011/2012. There are generally higher r^2 -values in the wolf area, indicating that the relationship is stronger in the wolf area compared to the wolf-free area.

Area	Mean (r^2)	Max (r^2)	Min (r^2)
Wolf area	0.85	0.99	0.13
Wolf-free area	0.58	0.98	0.00

Moose bag

The yearly average relative change of moose bag (*Figure 5*) is decreasing significantly faster ($p = .0002$) in the wolf area compared to the wolf-free area in 2008/2009-2011/2012 and there is no significant difference ($p = .2704$) between the areas in 1999/2000-2007/2008. The moose bag in both areas are starting to decrease from the year 2001/2002 (compared to the base year) and are decreasing throughout the time series, except for the wolf-free area in the last time step 2011/2012 were slightly more moose where harvested compared to the base year (1998/1999). The moose bag in the wolf area are continuing to decrease during the whole times series, however the decline is lesser toward the end of the period. The total rate of change (i.e. 95 % CI of slopes) is not significantly different between the two areas. This result partly coincide with prediction (C) that the moose bag will increase slower and be less positive in the wolf area compared to the wolf-free area since there was not a significant difference in the rate of change of the total time series, however less positive development in the wolf area compared to the wolf-free area from the year 2008/2009. Thus there is a more positive development of the number of harvested moose in the wolf-free area during the four last years in the studied time period.

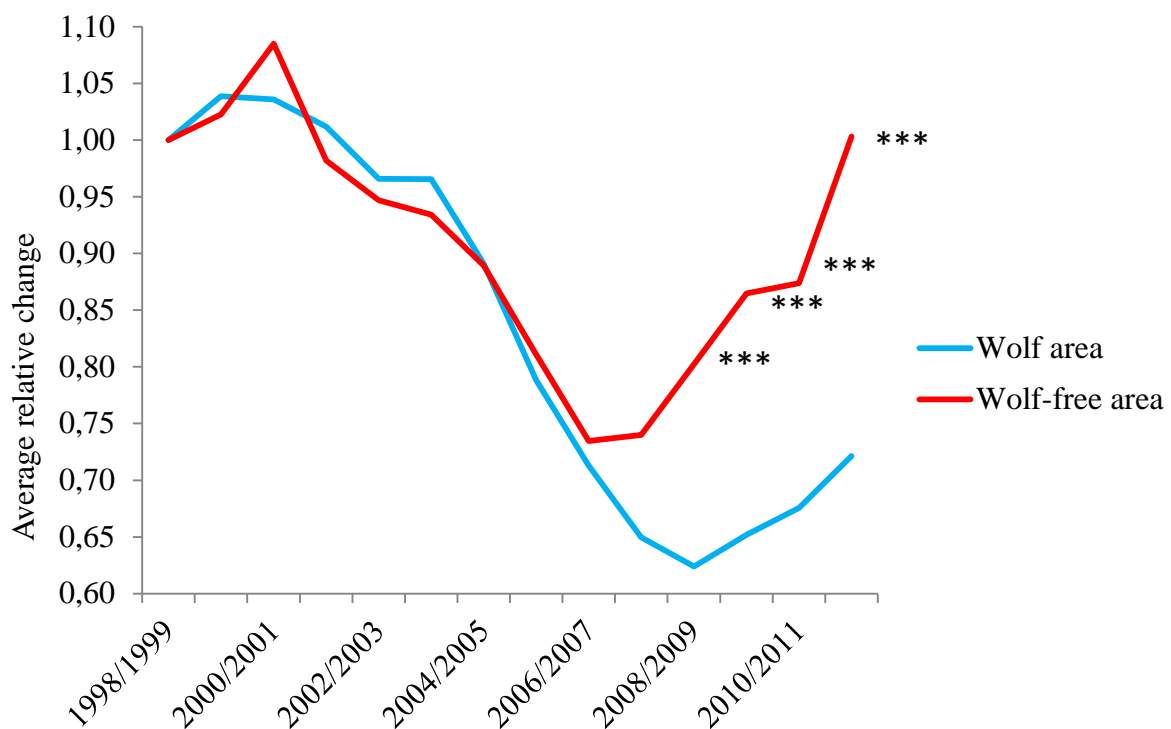


Figure 5. The average relative change of moose bag in the time series 1998/1999-2011/2012. Base year 1998/1999; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

The results of the linear regression analysis of number of wolves (independent variable) and moose bag (dependent variable) per county (*Table 3*) and per municipality (*Table 4*) reveal that the relationship between the dependent and independent variable is generally stronger in the wolf area compared to the wolf-free area on both levels (i.e. county and municipality).

When considering the national level (Sweden; all counties aggregated, *Table 3*) there is no relationship between the variables. The highest negative r^2 -values on the county-level is in the wolf counties Västmanland ($r^2 = 0.86$), Dalarna ($r^2 = 0.81$) and Gävleborg ($r^2 = 0.75$) and in the wolf-free area the counties of Södermanland ($r^2 = 0.82$), Uppsala ($r^2 = 0.75$) and Östergötland ($r^2 = 0.29$) has the highest r^2 -values.

Table 3. Summary of results from the linear regression analysis of the relationship between number of wolves (independent variable) and number of sold hunting licenses (dependent variable) per county over the time period 1998/1999-2011/2012. The relationship (i.e. r = values) between the variables is denoted with (-) or (+) to show if it is negative or positive.

Wolf-free area (County)	Relationship (+/-)	r^2	Wolf area (County)	Relationship (+/-)	r^2
Södermanland	-	0.82	Västmanland	-	0.86
Uppsala	-	0.75	Dalarna	-	0.81
Blekinge	+	0.59	Gävleborg	-	0.75
Norrbottn	+	0.55	Örebro	-	0.72
Östergötland	-	0.29	Värmland	-	0.71
Skåne	-	0.28	Stockholm	-	0.71
Kronoberg	+	0.17	V. Götaland	-	0.47
Halland	-	0.06	Jämtland	-	0.10
Västerbotten	-	0.01	Västernorrland	-	0.06
Kalmar	-	0.00			
Jönköping	-	0.00			
Sweden	-	0.17			

The variation in the r^2 -values on the municipality level (*Table 4*) shows that the mean r^2 -value is higher in the wolf area compared to the wolf-free area, suggesting that there is a stronger relationship between the variables in the wolf area compared to the wolf-free area. These results show that that relationship of the dependent and independent variable is generally stronger in the wolf area compared to the wolf-free area. This indicates that wolves are affecting the moose bag to some degree, but the relationship is generally not so strong. However some counties and municipalities are showing particularly strong relationships between the variables (e.g. municipalities in the counties of Värmland, Gävleborg and Dalarna). It is shown by the regression analysis that the variation in moose bag could to some degree be explained through the growing number of wolves, however other factors are clearly also affecting this relationship. From this result it does not seem like wolves have had a strong general effect on the number of harvested moose yet, however this result indicates that the relationship is stronger on a local level than on a regional or national level.

Table 4. Summary of the mean, maximum and minimum r^2 - values (r = negative) from the linear regression analysis of the relationship between number of wolves (independent variable) and moose bag (dependent variable) per municipality in the time period 1998/1999- 2011/2012. There are generally higher r^2 -values in the wolf area, indicating that the relationship is stronger in the wolf area compared to the wolf-free area.

Area	Mean (r^2)	Max (r^2)	Min (r^2)
Wolf area	0.58	0.94	0.00
Wolf-free area	0.33	0.90	0.00

Forest Holdings

There are significantly higher ($p = .0466$) average purchase prices (SEK/ha) of forest holdings in the wolf-free area compared to the wolf area in 1999-2004 and 2006-2012, the difference is not significant ($p = .1014$) in 1997-1998 and 2005. This indicates that the forest holdings in the wolf-free area are generally more valuable compared to those in the wolf area. There is no significant difference in the rate of change (i.e. 95 % CI of the slopes) of the purchase prices (moving average) between the two areas (*Figure 6*), meaning that the average purchase prices of the two areas are developing at the same rate and are therefore being affected by the same factors (e.g. timber prices and interest rate) in a similar way, and also indicating a lack of a factor affecting one area but not the other (e.g. wolf occurrence). These results partly concur with prediction (D) that the development of average purchase prices of forest holdings are slower and less positive in the wolf area compared to the wolf-free area. The results reveal that there is no difference in the development of the average purchase prices (moving average) between the areas, however the prices are less positive in the wolf area compared to the wolf-free area.

