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PhD-thesis

Attitudes towards large carnivores and acceptance of illegal hunting
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The importance of social attitudes and scales in large carnivore management

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Forord

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Tusen takk, mamma, Jonas og Tord! Tusen takk, Harry og Bjørn Petter! Tusen takk alle sammen!

Tord og Jonas med gaupeunger (2006). Photo: Lars Gangås

Kristin E. Gangås
Evenstad, Mai 2014

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Sammendrag

Over hele verden har det vært en tilbakegang i bestandene av store rovdyr. Mye av denne tilbakegangen skyldes konflikter med mennesker og menneskelige aktiviteter. Fra Skandinavia kjenner vi spesielt til konflikter mellom jordbruksnæring og rovvilt som tap av bufe, konflikter mellom jegere og rovvilt når rovviltet dreper jaktbart vilt, eller mellom jakthundeiere og ulv hvor jakthunder blir drept av ulv.

Konfliktene vi ser her i Skandinavia er i stor grad de samme som i andre deler av verden, med ulv i Nord-Amerika som tar krøtter, puma og grizzly som tar hjortevilt, eller tiger og snøleopard i India og Nepal som tar geiter og bufe. Likevel er det slik at når en spør folk flest, enten det er i Skandinavia eller andre deler av verden så ønsker de aller fleste å ta vare på rovviltet slik at artene ikke skal utryddes. Samtidig sier de samme menneskene at de likevel ikke ønsker å bo der disse rovviltartene etablerer seg. Slike spørreundersøkelser gjennomføres demografisk, hvor høyt befolkede områder som byer og tettsteder er hovedrepresentert og svarene er derfor representative for et lands flertall.

I denne avhandlingen har vi vært nysgjerrige på om slike holdninger kan variere geografisk, og vi har derfor spurt et likt antall folk i hver kommune gjennom hele Skandinavia om deres holdninger til rovvilt. I tillegg har vi data på hvor rovvilt er etablert, hvor mye bufe som er tatt i de ulike områdene, og hvor mye storvilt som er skutt under jakt. Vi kan derfor se om det er geografiske ulikheter i folks holdninger og om disse varierer mellom områder med rovvilt, sau eller tradisjoner for storviltjakt. Vi har også målt folks miljøholdninger, og kan sammenlikne holdninger til rovvilt med andre miljøholdninger.

Vi fant ingen sammenheng mellom folks holdninger til rovvilt eller generelle miljøholdninger og om det faktisk var rovvilt tilstede eller om de hadde opplevd tap av sau. I stedet fant vi en mer negativ holdning til rovvilt i områder som har sterke tradisjoner for storviltjakt eller har store mengder sau på beite uavhengig av om det er faktiske tap av sau eller ikke. Det var også større miljøvennlige holdninger blant de svenske respondentene enn hos de norske.

Videre har vi sett på hvordan årsaker til ulovlig jakt fordeler seg globalt. I Sør-Amerika drives det utstrakt levendefangst for ulovlig salg til dyrebutikker og kjæledyrindustrien verden over, mens i Asia jaktes dyr ulovlig i større grad for salg til legemiddelindustri. I Afrika skytes dyr ulovlig for bruk av mat, eller det jaktes elefanter og nesehorn for å tilfredsstille den vestliges verden etterspørsel etter elfenben. I Europa er ulovlig jakt knyttet til blant annet troféjakt eller ordinær jakt hvor dyr utover den lovlige kvoten blir tatt, eller relatert til tap av bufe. Det er selvsagt ikke absolutte grenser mellom årsakene til hvorfor ulovlig jakt oppstår, men det viser at det er stor variasjon i årsakene til ulovlig jakt. Det kreves ulike globale og lokale tiltak for å håndtere ulovlig jakt.

Å forvalte arter som rovvilt krever store arealer for at de skal ha muligheten til å kunne utvikle seg til levedyktige bestander, men i dette ligger det store utfordringer i å avsette områder hvor ikke mennesker og rovvilt kommer i konflikt med hverandre. Det er også en utfordring når spørreundersøkelser viser at 80 % av den generelle befolkningen sier ja til å ha

rovvilt i sitt land, men de kanskje ikke vil ha rovdyr etablert der de selv bor. Vi ønsker med denne undersøkelsen å vise at optimale områder for rovvilt ikke nødvendigvis baserer seg kun på naturlig egnede leveområder, men at folks toleranse for rovvilt også vil ha stor betydning i bestemmelsen av hvor forvaltningen bør legge til rette for fremtidens rovviltområder. Avhandlingen viser også at store forvaltningsområder, for eksempel på tvers av landegrenser, er konfliktskapende.

Abstract

Human population growth is escalating, threatening the conservation of wildlife and natural wildlife habitats as we face a growing demand for natural resources and areas for human land use. Wildlife managers cannot focus solely on ecological issues when managing wild species, but have to include humans in their decision making. Moreover, they have to deal with social perspectives such as local cultural traditions, people's acceptance of wildlife species and historical experience with wildlife in their landscape use.

In this thesis I have used geographical stratified sampling to map people's attitudes towards large carnivores, people's environmental value orientation, and the potential social conflict between people with regard to their acceptance of illegal hunting of carnivores. I have done this on a spatial scale related to predictors that have been shown to affect people's tolerance of carnivores. These include the distribution of carnivores, livestock farming and local hunting traditions. I have also reviewed the literature to see how illegal hunting differs globally between continents, both in what motivates illegal hunting and how the species exploited vary between continents. I have also studied how scaling in social sciences is not always well matched with ecological scaling, and discuss how management decisions made at a scale that suits public opinion, does not necessarily benefit ecological sustainability.

I found no correlation between carnivore presence and attitudes towards carnivores. Acceptance of illegal hunting was higher in areas with rural social values associated with big game hunting and free ranging sheep grazing. The potential for social conflict showed a positive correlation with the acceptance of illegal hunting and was highest in areas with intermediate human population densities. Respondents with pro-environmental values revealed a lower acceptance of illegal hunting and greater tolerance of carnivores than people with a more negative environmental value orientation.

There were clear spatial differences in the motivation for illegal hunting. Recreational Hunting and Harvesting was found to be the most commonly reported rationale for illegal hunting within all continents except Africa and Latin America. Trade was the second most reported rationale and associated with areas containing high biodiversity, while Bushmeat tended to be most common in continents with low Gross Domestic Product (GDP). Herbivores were the most reported species exploited illegally in all continents, generally followed by carnivores, while the exploitation of fish, sea mammals, primates and birds differed to a much greater extent, both between continents and with rationale.

When discussing the expressed mismatch in the spatial scale of ecological processes and social structures, my results show that certain attitudes are related to local spatial scales (e.g. feelings of fear), while tolerance to carnivores in general was associated with a broader scale (national level). For large carnivores it would be ecologically preferable to establish a common Scandinavian management model, but this has the potential to exacerbate social conflicts.

My work contributes to an increased understanding of how human's acceptance of wildlife, together with an awareness of the social and ecological scales, should be taken into account to ease conflicts in wildlife management. This may enable better conservation of species and habitats in the future, not only when it comes to large carnivores on the Scandinavian Peninsula, but global wildlife management in general.

1. Background

The spatiotemporal distribution of species is driven by ecological factors such as the distribution of suitable habitats, access to mates and food availability (Morris 2011). It has become obvious that humans also affect ecological processes and patterns, dramatically threatening biodiversity due to direct exploitation, habitat destruction, introduction of alien species, spreading of pathogens and the discharge of environmental poisons or emissions causing climate change (Dirzo & Raven 2003; Hoffmann *et al.* 2010; Barnosky *et al.* 2011). According to Dirzo and Raven (2010), exploitation, in terms of hunting, harvesting, lethal control, trade and collection, is the second largest threat to conservation of species following habitat destruction. It threatens 47 %, 34 % and 8 % of the birds, mammals and plants registered in the IUCN red list.

Human impact is quite obvious with regard to the threats facing the abundance of large carnivores. Ecologically their populations are regulated by prey availability, intra-guild competition and self-regulation (see Andreassen, Wegge & Neo-Muhapeleng 2014 and references therein). As carnivores are the top trophic level of food webs, they have large space requirements (Linnell *et al.* 2001; Persson, Wedholm & Segerstrom 2010; Mattisson *et al.* 2013) which complicates their management, as, for instance, they easily move outside protected areas (Ripple *et al.* 2014), creating conflicts with humans (Woodroffe & Ginsberg 1998). The most typical conflicts between carnivores and humans arise in areas where farmers experience depredation of livestock (Goldstein *et al.* 2006; Holmern, Nyahongo & Roskaft 2007; Kaartinen, Luoto & Kojola 2009), hunters experience competition for game species (Andren *et al.* 2006) or loss of hunting dogs (Kojola & Kuittinen 2002; Treves *et al.* 2009), or where local people face a risk of being killed or injured by carnivores (Goodrich *et al.* 2011; Liu *et al.* 2011). Additionally, there is a socio-political component that challenges the co-existence of humans and carnivores. Some perceive the existence of carnivores as representing a political provocation against local self-government and a feeling of being overruled by central authorities that are managing and conserving large carnivores (Skogen, Mauz & Krange 2006). The consequences of these conflicts complicate carnivore management as they lead to an increased acceptance of lethal retaliation through the legal or illegal killing of carnivores (Holmern, Nyahongo & Roskaft 2007; Ambarli & Bilgin 2008; Kissui 2008). Illegal killing of large carnivores has been estimated to account for 46 – 60 % of all registered mortality of large carnivores such as the lynx *(Lynx lynx)*, wolverine *(Gulo*

gulo) and wolf *(Canis lupus)* (Andren *et al.* 2006; Persson, Ericsson & Segerstrom 2009; Liberg *et al.* 2012) in Scandinavia. It thereby represents one of the most severe consequences of human – carnivore conflicts. Therefore human activity has to be taken into account when identifying suitable habitats of species that conflict with humans. In particular, people's tolerance for dealing with problem animals is crucial for conserving species in areas where these animals conflict with human interests (Thornton 2009; Treves 2009).

Many countries in Europe and other parts of the World are currently striving to develop carnivore management policies that are perceived as socially acceptable by large segments of the public (Chapron *et al.* 2003). This has led to a wide array of surveys asking people whether they can accept large carnivores, under what conditions they can accept large carnivores and within what distance of their homes people could accept the establishment of carnivores (Bjerke, Odegardstuen & Kaltenborn 1998; Williams, Ericsson & Heberlein 2002; Zimmermann, Walpole & Leader-Williams 2005; Treves & Martin 2011). Most people respond positively to environmental conservation initiatives that they believe are positive to society as a whole, but tend to oppose initiatives that require the establishment of conservation efforts where they themselves live, a phenomenon known as NIMBY-ism (Not In My Back Yard) (Lidskog & Elander 1992). This NIMBY effect is reflected in attitudes toward carnivores as e.g. 73 – 87 % of Norwegian residents are positive to questions like "Do these species have a right to exist in Norway?", but less than 40 % accept having carnivores closer than 10 km to where they themselves live (Zimmermann, Wabakken & Dötterer 2001; Roskaft *et al.* 2007). A Finnish study showed that people living in wolf areas were less afraid of wolves compared to people living outside wolf areas, but they were not more positive to the establishment of wolves (Bisi *et al.* 2007). In Wisconsin, Treves et al. (2013) repeated a survey carried out in 2001 and 2004, and found that residents' attitudes toward wolves became more negative after they had been living with wolves for a period of 5 – 8 years. As the wolf population increased, people became more negative to the close vicinity of wolves, a situation that also led to an increased acceptance of killing wolves both legally and illegally (Treves, Naughton-Treves & Shelley 2013).

The studies mentioned above show how attitudes towards large carnivores change in relation to the vicinity of and exposure to carnivores. Due to the rather patchy distribution of large carnivore populations, we may expect that humans with specific attitudes to the environment and carnivores would have a spatial distribution associated with the carnivore presence.

Hence, I mapped the geographical distributions of a typical social response (i.e. environmental attitudes and attitudes towards carnivores) by using methods commonly used in the natural sciences. The human–carnivore system is a particularly good model to study attitudes associated with the geo-spatial distribution of human-wildlife conflicts, as attitudes towards carnivores are strongly polarized, and because the presence of carnivores and the human-carnivore problems vary spatially.

2. Aims and concepts

2.1. The Aim

The overall aim of this research project is to contribute to the sustainable management of biological resources including large carnivores. In such a context, my contribution is on the spatial scale of socio-ecological aspects of sustainable management.

More specifically I focus on the following questions:

1) Attitudes: How do geographically explicit descriptors (e.g. presence of carnivores) correlate with attitudes towards carnivores (Paper I) and environmental value orientation (II), with special emphasis on illegal hunting (Paper I, II and III)?
2) Spatial scale: How well does the size of management units fit the spatial scale of ecological and social processes (Paper IV)?

The literature indicates that the presence of large carnivores and socio-cultural traditions affect attitudes toward carnivores. Such attitudes may also be related to more general environmental value orientations. I therefore expected that attitudes towards large carnivores and other environmental issues would vary spatially, in accordance with the presence of carnivores or the history of large carnivore establishment.

2.2. List of papers

The following thesis consists of the four papers described below.

Paper I: Gangaas KE, Kaltenborn BP, Andreassen HP (2013) Geo-Spatial Aspects of Acceptance of Illegal Hunting of Large Carnivores in Scandinavia. PLoS ONE 8(7): e68849. doi:10.1371

Paper II: Gangaas KE, Kaltenborn BP, Andreassen HP (2013) Environmental attitudes associate with large-scale cultural differences, not to local environmental conflicts (In press Environmental Conservation)

Paper III: Gangaas KE, Kaltenborn BP, Andreassen HP (2013) Global differences in the motivation for illegal hunting (Submitted Conservation Biology)

Paper IV: Andreassen HP, Gangaas KE, Kaltenborn BP, (2013) Matching social-ecological systems by understanding the spatial scale of environmental attitudes (Submitted Biological conservation)

In the first paper (Paper I), my colleagues and I looked at how attitudes towards large carnivores associate with spatial variables such as the presence of carnivores or livestock farming, represented by free ranging sheep and the number of sheep killed by carnivores. Since problems with carnivores have also been shown to associate with local hunting traditions (Skogen & Krange 2003), we included the spatial distribution of big game hunting as a predictor. Previous studies have also shown that demographic variables are important in understanding the variation in attitudes. Younger people with higher education show a greater willingness to conserve species and accept large carnivores than elderly and less well educated people (Williams, Ericsson & Heberlein 2002; Røskaft *et al.* 2003; Roskaft *et al.* 2007).We therefore included the following demographic variables as covariates in our models: gender, age, education level and income. Additionally we looked at the extent to which there was a disagreement between people in their acceptance of illegal hunting, by using the Potential Conflict Index (PCI; Manfredo 2003) to map any potential social conflict.

In the second paper (Paper II), we looked at how people's environmental value orientation could predict attitudes (e.g. willingness to kill carnivores illegally to prevent carnivore establishment) towards carnivores, which in turn was expected to predict certain behaviour. We expected that people with an ecocentric value orientation would have higher acceptance

of carnivores than people with an anthropocentric value orientation, while willingness to illegally hunt would associate with anthropocentric environmental values. However, due to the NIMBY effect described above, we also expected that even ecocentric people who might be positive towards large carnivores in general, would not accept carnivores close to where they were living (Paper II).

The motivation for illegal hunting of carnivores in Scandinavia has been shown to be strongly related to local political opposition to central authorities (Skogen 2003; Skogen & Krange 2003). Muth and Bowe (1998) reviewed the literature on illegal hunting in North America and emphasized how local culture and people's traditions were important factors in understanding the motivation for illegal hunting. They also described how these factors were the driving forces of the different typologies of illegal hunting, something that is also described more recently in the literature (Muth & Bowe 1998; Bell, Hampshire & Topalidou 2007; Kuhl *et al.* 2009). In the third paper (Paper III), we reviewed the scientific literature relating to illegal hunting from across the world to see whether Muth and Bowe's (1998) categories of motivations for illegal hunting were valid worldwide.