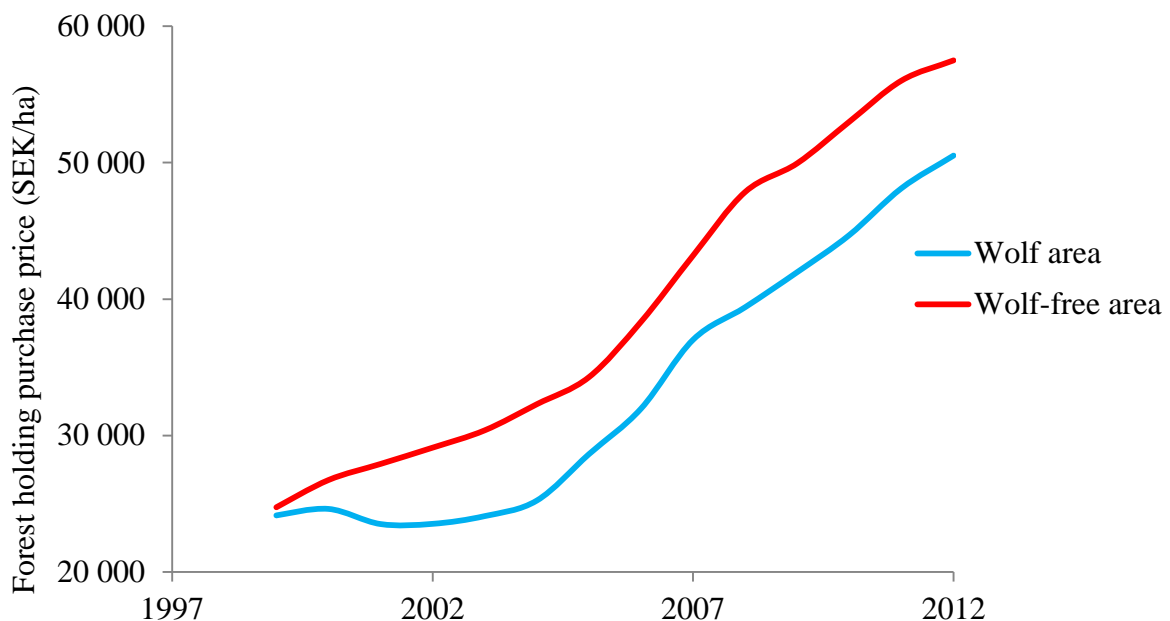


Figure 6. Moving average of forest holding average purchase prices (SEK/ha) in the time series 1997-2012; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

House sales

There is significantly higher ($p < .0001$) average purchase prices on houses in the wolf-free area compared to the wolf area during the whole time series 1990-2011. There is a significantly higher ($p = .0035$) average relative change of average house prices in the wolf-free area compared to the wolf area in 1992 and 1997-2011 and no significant difference ($p = .0852$) between the two areas in 1991 and 1993-1996 (Figure 7). Therefore during most of the years in the time period the average house prices have increased significantly faster in the wolf-free area compared to the wolf area. When considering the total rate of change in this variable throughout the time series (1990-2011) I found no significant difference between the slopes (95 % CI) in the two areas. When considering the result of significant differences in the development rate each year, this result is partly consistent with hypothesis (D) that the development of purchase prices of forest holdings and houses will be slower and less positive in the wolf area compared to the wolf-free area, since the development of average purchase prices of houses were significantly slower in 1997-2011 in the wolf area compared to the wolf-free area, furthermore the difference between the areas seem to increase. The average purchase prices are also significantly lower in the wolf area compared to the wolf-free area during the whole time series.

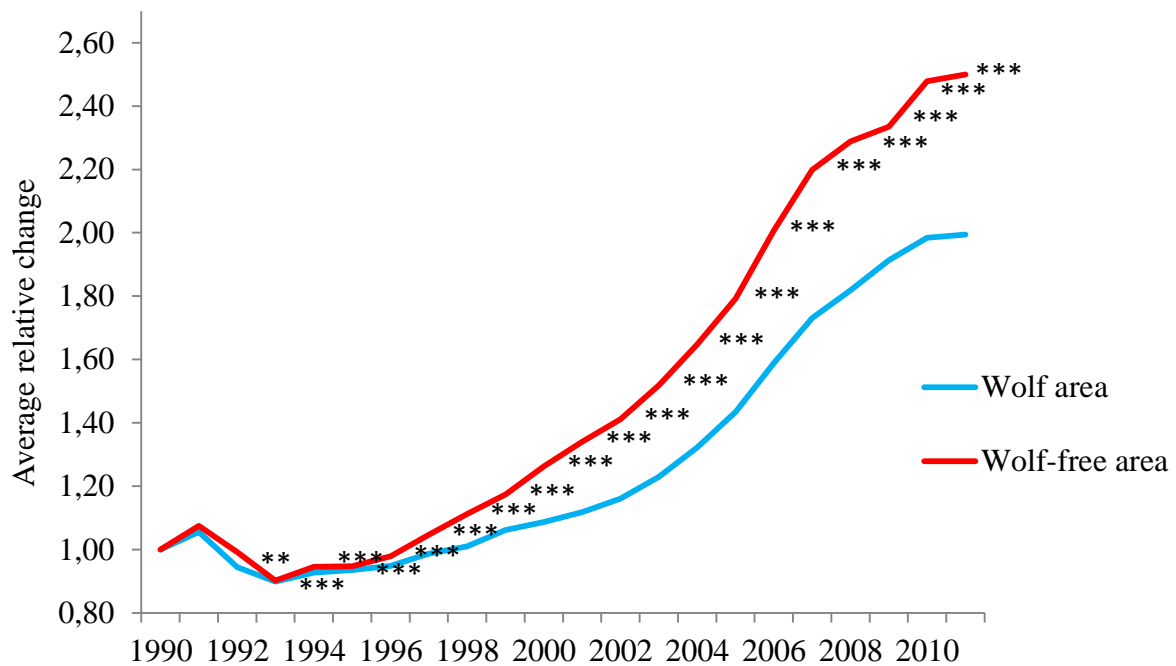


Figure 7. Average relative change of average purchase prices of houses in the time series 1990- 2011. Base year 1990; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

Socioeconomic development and the wolf as a symbol

Population density

There is a significantly faster ($p = .0167$) decrease in the average relative change in population density (Figure 8) during the years 1992-1993 and 1995-2012 and no significant difference ($p = .0932$) in 1994, in the wolf area compared to the wolf-free area. The difference between the areas is increasing toward the end of the time series where the population density in the wolf-free area is starting to increase from 2006, while the negative trend in the wolf area is continuing (compared to the base year). There is no significant difference in the total rate of change (i.e. 95 % CI of slopes) between the two areas, indicating that the development rate of average relative change in population density is equal in both areas. This result partly coincide with prediction (E) that the population density will be at a lower level and less positive in the wolf area compared to the wolf-free area since I did not find a difference in the total rate of change in this variable during the whole time series. However when testing the difference in individual years there is a faster decrease of the population density in the wolf area compared to the increase of the same in the wolf-free area in all years except for 1994. This variable is a factor of socioeconomic development, and these results indicate a more negative development in the wolf area while there is a more positive development in the wolf-free area considering population density.

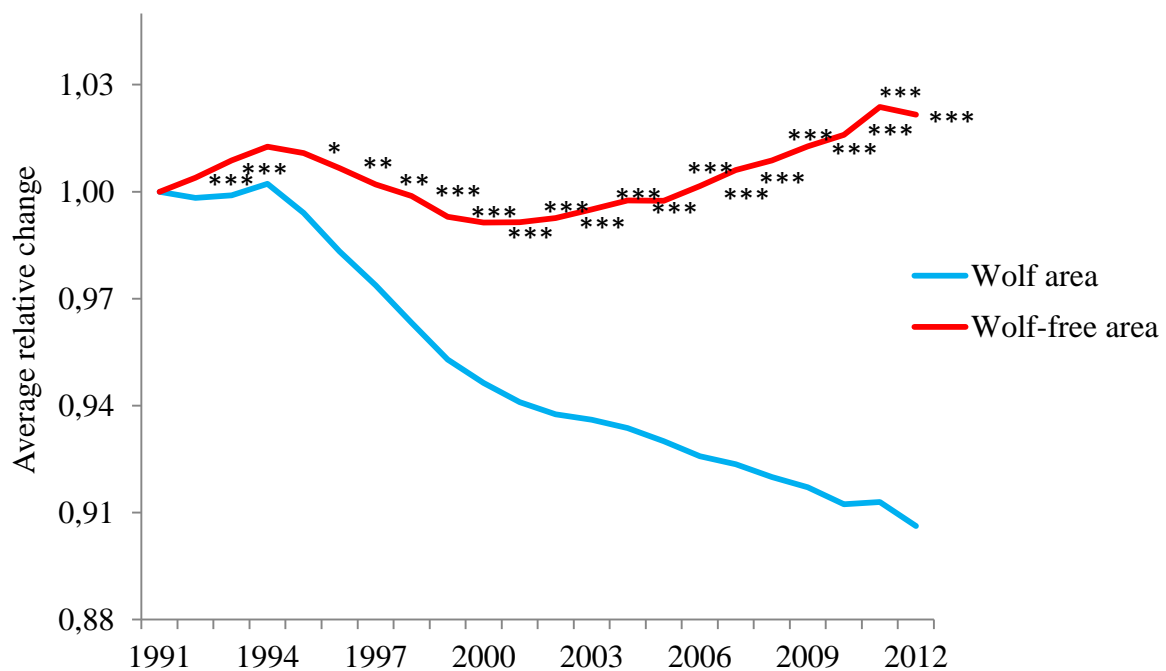


Figure 8. Average relative change in population density in the time series 1991- 2012. Base year 1991; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