The fourth paper (Paper VI) discusses the spatial scale at which the variance in environmental attitudes is highest. If the variance is highest at a local scale we may expect that attitudes are created at a fine grained spatial scale, e.g. within the household. If the variation in attitudes is highest at larger scales, e.g. between nations, we expect that national or political cultures are the basis for attitudes. We expected attitudes connected to local changes in environmental conditions (e.g. the presence or recolonization of specific carnivore species) to have the highest variation at a local scale (e.g. NIMBY effect at municipality level), attitudes towards carnivores in general (i.e. no specific species) to have the highest variation at an intermediate scale (e.g. county), and attitudes expressing environmental value orientations based on values and beliefs to have the highest variation at the largest spatial scale, e.g. at a national level. We argue that it is important to understand at what scale social responses are formed in order to fully understand environmental management. Furthermore management units of the same spatial scales as the scale with the greatest variation in attitude are prone to create conflicts between management and the public.

2.3. Human dimensions of large carnivores

As a result of the increased interactions and confrontations between humans and wildlife (Morzillo *et al.* 2007), the social sciences have been given a more important role in wildlife research and management often referred to as *human – dimensions of wildlife* (Manfredo 2008). The term human – dimensions was first introduced in the 1970s, and expands the concepts of human – wildlife interactions to include wildlife tourism, non-consumptive use of wildlife, economic impacts and how wildlife could be valued beyond their traditional hunting or conservation value (Manfredo 2008; Manfredo, Teel & Henry 2009).

The topic of human dimensions explores the relationship between humans' social organization and cognitive abilities in an attempt to understand the relationship between humans and wildlife. Social sciences encompass many disciplines from anthropology and ethnology to sociology and psychology. In this study, I have used a cognitive approach rooted in social-psychology where human's perceptions of wildlife are shaped by values and attitudes and influenced by norms formed by social groups (Manfredo 2008).

2.4. Values, attitudes and norms

Values are part of the cognitive hierarchy together with norms and attitudes (see below) (Manfredo & Dayer 2004). Values are fundamental and achieved early in life and highly resistant to change (Bjerke & Kaltenborn 1999; Manfredo & Dayer 2004). In an attempt to understand the diversity of social interests, several constructs of values, attitudes and behavior have developed. Fulton et al. (1996) describes *wildlife value orientation* (WVO) and distinguishes between *wildlife protection orientation*, *wildlife use orientation* and *wildlife appreciation orientation* (Fulton, Manfredo & Lipscomb 1996; Manfredo & Dayer 2004). People who tend towards a wildlife protection orientation, appreciate wildlife without any wish to exploit them through hunting, fishing etc. while people tending towards wildlife use orientation believe wildlife should be exploited for human benefits (Manfredo & Dayer 2004). Teel and Manfredo (2010) further categorized people's wildlife value orientation (WVO) into *domination value orientation* and *mutualism*. Domination value orientation relates to Thompson and Barton's (1994) anthropocentrism, looking upon wildlife (or nature) to be utilized, while mutualism associates with a desire for companionship with wildlife (Thompson & Barton 1994; Teel & Manfredo 2010). These concepts correspond with what is described as environmental value orientation; ecocentric values (wildlife protection) and

anthropocentric values (wildlife use) (Thompson & Barton 1994; Bjerke & Kaltenborn 1999). None of these concepts are absolute categories, but should be treated as gradients. The perception of wildlife conservation based on wildlife value orientation is expected to vary spatially as these values are set early in life (Kellert 1993; Bright, Manfredo & Fulton 2000), and reflected in different norms and behavior, e.g. the different motives for illegal hunting worldwide. On the one hand, pre-industrialized societies tended to believe that nature and the surrounding environment influenced their fate, and that wildlife represented food or income as long as they had access to these resources (Manfredo & Dayer 2004; Brashares *et al.* 2011). Other societies may exploit natural resources due to cultural aspects being disconnected from a wildlife related concept (Tadie & Fischer 2013). Post-industrialized societies on the other hand, commonly believe that humans have to take care of the environment (c.f. climate change) and might find themselves in a situation in which wildlife can be both of economic interest, and also contribute to pleasure and an increased quality of life (Jelinski, Krueger & Duffus 2002; Manfredo & Dayer 2004; Macmillan & Phillip 2008).

In scientific terms, attitudes may be defined as people's evaluation of their surroundings referring to an object, issue or an event (Eagly & Chaiken 2007; Manfredo 2008). Attitudes consist of three interrelated components; an emotional component relating to affection for the object, a cognitive component consisting of beliefs and an intention that the attitude will lead to behavior (Manfredo 2008; Bohner & Dickel 2011). Attitudes are not necessarily based on knowledge, e.g. people either like or dislike the wolf, regardless of whether they know a lot about wolves or not (Heberlein 2012). The attitudes give roots to beliefs such as "I like the wolf because I believe wolves are important in ecological processes", or "I do not like wolves because I believe they will ruin my future opportunities for moose *(Alces alces)* hunting". On the basis of how the wolf is being evaluated (good or bad), people make up their mind how they will act towards the wolf. Attitudes, as opposed to preferences or opinions, tend to be rather stable as they are based on values and beliefs in complex structures that are difficult to break apart (Heberlein 2012). More specifically, structures where a person's basic life values correspond with an issue that is of great interest or relevance to them make attitudes rather stable entities. This stability of attitudes makes them important for several reasons. Firstly they can be used for measuring people's thoughts on specific objects. Secondly, there is a general perception that attitudes closely relate to behavior (Manfredo 2008; St John *et al.* 2012). The validity of the relationship between attitudes and behavior has historically been heavily discussed , but today, attitudes are looked upon as appropriate to predict behavior

(Manfredo 2008). There are of course situations in which attitudes are not associated with the relevant behavior as they evidently do not rely on each other. For example, attitudes are driven by emotions and not by knowledge (Manfredo 2008; Heberlein 2012). However, we might behave according to laws and expectations even though this conflicts with our beliefs and attitudes. There is still a common perception among managers, politicians and common people that attitudes can be changed by a cognitive fix (trying to change people's attitude by giving them information and increased knowledge), but this is less likely compared to changes in behavior (Heberlein 2012). So when can attitudes really predict behavior? According to scientific theory, this relies on the strength of the attitude. When attitudes are part of your identity and based on strong emotional feelings and beliefs, the attitudes will be more likely to predict a certain behavior (Manfredo 2008; Heberlein 2012). This makes extreme attitudes significantly better predictors of behavior compared to more moderate attitudes (Manfredo 2008).

While attitudes are individually based perceptions of an object (Manfredo 2008), social norms can be defined as group-held perceptions of what is acceptable behavior in social life (Manfredo 2008; Heberlein 2012). Social norms direct people's behavior as they give clear expectations of what is acceptable, and what is unacceptable within the group (Manfredo 2008). They contribute to the formation of sub-groups or communities based on similarities in values and common acceptance of how to behave (e.g. zero tolerance of killing threatened wildlife species) (Manfredo & Dayer 2004). Norms come with sanctions for those not following these rules or norms (Manfredo *et al.* 1999; Heberlein 2012), which can be everything from disapproval, lack of status within the group or exclusion from the group. These group-held expectations or group-held rules guide communities and may make them more homogenous and predictable (Manfredo 2008; St John, Edwards-Jones & Jones 2010; Heberlein 2012). Theoretical approaches used to interpret the complexity in social valuation of people's views of nature include the theory of Social Representation (Buijs *et al.* 2012) and the cognitive hierarchy model (Manfredo, Teel & Henry 2009). Social Representation conceptualizes commonsense knowledge and how different social groups come up with different terms used for collectively coping with novel situations, while cognitive approaches (e.g. environmental value orientation) focus on differences in opinions between individuals (Selge & Fischer 2011; Buijs *et al.* 2012).

In this thesis I have used the concept of environmental value orientations to interpret people's evaluation of wildlife.

This discussion illustrates that the concept of attitudes consists of complex structures, including, amongst others, basic value orientation. Hence, our estimates of attitudes towards illegal hunting of carnivores (Paper I) do not necessarily mean that illegal hunting will be committed. The actual behavior may, for instance, depend on whether or not there is a social norm in the area of high acceptance of illegal hunting and on people's basic value orientation. While in Paper I we study attitudes towards illegal hunting of carnivores, we study basic environmental value orientation and its connection to carnivore attitudes in Paper II. In Paper III we study the global differences in the motivation for illegal hunting, which is to some extent described by cultural differences embedding certain norms or socially acceptable behaviors.

2.5. Scaling

The understanding of sociopolitical influence is crucial for efficient management of carnivores and to reach an understanding of what is driving human-carnivore conflicts (Treves & Karanth 2003; Treves, Wallace & White 2009). Ecosystem management based on both ecological and social sciences is challenging because the processes studied by these two disciplines relate to different spatial scales. Here I only focus on the spatial extent (i.e. the size of the area in focus). In ecology the study area is often determined by the species and the level of organization studied (i.e. molecules, individuals, populations, ecological communities, ecosystems or landscapes, e.g. Wiens 1989; Gaillard *et al.* 2010; Figure 1). For instance, small mammals usually use smaller areas than large mammals, studies of individual plants generally require smaller areas than studies of individual moving animals, and the study of individuals require smaller areas than the study of populations.

Scaling in social sciences relates to individuals and groups of people and how these are organized in social structures that have a spatial dimension (Gibson, Ostrom & Ahn 2000; Cumming, Cumming & Redman 2006). Gibson et al. (2000) defined the following spatial levels of political jurisdictions: household, community, regional, national and international (Figure 2). Wildlife authorities may base some or all their management units at any of these spatial scales.

The same spatial levels may be used to describe the development of attitudes. Some attitudes may evolve within the household while others are confined to the norms of the nation (Figure 2). Attitudes developed within the household may vary considerably between households within the community and I expect these to be less stable than those attitudes that are common over larger spatial scales (e.g. for the whole nation).

The mismatch between social and ecological scales complicates management of natural resources as management often functions at a different scale from that of the ecological processes subjected to management interventions (Szaro *et al.* 1998; Cumming, Cumming & Redman 2006). The presence of carnivores at a local scale may cause conflicts not observed at a larger scale, c.f. the NIMBY effect; people accept carnivores in their country (large scale), but not where they themselves live (local scale). Furthermore, the sustainable management of large carnivore populations may require the management of areas much larger than the management unit selected to manage individual carnivores.

If management is adaptive it may change over time which then complicates the scaling discussion with temporal scaling. Here I will ignore temporal scaling, and only discuss spatial scaling related to ecological scale and the area required to maintain biologically sustainable populations of a given species. Biological sustainability increases with increasing area, but approaches an asymptote as the area becomes large enough to be inhabited by a substantial population that can avoid extinction due to environmental and genetic stochasticity. In Paper IV we compare the ecological scale with the social spatial scale at which various attitudes towards carnivores and the environment in general are developed (i.e. where the variance between attitudes is largest), and how the size of management units will be affected by these two scales.

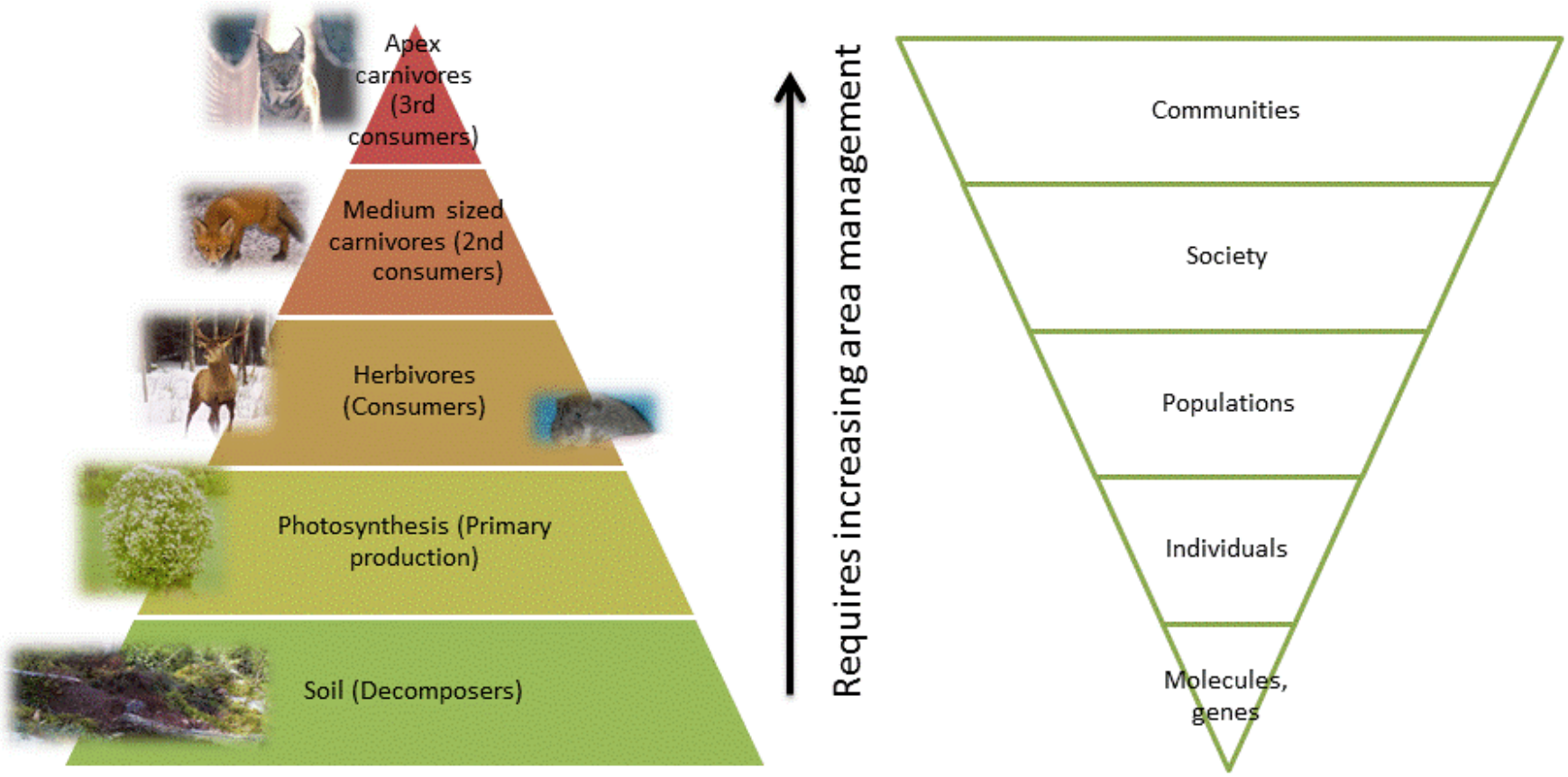

Figure 1. Ecological scales related to trophic levels and management scales organized in social levels. Area required for wildlife management increase the higher up in the organisation level you move.

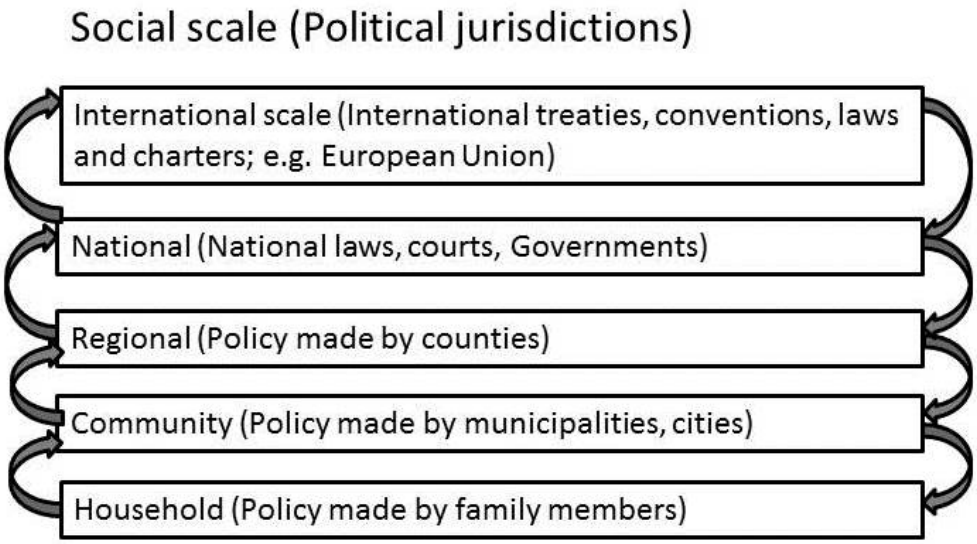

Figure 2. Social scale in relation to jurisdictional levels where decisions are made both in regard to ecological conservation and social concerns (after Gibson 2000).