Income

The average income is significantly higher ($p = .0001$) in the wolf-free area compared to the wolf area in each individual year throughout the time series 1991-2011 (Figure 9). There is a significantly higher ($p = .0003$) average relative income level in the wolf area compared to the wolf-free area in 1992-1996, no significant difference ($p = .0512$) in 1997-1999 and significantly higher ($p = .042$) average relative income in the wolf-free area compared to the wolf area in 2000-2011. There is no significant difference in the total rate of change (i.e. 95 % CI of slopes) in the average income when comparing the whole time series between the two areas. This infers a faster positive development in the wolf area in the beginning of the times series and a then a faster positive development in the wolf-free area in the latter half of the time series. This result generally concur with hypothesis (E) that there is a lower level and less positive development considering average income in the wolf area compared to the wolf-free area, indicating that there are either more job opportunities and/or jobs with higher salaries in the wolf-free area.

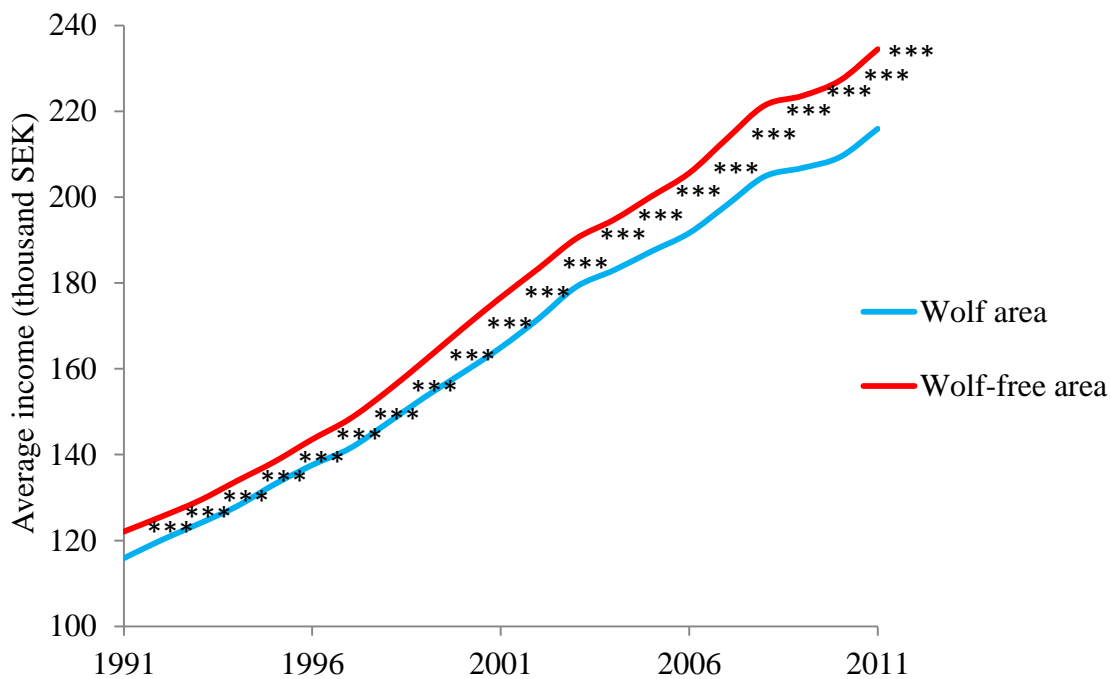


Figure 9. Average income in the time series 1990-2011; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

Higher Education

I found a significant higher ($p < .0001$) percentage of the population with higher education in the wolf-free area compared to the wolf area (1991-2011; *Figure 10*). There is no significant difference ($p = .0998$) in the average relative change of percentage of population with higher education 2000-2011 between the wolf area and the wolf-free area either in individual years or the total rate of change (i.e. 95 % CI of slope). This result partly concur with prediction (E) that there is a lower level of higher education level and also a less positive development of this variable in the wolf area compared to the wolf-free area since I found a significantly higher proportion of people with higher education in the wolf-free area. However I did not find a significant difference in the development of this variable between the two areas during this time series.

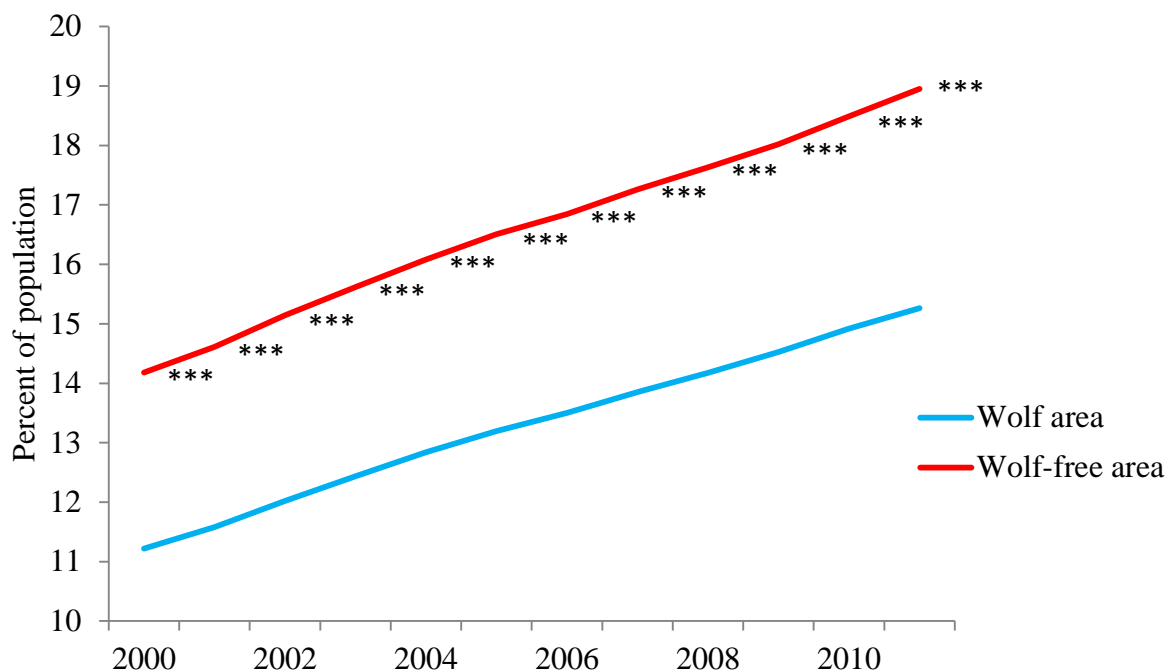


Figure 10. Percentage of people with higher education in the time series 2000-2011; wolf area (blue) and wolf-free area. * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

Age

There is a significantly higher ($p < .0001$) average age in the wolf area compared to the wolf-free area during the whole studied period (2000-2010; *Figure 11*). This concurs with prediction (E) that there is a higher average age in the wolf area compared to the wolf-free area over time.