3. Study area

3.1. The Scandinavian Peninsula

The questionnaire used in this thesis (Paper I and II) was conducted in Norway and Sweden which constitute the major part of the Scandinavian Peninsula (Figure 3). The Scandinavian Peninsula is connected to Russia in the most northern part of Norway and Finland eastbound. The most northern part of the peninsula is 71°N in Norway and the most southern point is 55°N in Southern Sweden. The northern part is characterized by tundra and a subarctic climate, and the western parts by a marine climate where the Gulf Stream keeps the coast free of ice. The southern and mid parts of the peninsula are characterized by large contiguous areas of boreal forest (boreal forest covers approximately 37 % of Norway and 53 % of Sweden) and a continental climate. Along the border of Norway and Sweden there is a mountain range which in general divides Norway from Sweden except from the most southern part where the mountain area is located on the Norwegian side.

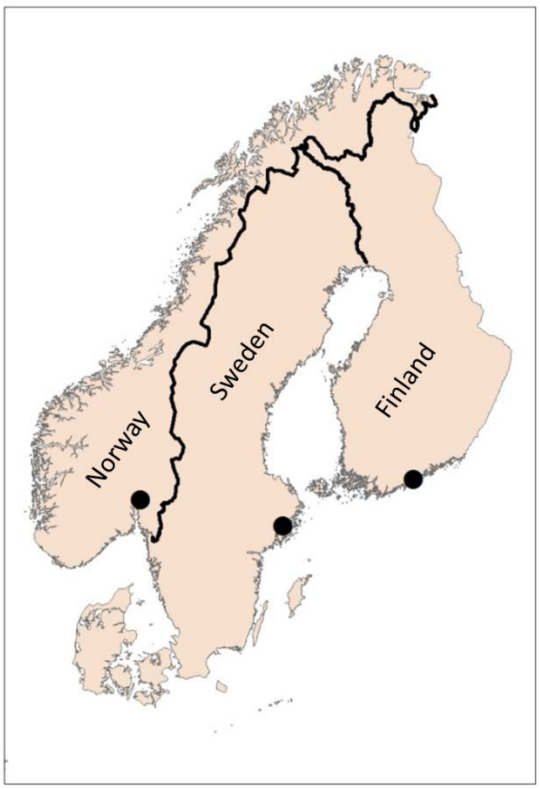

Figure 3. The Scandinavian Peninsula with the country boundaries and the capitals.

The size of the countries are approximately 385 000 km² (Norway) and 450 000 km² (Sweden), and only 3 % and 8 % of the land is cultivated in each country respectively (UN 2013; www.globalis.no).

More than 30 % of the area of Norway lies above or north of the forest border line. The human population size is approximately 5.1 million (18 person/km^2) in Norway and 9.4 (26 persons/km^2) million in Sweden (Statistics Norway; www.ssb.no, Statistics Sweden; www.scb.se), and 84 % of the human population is clustered around the cities in both countries (UN 2013; www.globalis.no). The rural population density is 2.9 persons/km^2 in Norway and 4.2 persons/km^2 in Sweden. Agriculture represents approximately 2.5 % in Norway and 3.2 % of the total employment in Sweden.

3.2. Management and politics

Norway and Sweden share responsibility for the Scandinavian populations of large carnivores: the wolf, brown bear (*Ursus arctos*), wolverine and lynx. Scandinavian carnivore conservation shifted from eradication and state bounties in early 1900 (Linnell *et al.* 2010), to

total protection by law and subsequently to the current year-to-year regulation by hunting quotas and adaptive management (Ericsson *et al.* 2004; Bull *et al.* 2009). In Sweden the brown bear was already protected in 1913 and the lynx in 1927 (www.artfakta.se), while in Norway all the carnivore species were protected by law in the 1970s (Swenson *et al.* 1995). As a result of successful protection efforts, both Norwegian and Swedish management allow harvest of all carnivore species today.

Both Sweden and Norway are parliamentary democracies. At the national level, the public is represented by the Riksdag in Sweden (Swedish parliament) and Stortinget in Norway (Norwegian parliament) which has legislative power (Figure 4). The Governments in both countries implement the Riksdag's and Stortinget's decisions and draw up proposals for new laws or law amendments. The target carnivore population sizes are set by the Riksdag and Stortinget. Sweden has to adjust its carnivore population size in line with the European Union's (EU) Habitat Directive which is legislation that requires protection of large carnivores (EU 1992). Norway is not a member of EU and therefore not subject to the EU Habitat Directive, so may set carnivore population goals based on the Bern convention which is far less restrictive. Sweden has to report on its carnivore conservation status to EU every 6th year. Both countries have county councils and county Governors with professional wildlife management experts (county level) and municipality councils (municipality level).

Once the overall carnivore population goals are set by Government at a national level, the National Environmental Agency (in each country respectively) has the responsibility for implementing the management, and parts of the implementation are delegated down to county administration in Sweden and a political elected committee in Norway (Figure 4). The political committee implements management actions such as hunting quotas and allocation of money to preventive measures, but they are controlled by the county administration which works as a secretariat and is also an appellate authority for the political committee (Figure 4). In Sweden the carnivore management has partly been delegated to county administrative boards (county level), but hunting quotas for example are set by the Environmental Protection Agency (national level). From 2014 Sweden is changing the organization of its carnivore management as they want to improve local participation by delegating more responsibility down to the county level (www.naturvardsverket.se).

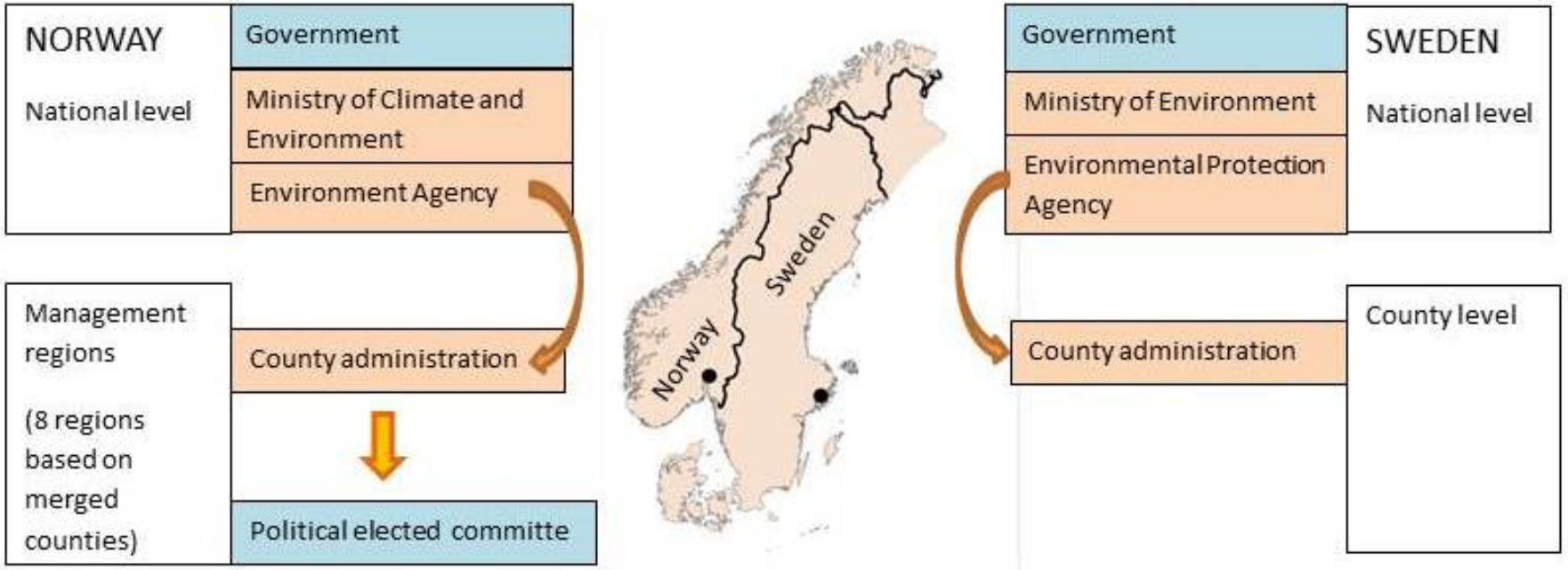

Figure 4 A depiction of how carnivore management is organized in Norway and Sweden. Blue boxes are politically elected units, and orange boxes are units employed with professional skills. The yellow arrows shows that the county administration is appellate authority for the Political elected committee (i.e. if the wolf hunting quota is set too high), and that the Environment Agencies are appellate authority for the county administration.

Wolves have recolonized the south-eastern part of the Scandinavian Peninsula, but are not evenly distributed between the two countries. Approximately 90 % of the wolf population is found in the Swedish part of the Peninsula. The Norwegian management objectives for carnivore population abundances are much lower than in Sweden (www.rovviltportalen.no; www.naturvardsverket.se). Norwegian politicians have decided to keep a low wolf population due to the conflict with livestock farming. Their goal is a maximum of 3 reproducing wolf packs (approximately 20 – 30 individuals). The management goals in Sweden are set to 20 reproductions (270 individuals) (www.naturvardsverket.se), hence there are approximately 350 wolves existing today. When wolves migrate from Sweden and cross the Norwegian border they are likely to be killed due to preventive measures to avert depredation of free ranging sheep, or because of the lower population goal in Norway.

Management authorities in Norway and Sweden have developed several separate management plans (Norwegian Government 1992; Norwegian Government 1997; Persson 2000) to deal with the conflicts arising from increasing carnivore populations. Management plans and actions carried out by one country heavily affect the carnivore situation in the other country. This contributes to disagreements both between and within the countries with regard to how large the Scandinavian carnivore populations ought to be, where the carnivores should be allowed to establish and how management objectives are to be reached (e.g. having carnivore zones or not). This has been debated and discussed since the carnivore populations began increasing in the early 1970s, and the debate is most heated when discussing the shared wolf population. At present there are no mutual agreements or formalities between Norway and Sweden in how to manage the shared carnivore populations in spite of the fact that carnivores move freely throughout the whole Peninsula.

Another disparity between Norwegian and Swedish management are the differences in agricultural subsidies. Norwegian agriculture is among the most highly subsidized in Europe (www.oecd.org). Governmental subsidies are built to support farming, animal husbandry and human settlements throughout the whole country (Sorensen 2003; Otterlei & Sande 2010). When Sweden got its EU membership, agricultural subsidies increased as there had been no tradition of highly subsidized agriculture. However, the subsidies are almost half of the Norwegian Government payment. Sweden is mainly compensating for the loss of income due to differences in food prices, and subsidies are not directed as much towards farming, food production or animal husbandry as they are in Norway (www.jordbruksverket.se). The high

subsidies in Norway are a result of the two-fold policy to maintain sustainable carnivore populations to political goals set by the Parliament and simultaneously maintaining local and vibrant communities with active use of marginal land resources throughout the whole country (www.miljodirektoratet.no). The latter point includes free-ranging sheep, hunting activities and rural livestock production that tend to conflict with having large carnivores in the same area (Berger 2006; Kaartinen, Luoto & Kojola 2009; Muhly & Musiani 2009; Treves 2009; Karlsson & Johansson 2010).

3.3. Historic distribution of carnivores in Scandinavia

All four large carnivores species were killed with high state-financed bounties throughout the seventeenth and eighteenth century (Swenson *et al.* 1995; Woodroffe, Thirgood & Rabinowitz 2005). More than 4 200 large carnivores were registered killed in Scandinavia during the period from 1856 to 1860 (Statistic Norway; www.ssb.no, and Statistic Sweden; www.scb.se). The brown bear is the species with the highest number of reported kills (Statistic Norway; www.ssb.no, and Statistic Sweden; www.scb.se; Table 1, Figure 5). The distribution of killed animals might be used as an indicator of where large carnivores were distributed during these years and thereby represent a historical window of carnivore abundance (Figure 5).

Table 1. Number of bounties paid specified by each carnivore species in the period of 1856 – 1860 in both Norway (N) and Sweden (S; Statistic Norway; www.ssb.no, and Statistic Sweden; www.scb.se).

Country	Bear	Wolf	Wolverine	Lynx
N	249	241	69	124
S	1158	898	611	852

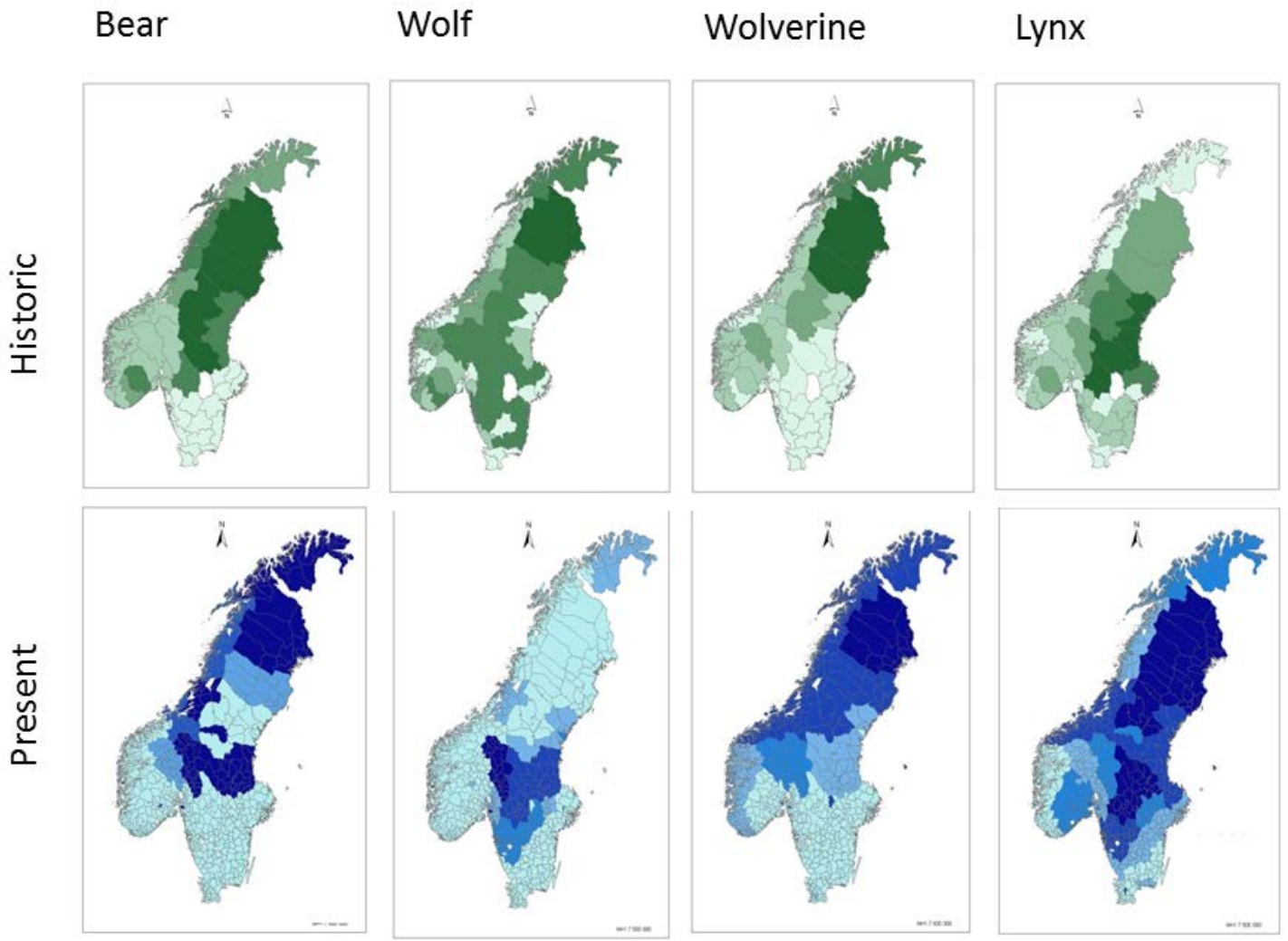

Figure 5. Historic distribution (upper panel) of large carnivores in Scandinavia based on bounties paid in the years 1856-1860, and present distribution (lower panel) in Scandinavia today (Rovbasen 2010). The higher the density, the darker the color.