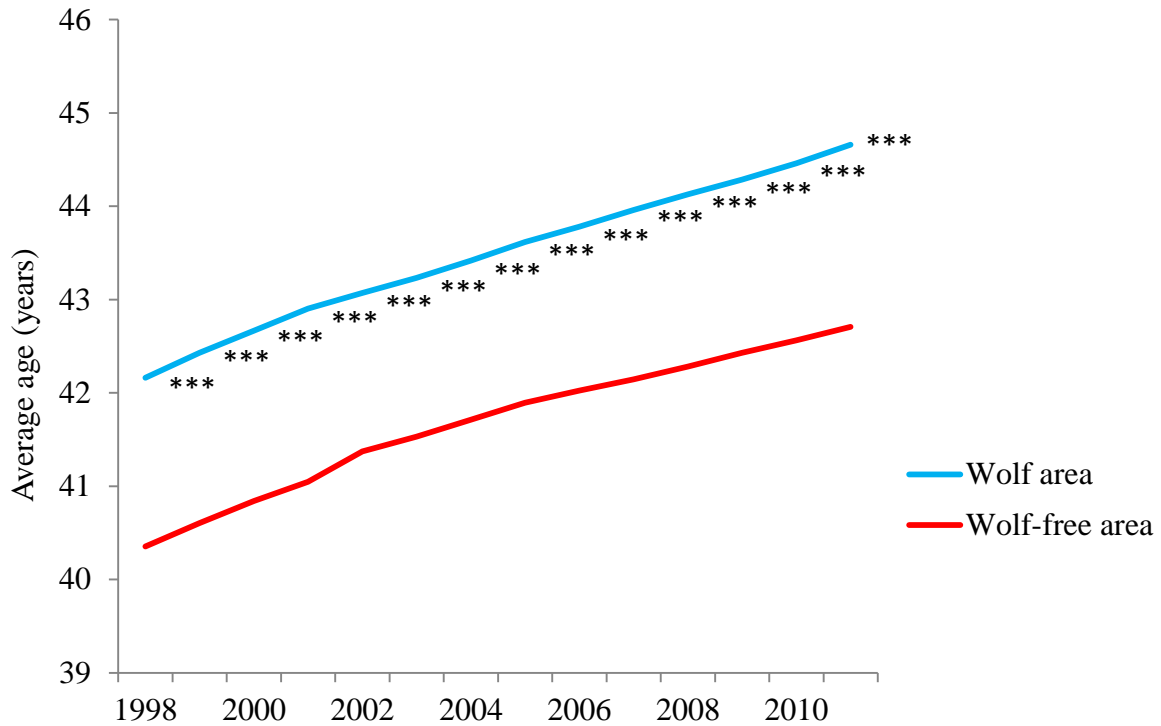


Figure 11. Average age in the time series 1998-2011; wolf area (blue) and wolf-free area. * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

Unemployment

I found a significantly higher ($p = .0175$) proportion of unemployed people in 1996-2010, and no significant differences ($p = .1068$) in the last time steps 2011-2012 in the wolf area compared to the wolf-free area (*Figure 12*). This concurs with prediction (E) that there is a higher proportion of unemployed people in the wolf area compared to the wolf-free area over time (except for the last two time steps in the time series). This result indicates that there has been a more negative socioeconomic situation considering this variable in the wolf area compared to the wolf-free area, however the difference decreased over the time period, and ended with a non-significant difference in end of the period.

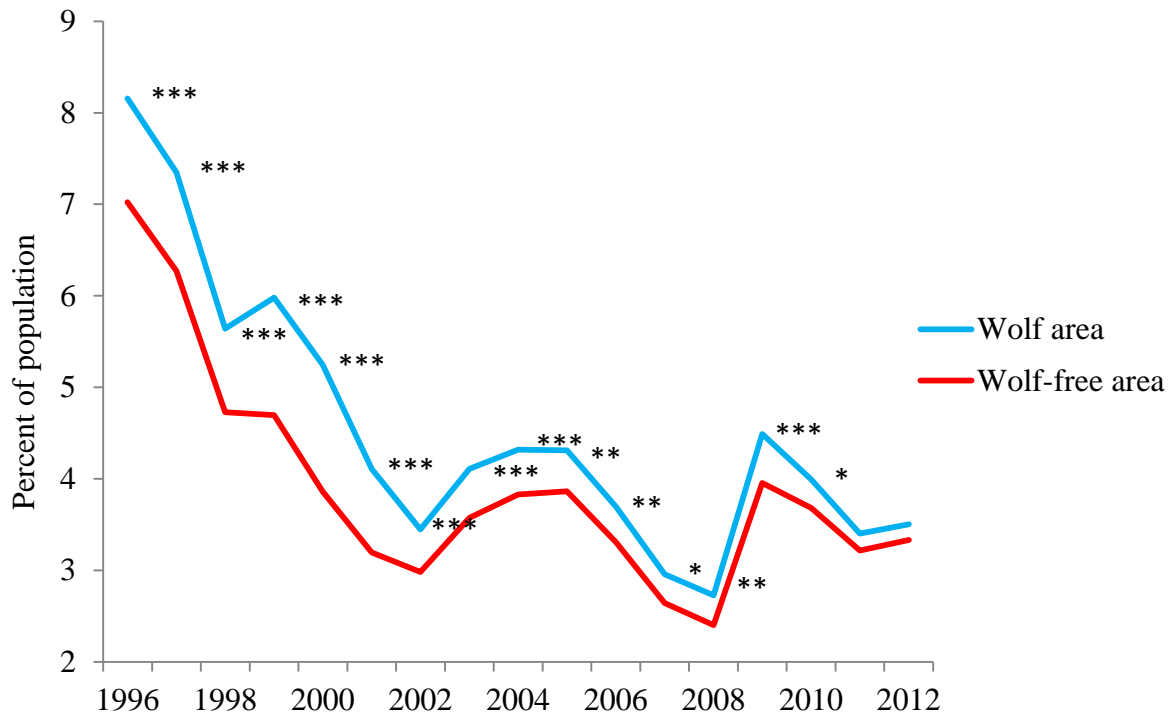


Figure 12. Percentage of people that are unemployed in the times series 1996-2012; wolf area (blue) and wolf-free area (red). * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$.

Ranking system

The ranking system is based on the socioeconomic situation in nearly all municipalities in Sweden (two were removed because of missing data) (Figure 13). The included socioeconomic factors was: average income (2011), population density development (2012/1991), Age (2011), Unemployment level (2012), percentage of population per municipality (2011). The number of municipalities in the wolf area with a pressure score < 2 is 35 (i.e. 59 %), and the same for the wolf-free area is 64 municipalities (i.e. 28 %). This results show that the highest proportion of municipalities with the least positive socioeconomic situation is found in the wolf area, however municipalities in the wolf-free area are ranging from pressure scores worse than the wolf area and approximately 1/3 of all municipalities have a better socioeconomic situation than any municipality in the wolf area.

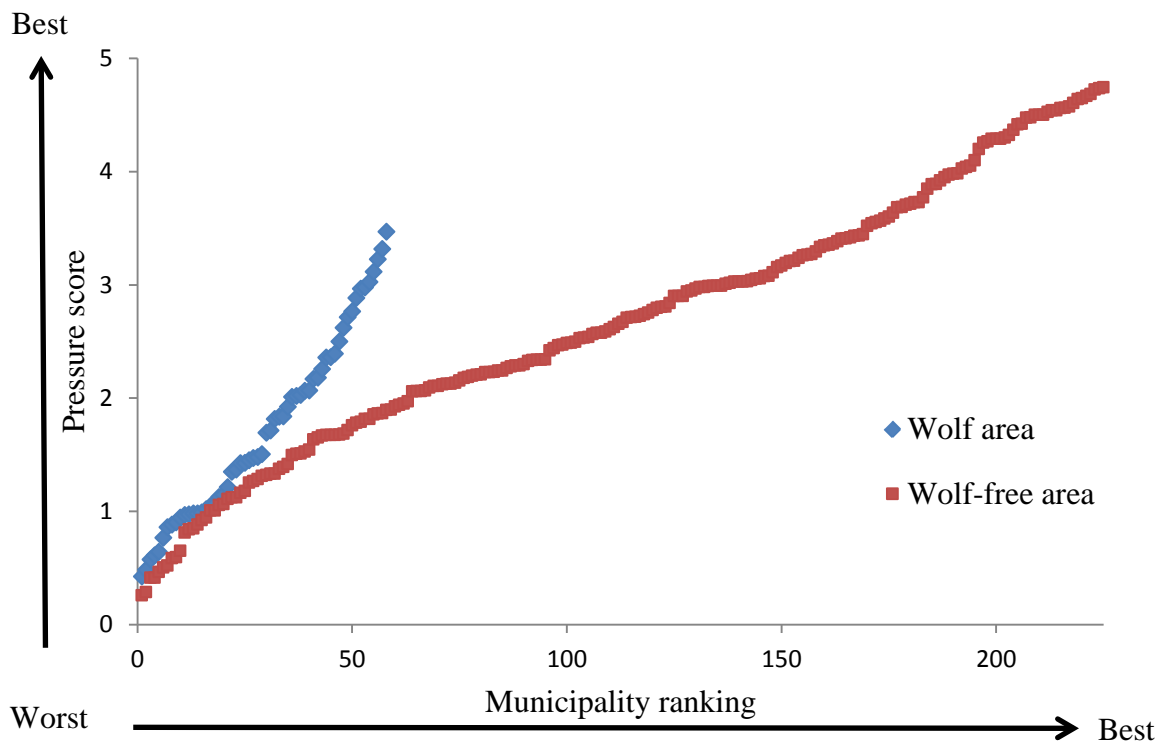


Figure 13. The ranking system of the socioeconomic situation in all municipalities; wolf area (blue) and wolf-free area (red), based on the pressure score (0 [worst]-5 [best]) calculated from the summed individual rankings of the included socioeconomic factors (i.e. average income, population density development, age, unemployment level and percentage of population with higher education).

The municipalities with lowest pressure score (i.e. worst socioeconomic situation) is listed in *Table 5*. Most counties in the wolf area (7/9) are represented in this table. Considering the wolf-free area there are municipalities in the northernmost counties that have the worst socioeconomic situation, however municipalities in more southern parts (e.g. in the county of Kalmar) also qualifies to this list. Note however that the worst socioeconomic situation of all municipalities (including both areas) is found in municipalities in the northernmost counties in the wolf-free area.

Table 5. Summary of the 20 municipalities with worst socioeconomic development according to the ranking system (*Figure 14*) reaching from 1 = worst to 20 = best, in total 228 municipalities. The pressure score is based on the combined ranking of all individual rankings in five classes (average income, population density development, age, unemployment level and percentage of population with higher education).

Rank	Wolf area		Wolf-free area	
	<i>Municipality</i>	<i>County</i>	<i>Municipality</i>	<i>County</i>
1	Ljusnarsberg	Örebro	Åsele	Västerbotten
2	Älvdalen	Dalarna	Dorotea	Västerbotten
3	Hällefors	Örebro	Sorsele	Västerbotten
4	Filipstad	Värmland	Strömsund	Jämtland
5	Härjedalen	Jämtland	Bjurholm	Västerbotten
6	Ljusdal	Gävleborg	Överkalix	Norrbotten
7	Ånge	Västernorrland	Bräcke	Jämtland
8	Bengtsfors	V. Götaland	Ragunda	Jämtland
9	Hagfors	Värmland	Övertorneå	Norrbotten
10	Munkfors	Värmland	Pajala	Norrbotten
11	Färgelanda	V. Götaland	Hultsfred	Kalmar
12	Orsa	Dalarna	Högsby	Kalmar
13	Ovanåker	Gävleborg	Vilhelmina	Västerbotten
14	Dals-Ed	V. Götaland	Haparanda	Norrbotten
15	Ockelbo	Gävleborg	Sollefteå	Västernorrland
16	Storfors	Värmland	Berg	Norrbotten
17	Vansbro	Dalarna	Nordanstig	Gävleborg
18	Eda	Värmland	Gullspång	V. Götaland
19	Mellerud	V. Götaland	Torsås	Kalmar
20	Torsby	Värmland	Norsjö	Västerbotten

Summary of predictions and results

A summary of all predictions and results (*Table 6*) reveal that wolves today have a generally small effect on the included economic interests and recreational and cultural values in Sweden. There is no difference in development between the two areas concerning number of sheep holdings or average purchase prices of forest holdings. Hunting licenses are decreasing faster in the wolf area, indicating that wolves might have an effect on the general hunting interest in Sweden. This is further supported through the strong relationship between number of wolves and number of sold hunting licenses over time. It is a lesser positive increase in moose bag in the wolf area in the four last years of the studied time series, although the relationship between number of wolves and moose bag is not particularly strong inferring that wolves probably have a minor effect (if any). When comparing the socioeconomic situation in the wolf area and wolf-free area there is generally a lesser positive, and in some cases even negative development, in the wolf area compared to the wolf-free area. This implies that the socioeconomic development is strongest and most positive in the wolf-free area.

Table 6. Summary of all predictions and results. WF = wolf area, WFA = wolf-free area, 0 = no difference in development rate, +/- = positive/negative development, [+] = less positive development, [-] = less negative development.

Predictions	Wolf area	Wolf-free area	Comment
Sheep holdings	0	0	
Hunting licenses	-	[-]	
Moose bag	-	+	
Forest holdings	0	0	WFA: higher prices
Houses	[+]	+	WFA: higher prices
Pop. density	-	+	
Average income	[+]	+	WFA: higher income
Higher education	0	0	WFA: higher % of pop. with high. ed.
Unemployment	0	0	WF: higher level in previous years.
Age	0	0	WF: higher age

Discussion

This is the first study of its kind investigating the fears expressed in the current wolf debate concerning economic interests (e.g. Miller et al. 1998; Bostedt & Grahn 2008; Sommers et al. 2010) and recreational and cultural values (e.g. Ericsson & Heberlein 2003; Skogen & Krangle 2003; Skonhøft 2006; Bisi et al. 2007) on a municipality level. As well as the socioeconomic background of the wolf area and the wolf-free area in Sweden; of which the latter is according to this study most likely affecting the intensity of the wolf debate (consistent with Dickman 2010; social factors affect conflict intensity). The results of this study do not support the magnitude of fears expressed in the recent wolf debate concerning the effect on the sheep farming industry, forest holding prices and house prices, however my results support the fear concerning wolf occurrence affecting hunter's participation and to some degree the size of the moose bag. In this study I have shown that the increasing number of wolves has not yet affected the sheep industry in Sweden as a whole concerning the development of number of sheep holdings. This study suggests that wolves may be an adding factor to the general decrease in number of sold hunting licenses which implies that wolves may have an enhancing effect on the rate of decrease in number of sold hunting licenses which subsequently may have negative implications for the general wildlife management in Sweden. Furthermore this study suggests that the decline in the moose bag during the studied time period could to some degree potentially be explained by the growing number of wolves, however other factors are clearly also affecting this relationship. I found no evidence that wolves have an affect the average purchase prices of forest holdings, however interesting is that during most of the studied time period the prices were generally higher in the wolf-free area inferring that this fact might have resulted in the current fear of wolves affecting the prices of forest holdings. However there are probably local effects of wolf occurrence on some forest holdings with important hunting grounds, especially if other predators as for example bears are also present which may increase the predation pressure on moose. There is both a significantly faster positive development and a higher price level of houses in the wolf-

free area compared to the wolf area during most of the studied time series indicating that it is more attractive to live in areas outside of the wolf area. This suggests that there is a lesser positive socioeconomic development in the wolf area which affects peoples' willingness to live there. In general my findings concerning different socioeconomic factors (i.e. population density, average income, percentage of people with higher education, age and unemployment) indicates that there is a lesser positive socioeconomic development, and for some factors even negative development, in the wolf area compared to the wolf-free area. Wolves are most likely not the cause of this development, the species comeback and the more positive socioeconomic development in the wolf-free area are coincidentally occurring simultaneously. People's perception of the severity of the consequences of a species is based on social, cultural and personal factors (Dickman 2010). The intensity of a conflict may therefore be amplified if a group perceive themselves as more vulnerable considering social factors than another group (Dickman 2010). This infer that due to the lesser positive development of socioeconomic variables in the wolf area compared to the wolf-free area and the strong symbol-value of this species, wolves may actually function as a structural symbol of negative socioeconomic development in the wolf area and thereby enhancing the intensity of the negativity in the wolf debate.

Concerns for economic interests and recreational and cultural values

Sheep holdings

I found no difference in the development of number of sheep holdings between the wolf area and wolf-free area which indicates that the same overarching factors are affecting both areas equally (e.g. legislation and subsidies). This means that today with the current wolf population, wolf occurrence do not affect the sheep industry as a whole; however on a local level there can be severe problems (Graham et al. 2005). Both the total number of sheep holdings and the total number of sheep has increased in Sweden during 2001-2012 with 15 % and 35 % respectively (Swedish Board of Agriculture 2012). Furthermore, the number of sheep attacks has increased from approximately 10 attacks in 1997 to 62 attacks in 2011 (with variation in the number of sheep killed), although there are great variations in number of attacks between years (Karlsson et al. 2012) this indicates that the number of attacks have increased as the wolf population has grown in size. Issues for sheep farming pertaining to wolf occurrence is based on predation which implies economic hardships, heavier work load and emotional stress (Skogen & Krangle 2003). Also, farmers view themselves as facing complicated regulations and an unsure future (in the sense of carnivore presence) and that their efforts in preserving cultural values are underestimated (Sjölander-Lindqvist 2009). According to Sjölander-Lindqvist (2009) "...the European Union (EU) has stated that small-scale farming is important for maintaining the landscape and safeguarding the survival of values associated with 'agri-environmental' habitats". Furthermore Sweden is also obligated to act according to the EU Habitat Directive which includes restraints considering how to manage protected animals, e.g. considering killing individuals (Sandström et al. 2009). Hence there is a conflict between promoting different values related to farming and conservation efforts.