3.4. Present distribution of carnivores in Scandinavia

After a total absence in the late 1960s, wolves first reappeared in Scandinavia in 1978 (Wabakken *et al.* 2001) and the population today counts approximately 330 individuals (Wabakken *et al.* 2013). The brown bear population was as low as 130 individuals in 1920-30s, but increased to more than 2 500 individuals in 1995 (Swenson *et al.* 1995) and approximately 3 000 – 3 500 in 2012 (www.rovdata.no; www.naturvardsverket.se). The wolverine and lynx populations are ca. 1 000 and 2 000 individuals, respectively (Norwegian Directorate for Nature Management; Swedish Environmental Protection Agency). None of the large carnivore species are evenly distributed throughout the peninsula and Sweden has the major share of most species (Figure 5).

The carnivore population estimates are based on monitoring programs adapted to each carnivore species using scat analyses, snow tracking, radio collared individuals or genetic analyses of DNA extraction from hairs, scats etc. (Hedmark & Ellegren 2007; Linnell *et al.* 2007).

3.5. Carnivore conflicting livestock production

More than 2 200 carnivores have been registered as dead (both natural and human caused) in the Norwegian *Rovbasen* in the years 1988 to 2010. Of these, more than 85 % were killed legally through hunting or management actions (lethal control) (Rovbasen, Directorate of Nature Management; www.dirnat.no). A total of more than 24 000 sheep have been registered as killed by large carnivores in the same period in Norway. Predation of livestock has been claimed as one of the main reasons why carnivores are still being killed in Norway and Sweden. Fear of the loss of game species, as carnivores compete with hunters for their prey, is another reason claimed.

Around 450 000 sheep are found in Sweden, but they are fenced and highly protected against predation. Consequently sheep depredation is a minor issue in the Swedish carnivore-human conflict. By contrast, in Norway more than 2 million sheep graze and range freely in the mountains and forests during summer and are much more vulnerable to predation (Dahle *et al.* 1998). The numbers we have used for sheep density can be interpreted as sheep available for predation. Hence, the analyses that include sheep density or sheep loss (Paper I) are only valid for Norway.

4. Methods

4.1. Questionnaire

Three of the four Papers attached in this dissertation are based on a survey where we have asked for people's attitudes and value orientation related to carnivores and carnivore management all over the Scandinavian Peninsula (Paper I, II and IV). Paper III is based on a literature review from Web of Science (Thomson Reuters 2013) were we search for papers on illegal hunting or poaching.

In order to obtain responses that were evenly distributed throughout Scandinavia independent of human population density, we used geographical stratified sampling and surveyed 4 - 5 people in each municipality in Sweden and in Norway. Data on attitudes towards carnivores were collected through a telephone survey carried out by a data collection agency (www.norstat.no).

The data collection agency (NORSTAT) bases its sample on existing registers that are publicly available when they collect data by telephone interviews. The geographical stratified sampling was important in order to assess the spatial distribution of potential conflict level and useful for comparing attitudes of people living inside and outside zoning areas, such as the wolf zone in Norway. However, as the sample represents a very small proportion of people living in high density areas such as cities and suburban areas it does not measure the general opinion of people living in a specific region (e.g. county or country).

The questionnaire contained approximately 30 questions, focusing on people's attitudes towards having large carnivores present in their country and their municipality, and if they were willing to live in a carnivore area themselves (Paper II). They were also asked general questions on environmental values (e.g. "The balance in nature is delicate and easily upset", "The so-called "ecological crisis" facing human kind has been greatly exaggerated"). Some of the questions focused specifically on the respondents' tolerance to illegal hunting (Paper I), and some of the respondents were even asked if they would illegally hunt themselves to eradicate the carnivores (Paper II).

4.2. Analysis procedures

All questions dealing with attitudes and tolerance were answered in a Likert type response format ranging from “strongly disagree”, “disagree”, “neither agree nor disagree”, “agree”, to “strongly agree”. This made it possible to estimate divergence between people’s attitudes within municipalities or counties. We applied the potential conflict index (PCI) to estimate the divergence in attitudes toward illegal hunting (Manfredo 2003; Vaske *et al.* 2010; paper I). The PCI ranges from 0 to 1, where PCI = 0 indicates high consensus and therefore low conflict level, while PCI =1 means low consensus and a potentially high conflict level (Vaske *et al.* 2010). This means that if everyone in an area agrees that illegal hunting is either acceptable or unacceptable the PCI would be low, while more diversity across opinions would result in high PCI values (Paper I).

In addition we used the New Environmental Paradigm (NEP) described by Dunlap and Vanliere (1978) to describe people’s environmental value orientation. NEP is described as a conceptualized measure of people’s environmental value orientation measuring values, beliefs and attitudes (Dunlap *et al.* 2000; Ardahan 2012). Previous studies have shown how high NEP-scores correlate with pro-environmental values like ecocentric values (Stern *et al.* 1995; Dunlap *et al.* 2000) and low NEP-scores are associated with anthropocentric values (Rauwald & Moore 2002; Luo & Deng 2008; Ardahan 2012b). People with ecocentric values look upon nature as having intrinsic value regardless of human utilitarian needs, and may also be more willing to conserve nature as a precautious measure to prevent future extinction of species or habitats (Kortenkamp & Moore 2001; Hunter & Rinner 2004). Here, I estimated NEP in a gradient from anthropocentric to ecocentric by using 7 statements related to environmental beliefs. For instance, people highly agreeing with the statement “If things continue on their present course we will soon experience a major ecological catastrophe” would lie towards the ecocentrism end of the gradient. In contrast, people highly agreeing with the statement “The so-called “ecological crisis” facing human kind has been greatly exaggerated” would lie towards the anthropocentric end of the gradient (Gerhard 2004).

Hence, I used three kinds of main response variables:

1) Attitudes towards carnivores and illegal hunting based on responses from the questionnaire (Paper I, II and IV);
2) NEP-scores based on responses from the questionnaire (Paper II); and
3) PCI at the county level (Paper I).

To explain the variation in the responses we used the following descriptors of carnivore presence as our main predictors (Paper I and II):

1) The density of each of the four large carnivores at the municipality level today as 4 separate predictor variables (Norwegian "Rovbasen"; www.dirnat.no and the Swedish "Rovdjursforum"; www.naturvardsverket.se). The numbers do not represent the total number of carnivores in an area, but rather the minimum number of individuals known to be present. Methods used for estimating minimum population densities are based on yearly species-specific records like snow-tracking and radio-tracking family groups of lynx, wolves and wolverines, counts of bear- and wolverine dens and DNA analyses of scats (Linnell *et al.* 2007).
2) Carnivore density in historical time (i.e.1856-1860) is based on bounties paid (Statistics Norway (www.SSB.no) and Statistics Sweden (www.SCB.se; Paper I).

In addition we included the following spatial descriptors:

1) Country (Paper I, II, IV).
2) Presence of a wolf zone (only in Norway, Paper I).
3) Big game hunting practices as a strong rural tradition (Paper I and II)
4) Traditions related to sheep farming as the number of free ranging sheep (only in Norway, Paper I) and number of sheep depredated by large carnivores (only in Norway, Paper I and II)
5) Human density (Paper I and II).

In the analyses of acceptance of illegal hunting at the individual level (Paper I) and in the analyses of environmental value orientation (Paper II) we also included covariates that have been found to be important predictors in human-wildlife conflicts (Bjerke, Reitan & Kellert 1998; Bjerke & Kaltenborn 1999; Naughton-Treves, Grossberg & Treves 2003) such as education level, sex and age (Paper I) and personal income (Paper II).

We used generalised linear mixed models (GLMM) to reveal associations between the responses and the various predictor variables using municipality, county and/or country as random variables where appropriate (Zuur *et al.* 2009).