In Sweden, 85 % of all sheep holdings have less than 50 sheep (Thorstensson 2012). Counties with stationary wolf territories generally includes small-scaled agricultural farming compared to the southern part of the country; and their income is dependent on a number of factors such as e.g. EU subsidies and income from hunting ground leases (Sjölander-Lindqvist 2009). According to Thorstensson (2012), a survey regarding how sheep holding owners plan to change the structure of their holdings during the upcoming three years, the ones planning to reduce the size or even discontinue with their holding (due to lack of time or economic reasons) are all found among the owners of smallest sized sheep holdings. Generally, the most important reasons to practice sheep farming is foremost to maintain an open landscape, second to work with animals and third for economic profit; the third reason is more important for owners of larger scale sheep holdings (Thorstensson 2012). Furthermore the sheep industry is moving towards a more large scale approach, meaning that the number of sheep in each holding is increasing (Thorstensson 2012). Wolf depredation in a small sheep holding will probably infer a greater economic burden due to already existing economic hardship than depredation in a larger holding with a more beneficial economic situation and hence can withstand losses to a higher degree (note: that this is only when considering the economic aspect, not the emotional). Through predation wolves may therefore potentially add to already existing economic hardships of smaller scaled sheep holdings, and may therefore be the determining factor of either maintaining the practice or discontinuing it (and possibly force people to leave the countryside). Thereby the wolf may be an adding factor that drives the industry further towards larger scale holdings and this development could potentially be devastating for maintaining local cultural traditions and cultural heritage. Even though sheep lost to predation are compensated somewhat higher than the market value of sheep, (Karlsson & Johansson 2010) (and available subsidies for carnivore proof-fences; Karlsson 2007) this does not make up for the emotional hardship entailing the loss (Graham et al. 2005), which probably is the most important factor regarding the wolf debate since according to Thorstensson (2012) the economic aspect is not the most important reason for practicing sheep farming. Since farming is generally small-scaled in the wolf area (compared to Sweden in general) (Sjölander-Lindqvist 2009) and that the smaller farms are probably more economically vulnerable (because it is the owners of smaller sheep holdings that say they might quit their practice in the upcoming years; Thorstensson 2012) this is an important aspect to consider. Farmers fear that preserving viable carnivore populations could result in a loss of cultural and nature heritage through declining forest and farm communities (Sjölander-Lindqvist 2009). The most important thing in sheep farming is to keep the landscapes open (Thorstensson 2012), and not the economic interest as might be the preconceived notion. The question is how do we protect the aspect of open landscapes and preserving local cultural values and traditions alongside with an increasing wolf population? Moreover, how do we at the same time increase acceptance for the management and thus acceptance for carnivore presence, which according to Karlsson (2007) is on factor of great significance when it comes to long-term presence of carnivores? Since both the number of wolves (Svensson et al. 2012) as well as the number of sheep is increasing (Swedish Board of Agriculture 2012), this implies a great challenge for the future wolf management in Sweden due to the potential increase in this carnivore-human conflict. Human-wildlife conflicts are complex, actual predation damage is just one factor included its complexity, social factors also play an

important role (Dickman 2010). The reduction of human-wildlife conflicts is essential to successful carnivore preservation (Linnell et al. 1996). The need of proactive and reactive measures to mitigate predation (e.g. Karlsson & Johansson 2012) will probably increase if the number of wolves also increases in order to counter the potentially adverse effects that may follow through e.g. increased predation pressure.

Hunting licenses

This study suggests that wolf occurrence might enhance the rate of decrease of the already declining number of sold hunting licenses in the wolf area compared to the wolf-free area. Even though I did not find a difference when comparing the total time series between the areas I found a significant difference from 2007/2008 which indicates that a factor, other than the overarching social factors affecting both areas, is having an additive effect in the wolf area but not the wolf-free area. The effect of wolf occurrence on this variable is further supported through testing the relationship between the number of wolves and the number of sold hunting licenses and finding a strong relationship between these variables in the wolf area (even though a regression analysis does not assume a casual effect between the included variables; Fowler et al. 1998). However since the number of sold hunting licenses is decreasing (as is the trend in many European countries as well as in North America; Heberlein et al. 2008) in both areas (*Figure 4*), wolves occurrence may only explain a part of this decrease. As previously mentioned, in Sweden hunting licenses is based on where people live and not where they hunt (Bladh, D. pers. comm. 2012). According to Heberlein et al. (2002) participation in the activity of hunting is best explained by the factor of rural culture which suggests that high participation is based on strong rural communities and farms with positive development, the level of participation is lesser explained by e.g. population density, available forest land, age, income, unemployment and gender (Heberlein et al. 2002).

The decreasing number of sold hunting licenses could probably to some degree be explained by the declining population density in both areas, since in general Sweden is a rural country. However due to the higher proportion of rural areas in the wolf area and the declining population density that weakens rural communities, this could probably affect the number of sold hunting licenses more negatively in the wolf area compared to the wolf-free area. This implies that the ongoing urbanization process and marginalization of rural communities (Antrop 2004; Kolmodin et al. 2009) likely have an adverse effect on the hunting participation (i.e. number of sold hunting licenses). Hence a negative development in rural communities implies a negative development of the hunting participation because hunting participation is negatively affected through weak rural communities (Heberlein et al. 2002). This infers that the ongoing process of urbanization in Sweden (Antrop 2004) may partly be responsible for the slower decline of hunters in the wolf-free area which to a higher degree consists of urban areas where people tend to move to.

Hunting is an important rural activity and of great cultural value (Heberlein & Willebrand 1998; Heberlein & Ericsson 2005; Milner et al. 2005; Skonhofs 2006). Hunting in Sweden is regulated through the national hunting law (Anonymous 1987A, B) and the EU Habitats Directive (Anonymous 1992). If it is desirable to preserve its significant value as a part of the

cultural heritage in the future it may be needed to reverse the negative trend in number of sold hunting licenses. In order to counter the part of the negative development that the wolves may be responsible for, there are probably many different solutions and related problems. However the basis is either to decrease the number of wolves or to make them valuable and interesting for hunters as a new game species rather than only constituting a burden, of which both is difficult to achieve because of current legislation and controversy. It is important that wolves become a valuable resource for hunters through e.g. sport hunting (Zimmermann et al. 2001; Heberlein & Ericsson 2008) since hunters traditionally tends to care for species available for sport hunting, and thus not only cause negative effects for this interest group (Heberlein & Ericsson 2008). Furthermore the value of wolves could also increase through tourism activities and employing people in local areas in the activities based on wolf presence (Zimmermann et al. 2001). However, moose hunting is also an important tourism activity (Skogen & Krange 2003) as well as other moose related activities e.g. included in zoos, in safaris and moose parks (Brandin 2009). This could probably cause conflicting tourism opportunities in some areas.

Along with the right to hunt comes an obligation to exercise wildlife management (Anonymous 1987B). In the field wildlife management in Sweden is inter alia carried out through the practice of hunting. This involves e.g. controlling wildlife populations through hunting both during regular hunting seasons as well as through protective hunting on e.g. carnivores, moose, and seals; lack of which would result in extensive damages by wildlife to forestry, agriculture and traffic. Moose in high numbers are for example causing damages to forestry (e.g. Hörnberg 2001) and traffic safety (e.g. Seiler 2004, 2005). Furthermore hunters take responsibility for tracking down injured wildlife (Anonymous 1987A, B) and estimating moose populations (Ericsson & Wallin 1999). Revenues from the selling of hunting licenses are part of funding both wildlife management and research (Anonymous 2013B). Therefore because of the downward trend in the number of sold hunting licenses, and the importance of hunting for both wildlife management and research, it is important to take the potentially negative effects of wolves on hunter numbers into consideration when managing the wolf population since Sweden's wildlife management is largely based on hunter participation.

Moose bag

This study suggests a significantly less positive development of annual moose bag in the wolf area compared to the wolf-free area in the four last years of the studied time period. This suggests that there may be additional factors affecting the development in the wolf area and thus giving rise to the difference between the two areas, the wolf is such a possible additive factor. The moose population has declined since the 1980's as a consequence to changed management strategies (due to e.g. an increase of forest damage and traffic accidents) (Anonymous 2006), however from 2008/2009 the negative trend has turned around and the population is now increasing (Kindberg et al. 2009). When testing the relationship between the size of the moose bag and the growing number of wolves I found that the variation in moose bag could to some degree be explained through the growing number of wolves, however other factors are clearly also affecting this relationship (e.g. changes in management goals and harvest strategies). According to Nilsen et al. (2005) wolves can have a negative

effect on moose numbers on the local scale if the harvest strategies are not adjusted for carnivore presence.

Despite of the generally lower degree of explanation on the municipality level some counties in the wolf-free area are showing strong relationships. The reason for these high degrees of explanation of the relationship in the counties of Södermanland and Uppsala (i.e. wolf-free area) may be explained by increasing numbers of other deer species with a decline of the moose population as a consequence due to competition, in those counties. Moreover, the number of harvested moose in these counties is quite small (approximately 1,000 moose) which means that small variations between years in the number of harvested moose may have a relatively larger impact on the relationship (number of wolves and moose bag) in these counties than in counties with a larger annual moose bag (e.g. Västerbotten approximately 14,000 moose is harvested each year; *Figure 2*). The results do not suggest that wolves have had a greater effect on the number of harvested moose yet, however the results indicates that the relationship is stronger on a municipality level than on a county level. Furthermore the data from the county of Norrbotten appeared incorrect; therefore I used data provided directly from the County Administration Board of Norrbotten. This fact raises concerns on how good the quality in the VILTDATA database is, a poor quality have the potential to affect my results from analyzing this variable.

The moose hunting event is (as mentioned earlier) of great cultural value in rural Sweden, probably the most important happening of the year in some places (Skonhoft 2006). The interest is affected by wolves through competition for moose and fear of attacks on hunting dogs (Skonhoft 2006). This implies that the presence of wolves could have an effect on the recreation value of moose hunting through creating an association with worrying and fear (i.e. due to potential dog attacks) along with this activity, disturbing its value as the most important activity during the year. Hence such a switch from moose hunting being the most valued activity to being associated with feelings of fear could result in the wolf becoming a symbol of all this negativity, although (in general) the species occurrence does not have any greater effect on the number of harvested moose. However wolves killing dogs will probably be a great problem because of all the emotion involved even though the number attacked and killed dogs generally is not very high. Hunters invest a lot of time and money in their hunting dogs and the relationship with their dogs is very strong; many hunters regard the companionship with their dog during the hunt as more important than to just killing a prey (Skogen & Kränge 2003). The common practice of moose hunting with unleashed dogs is considered as non-feasible nowadays in wolf areas due to the risk of predation (Skogen & Kränge 2003). Consequently the loss of this type of moose hunt with dogs is a sensitive and upsetting issue (Skogen & Kränge 2003). Moose hunting effort and the tradition of using dogs in the hunting activity is therefore probably to some degree affected by the fear of losing hunting dogs which makes dog owners less willing to use dogs in hunting activities. Without the dogs the hunting is harder and less efficient which can affect the hunting success, and may lead to a decrease in the number of harvested moose although moose is not solely hunted with dogs. Since the fear of losing hunting dogs to wolf predation may act to lower the recreational value of the hunting activity it could in the end have an effect on the general hunting interest

and hunting participation (i.e. number of sold hunting licenses). Ultimately, this could have consequences for both forestry as well as traffic safety since the moose population will increase (and thus cause damages, as mentioned earlier) if there are too few hunters available and willing to reduce and keep the population at an appropriate level.

Forest holdings

I found no difference between the development of average purchase prices of forest holdings between the wolf area and the wolf-free area; however the prices are generally higher in the wolf-free area during the studied time period. The lack of difference in the price development between the two areas indicates that the same overarching factors are affecting both areas in similar ways (e.g. timber prices, interest rate: Anonymous 2012) and that no adding factor have a significant effect on the price development in either one area over the other. Total prices of forest holdings include a number of factors e.g. timber prices, interest rate, economic situation, hunting rights, recreation value and the perception of owning (Anonymous 2012). Of these, the factors that possibly could be affected by wolf occurrence are the hunting rights, mostly due to lesser valued hunting grounds because of moose predation and the risk of dog attacks, and also other recreation activities (e.g. berry-picking and hiking) because of fear for pet and human safety. However since the soft values of hunting, recreation and the perception of owning a forest holding is increasingly important for the total prices of forest holdings (Anonymous 2012), there might be a difference in the price development of the two areas in the future if the wolf population continues to increase in numbers. Hence since there is no significant difference in the price development between the two areas, the occurrence of wolves probably do not affect forest holding prices today. However it is possible that it still may have a local effect, especially on the leasing prices of private hunting grounds (if both moose and carnivores are present) where private forest holding owners lease their forest land with hunting rights to other hunters. The leasing prices of hunting grounds are not covered within the scope of this study; however I suggest that they should be investigated in the future. Even though the wolves do not affect the price development of forest holdings as it is now, it could potentially be of benefit in the future either not having wolves at all or having a low risk of re-colonizing wolves in close proximity to one's holding. In this way absence of wolves could thus become an asset for landowners and increasing the market price of the holdings without carnivore presence. Interesting is that during most of the years in the studied time series the prices of the forest holdings in the wolf-free area is significantly higher than in the wolf area, suggesting that the holdings outside of the wolf area is generally more valuable. This development is most likely not affected by the wolves per se, however it is occurring parallel to the wolves return, implying that in the debate wolves may take the blame for the lesser positive value of forest holdings in the wolf area compared to the wolf-free area. Thus wolves become a symbol of lesser positive price development in the wolf area, even though they are not having an actual effect on this variable.

House sales

The average purchase prices are significantly higher in the wolf-free area compared to the wolf area during the whole time series, implying that houses are valued higher in the wolf-

free area. I did not find a significant difference in the development of house prices between the areas when considering the total time series. This indicates that the same overarching factors are affecting both areas in the similar ways and the lack of an adding factor that significantly affects one area more than the other. However when testing for differences in individual years I found a faster positive development of house prices in the wolf-free area compared to the wolf area and furthermore, this difference seems to increase in magnitude in the latter part of the time series (*Figure 7*). Price development of real estate's partly reflects people's willingness to pay to live in a certain location (Bjerke et al. 2012) and since wolves may affect the factor of fear of pet and human safety when it comes to houses (very few people generally speaking are affected with direct predation; Karlsson & Sjöström 2007), the direct effect of wolves on prices is probably low in general. Other factors are instead playing a more important role in the price development of houses (e.g. interest rate and conjuncture; Anonymous 2008B). However the factor of fear could have a local effect, e.g. when choosing between two houses at two different locations the occurrence of wolves may be a determining factor for choosing one house over the other assuming all other factors equal. Or the other way around, some people perhaps prefer to live in an area with wolves rather than without wolves. This effect is likely very small (or balanced, dependent on peoples preferences) and will hence not affect the general price development of houses as it is today, with the actual number of wolves. However the effect might be greater if the number of wolves would increase significantly in the future, even though this is not very likely because of the controversy surrounding this species. What is the most interesting aspect considering house prices is that the stronger and more positive development of the prices in the wolf-free area is an indication of urbanization, i.e. that there are generally more job opportunities and more attractive to live in more urban than rural areas which are experiencing less positive development (Bjerke et al. 2012). Lesser positive development in house prices in specific areas are affecting the growth of population density negatively in those areas (Bjerket et al. 2012). Wolves are most likely not affecting the price development of houses, however once again the return of this species is occurring parallel to the more positive development in urban areas, likely making the wolf a symbol of negative development in rural areas, even though it is not actually affecting this development.

Socioeconomic development and the wolf as a symbol

My results reveal a negative development of population density in the wolf area whilst a slightly positive development in the wolf-free area. The faster decrease of population density during most years in the wolf area indicates a more severe loss of population in this area while the population is increasing in the wolf-free area. *Figure 8* is visualizing an increasing difference between the two areas over the years and that the largest difference is found in the last time step of the times series, which therefore indicates that this trend will continue in upcoming years. People will thus move from rural areas to more urban areas, this urbanization trend is consistent with the literature (Antrop 2004; Kolmodin et al. 2009). The average income level is higher in the wolf-free area compared to the wolf area throughout the studied time period. I did not find a significant difference in the development of income between the areas, although the increase in the wolf-free area in the latter part of the time period is

significantly higher indicating that the difference between the areas is increasing and the trend is likely to continue in the future and lead to a bigger gap in income between the areas. A weak increase of average income in rural areas compared to urban areas may possibly cause a weaker growth potential in the future (Bjerke et al. 2012). There is no significant difference in the development of percentage of people with higher education between the wolf area and the wolf-free area. However there are a significantly higher proportion of people with higher education in the wolf-free area compared to the wolf area throughout the time series. Even though there is no difference in the actual development of proportion of people with higher education level, a lower proportion in the wolf area indicates fewer well-paid jobs since high paid jobs often require a higher education levels, which therefore have implications for income level (Bjerke et al. 2012). People are generally older in the wolf area, indicating that people tend to move from that area. There is a higher proportion of unemployed people in the wolf area compared to the wolf-free area throughout the studied time series except for the two last years. This result indicates that there has been a more negative development considering this variable in the wolf area compared to the wolf-free area; however the difference decreased over the time period and ended with a non-significant difference in the end of the period. Even though the proportion of people that are unemployed do not differ between the two areas in the last time step, people living in the municipalities with higher unemployment previous years may still identify themselves with the past situation. In summary, a generally less positive, and for some factors even negative development in the wolf area (and the strong symbol value of carnivores; Kleiven et al. 2004) suggests that wolves become structural symbols of negative socioeconomic development even though the species per se do not cause this development. Wolves' return is coincidentally occurring simultaneously to this urbanization trend in Sweden.

Ranking system

The generally positive development in the wolf-free area is based on the large proportion of urban areas compared to the wolf area. However, there are municipalities in the northern part of the wolf-free area with even worse socioeconomic development than any municipality in the wolf area (*Figure 13*). Furthermore the highest number of moose is harvested in the northernmost counties (*Figure 2*) and the proportion of hunters is also highest in the northern counties (Swedish Environmental Protection Agency 2012). Also relevant in the northern counties is the problem with wolf predation on reindeers which is a huge issue (Anonymous 2013D) although not covered in this study. Thus based on this reasoning the wolf debate would probably be equal or even more severe in the northern parts of the country (than in the current wolf area) if wolves were allowed to establish there. However as it is today with the current carnivore policy (e.g. not allowing wolf establishment in the reindeer husbandry area; Anonymous 2013D) it is not very likely that wolves will establish in municipalities in the north. More relevant is probably the high risk of wolves spreading further south to municipalities with a poor socioeconomic situation (*Table 5*) e.g. municipalities in the counties of Kalmar and Västra Götaland (of which the latter already has wolf establishments). The question is: will the debate be as vivid and fierce in these municipalities and will the wolf be blamed for the negative socioeconomic development in these areas and act as a symbol of

this negative situation, even though wolves are not the cause of this development (since it is occurring prior to wolf establishment)? According to this study one would expect a strong debate and a fierce resistance to wolf occurrence if it were to colonize these areas. This study has thus pointed out areas which are subjected to poor socioeconomic development and due to the social factors effect on conflict intensity, these areas should be prioritized for mitigation measures of wolf consequences in the future, if wolves spread to those areas, which seems fairly likely. Because, as previously mentioned, the reduction of human-wildlife conflicts is essential to successful carnivore preservation (Linnell et al. 1996).

Conclusions

In this study I have examined some of the most highlighted fears concerning wolf occurrence on important economic interests and cultural values in Sweden. It is the local documented direct effects and fears of increasing consequences that dominates the wolf debate in the media. The results of this study do not support the magnitude of fears expressed in the recent wolf debate concerning the effect on the sheep farming industry and forest holding prices. However this study suggests that wolves may be an adding factor amplifying the already occurring general decrease of number of sold hunting licenses. Furthermore the results suggests that wolves may be a factor affecting the moose bag in the wolf area, although the weak relationship indicates that other factors are also affecting and explaining this relationship. It is not likely that wolves are driving the faster positive development of house prices in the wolf-free area because of the probably very local effect on prices. The wolves' re-colonization is occurring parallel to urban growth which is more likely the driver of negative socioeconomic development in rural areas since positive socioeconomic development is an indicator of urbanization (Antrop 2004). I found evidence that socioeconomic factors are probably affecting the intensity of the wolf debate (consistent with previous literature; Dickman 2010) due to the generally lesser positive socioeconomic development in the wolf area, and the according to Svensson et al. (2012) generally small number of predation events so far in Sweden which affect only a limited number of people. Urban growth not only infer that the general socioeconomic development turn lesser positive in the countryside; local cultural values and traditions like hunting participation is negatively affected through weak rural communities (Heberlein et al. 2002). Declining hunter numbers and hunter availability may influence many aspects of the wildlife management in Sweden through e.g. decreasing funds (which affect both management and research since parts of both are funded through hunting licenses; Anonymous 2013B) and lesser available resources for countering wildlife damages. Numbers of people share the view that the current carnivore politics add to the already occurring marginalization of rural communities (e.g. through promoting population declines because of hardships that entails carnivore presence) (Sjölander-Lindqvist 2009). Therefore promoting a positive rural development is needed if the goal is to protect and preserve local rural cultural traditions (e.g. considering hunters and sheep farming). Negative socioeconomic development affect people's well-being (Watson et al. 2010) and the future prosperity of communities (with including important local cultural values and traditions), therefore it is natural to use a present object which is perceived as threatening to these values as a scapegoat. In that way, because predators are strong and

unambiguous symbols (Kleiven et al. 2004), and the underlying social factors able to affect the intensity of a conflict (Dickman 2010) wolves in this case become a structural symbol of negative socioeconomic development and thereby enhancing the intensity of the negativity in the wolf debate in Sweden. Moreover this study has pointed out areas which are subjected to poor socioeconomic development (*Table 5*). These areas should be prioritized for conflict mitigation measures in the future if wolves will spread to those areas and if the central aim is to promote long-term viable wolf population. Thus, in Sweden with today's limited number of predation events, are social factors a more important driver of the wolf conflict than the actual number of predation events?

Management challenges

The wolf controversy is about how we perceive our surrounding natural resources and how they should be utilized, not just about the wolves per se (Sjölander-Lindqvist 2009). There are diverging perceptions on how we should use the landscape (Sjölander-Lindqvist 2009); should we promote conservation efforts, local traditions or cultural heritage? Is it possible to promote all interests at the same time? Consequently these differing perceptions create conflicts over how we ought to make use of the available resources. Since Sweden is obligated to follow the EU Habitat Directive which are promoting different interests (e.g. small-scale farming and long-term viable carnivore populations; Sjölander-Lindqvist 2009) it is a conflict between conservation efforts and preserving local cultural heritage for which different interest groups are expressing their strong opposing views in the media. Consequently the wolf policies and management is an enormous challenge for being accepted by differing interests, and the options how to manage the wolf population is not straightforward due to the complexity of the controversy and legislation. However, the reduction of human-wildlife conflicts is essential to successful carnivore preservation (Linnell et al. 1996). It is most likely not feasible to eradicate the wolf population in Sweden again, due to e.g. the EU and Swedish legislation and lobbying of environmental organizations. Therefore to mitigate the current conflict it is important to make the occurrence of wolves as a positive addition to the Swedish fauna (considering the problems it entails to different interests; Zimmermann 2001; Heberlein & Ericsson 2008), and not only as an animal threatening many important economic, recreational and cultural interests. This study shows that the interest for hunting is probably affected by wolves and therefore it is important to focus on this interest group since it influences the whole wildlife management in Sweden. Considering hunters wolves could be an available game species through a license hunt, since they tend to manage available game for long-term occurrence (Heberlein & Ericsson 2008). However since the genetic situation is so unfavorable (e.g. Liberg et al. 2005; Chapron et al. 2012) and due to the EU Habitats Directive (Anonymous 2008B) and Swedish legislation (Anonymous 1987A, B) it is not an easy task to remove individuals through a legitimate hunt, other than with the purpose of protecting private property through a protective hunt. On the other hand, if the wolf population is allowed to increase in numbers (and improve the poor genetic situation; Liberg et al. 2005) to legitimize a license hunt, one risks e.g. increased predation pressure on livestock. Or, if moose are allowed to increase in numbers (particularly in wolf areas) to make up for the predation loss, one risks increasing browsing damages. More

available solutions are e.g. as previously mentioned utilizing the carnivore resource in tourism which may create job opportunities in local areas (Zimmermann 2001), however this might compete with already established moose tourism which already brings benefits to local areas. Concluding this section, managing wolves is a complicated matter with as many solutions as problems.

Recommendations for future research

The wolf conflict and management is clearly both a biological and sociological issue and collaboration between social science and natural science is crucial for the success of wildlife management of a controversial species like the wolf. This study contributes with more support on how important social factors are in influencing conflict intensity and studies similar to this should be conducted in more areas where carnivores have returned and causes conflicts. It is of benefit to know drivers behind the conflicts when designing and implementing mitigation measures. Therefore, it is not enough to work with only mitigation measures for direct predation, one have to deal with the promotion of rural communities as well to promote local culture and tradition which probably will increase tolerance for wolves. Furthermore regarding specific economic interests and recreational and cultural values it might be of interest to investigate e.g. if wolf occurrence plays a role in making people quit their sheep holding practice on a local level (due to mostly emotional reasons), if wolf occurrence affect the leasing prices of hunting grounds (included in forest holdings) on local levels and how to make wolves a valuable addition to the Swedish fauna (e.g. potential conflict between carnivore and moose tourism); all to promote a long-term viable wolf population which is the current wolf policy in Sweden.

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