4.3. Representativeness of the geographically stratified survey

Due to the geographically stratified sampling scheme in our survey, our results do not reflect the mean attitudes of inhabitants of a county or a country, as urban areas are underrepresented compared to a random sample. Hence, eventual mean estimates for Norwegians or Swedes do not represent the mean Norwegian or Swede as it is not a random sample from the total population that has been asked, but it is a geographically stratified mean, i.e. all areas (municipalities) in each country are weighted equally. Attitudinal studies are usually done with demographic focus, being representative for a certain part of the human population (e.g. Norwegians versus Swedes, men versus women). Here, we were not interested in differences between demographic groups, but how carnivore presence and other spatially explicit descriptors were associated with attitudes toward carnivores. We do, however, compare attitudes between the two countries and discuss national differences, but we do not use the estimated values as an absolute estimate of the Norwegians' or Swedes' attitudes.

5. Results and discussions

5.1. Background

5.1.1. Associations between illegal hunting, environmental value orientation and potential conflict index

The acceptance of illegal hunting was independent of carnivore species (Paper I). Hence, if the respondent accepted illegal hunting of one carnivore species, he/she would most probably also accept illegal hunting of any other large carnivore species in Scandinavia. There was also a high positive correlation between acceptance of illegal hunting and PCI indicating that the areas with the highest acceptance of illegal hunting were the same areas where we found the greatest divergence of opinion (Paper I).

People who accepted illegal hunting of carnivores were expected to reveal low NEP-scores, being more anthropocentric than those who could not accept illegal hunting (Paper II). We also expected people that were willing to illegally hunt themselves to reveal anthropocentric values. To a large extent we confirmed these expectations, as people who accepted the free establishment of carnivores revealed ecocentric values (26 % of Norwegians and 24 % of Swedes). However, a number of people who accepted the free establishment of large

carnivores also revealed anthropocentric values (12 % of the Norwegians and 7 % of the Swedes; Paper II).

5.1.2. Correlation with demographic variables

Several previous studies have shown how attitudes toward large carnivores in general and wolves in particular associate positively with demographic variables such as education level, negatively with age and differ between genders (Bjerke, Reitan & Kellert 1998; Røskaft *et al.* 2003; Johansson *et al.* 2012). This was also applicable to our results which showed that the acceptance of illegal hunting decreased linearly with higher education level (Paper I, Figure 6). In addition, the elderly were more likely to accept illegal hunting compared to younger respondents, and men revealed a higher acceptance of illegal hunting than women (Paper I).

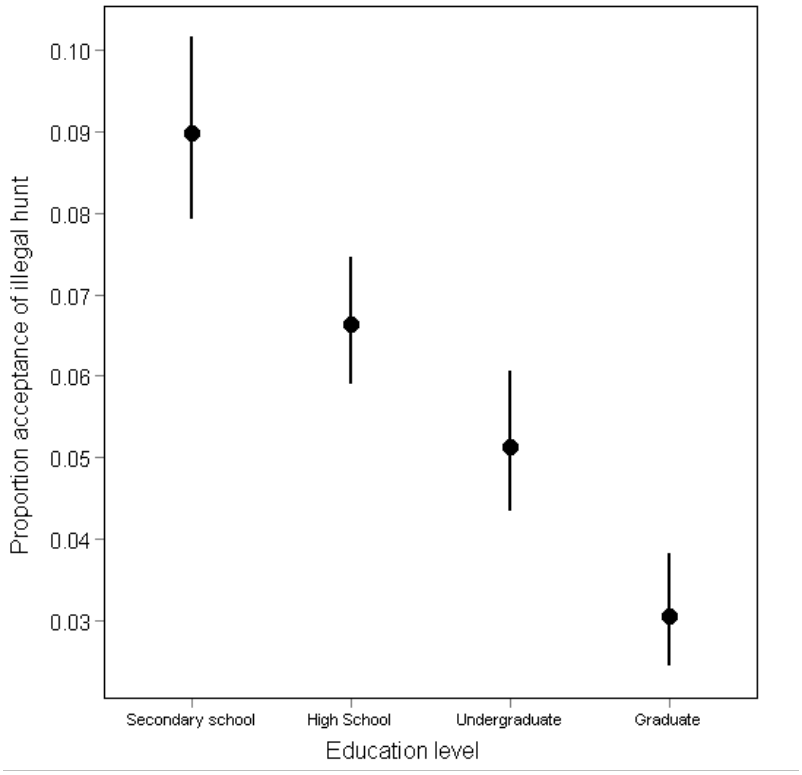

Figure 6. Acceptance of illegal hunting explained by education level in Scandinavia.

Environmental value orientation has also previously been shown to correlated with demographic variables. Ecocentrism (high NEP-scores) traditionally associates with younger people and correlates positively with higher education (Vaske *et al.* 2001; Vaske, Jacobs & Sijtsma 2011). This also corresponded with my results, as education level correlated positively with NEP-scores (i.e. higher degree of ecocentrism) and age correlated negatively

with NEP-scores (Paper II). In contrast to other studies(Casey & Scott 2006), my results (Paper II) showed that males were more ecocentric than females. In spite of this, men still accepted illegal hunting to a greater extent than women (Paper I).

The demographic variables that we included as covariates were therefore shown to be important predictors of attitudes towards illegal hunting and environmental value orientation.

5.2. The effects of carnivores and other spatial descriptors on attitudes and environmental value orientation (Paper I and II)

5.2.1. Rural traditional values

Neither present nor historic presence of the carnivore species, wolf zones or sheep depredation rates in Norway correlated with the acceptance of illegal hunting (Paper I) or environmental value orientation (Paper II) in our study.

Hence, we were not able to confirm our prediction that the presence of carnivores affected attitudes towards carnivores or general environmental value orientation. Other studies have shown that people may change their attitudes over time when living close to newly established carnivore territories and when being exposed to new carnivore situations (e.g. fear decreases and opposition might increase; Bisi *et al.* 2007; Treves, Naughton-Treves & Shelley 2013). Those studies may then have revealed a NIMBY-effect where people in general are positive toward carnivores, but do not accept their establishment too close to where they themselves are living.

The only spatial descriptor that was associated with the acceptance of illegal hunting was the tradition of big game hunting and country (Paper I). Big game hunting is related to rural traditional values which associate with anthropocentrism. Rural lifestyle and traditions are often used to explain differences in attitudes towards large carnivores (Bjerke & Kaltenborn 1999; Bowman *et al.* 2004; Rigg *et al.* 2011) as livestock farmers and hunters in general do not support carnivore conservation (Williams, Ericsson & Heberlein 2002; Ericsson & Heberlein 2003; Roskaft *et al.* 2007). The association between acceptance of illegal hunting and rural values (traditions of big game hunting; Paper I), might represent norms in rural communities where farmers, hunters and local residents express a feeling of being overruled by central authorities and lack local participation and involvement in carnivore management

decision (Williams, Ericsson & Heberlein 2002; Ericsson & Heberlein 2003; Skogen 2003). Hence, our results may indicate that acceptance of illegal hunting in Scandinavia is part of a cultural acceptance or opposition against central authorities, and therefore not related to the actual presence of carnivores.

5.2.2. Country differences

We found significant national differences between Norway and Sweden both with regard to acceptance of illegal hunting (Paper I) and how people responded to environmental value orientation (Paper II). In our geographical stratified sample, approximately 12 – 15 % of Norwegians could accept illegal hunting, while only 3 – 4 % of the Swedish respondents answered that they could accept illegal hunting (Paper I), and Swedes were in general more ecocentric than Norwegians (Paper II).

Most of the respondents in both countries (1 207 in Norway and 723 in Sweden) could accept the establishment of carnivores under certain conditions (zoning, protected areas), although Swedes that accepted carnivores under certain conditions had higher ecocentric NEP-scores than Norwegians. We also found that about 25 % of respondents in both countries were unwilling to live with carnivores, but in this case respondents in Sweden were more ecocentric than respondents in Norway.

Out of the 100 Norwegians that could not accept carnivores under any circumstances, 36 % were willing to shoot carnivores illegally themselves, while in Sweden only 2 of 21 (that would not accept carnivores at all) were willing to illegally hunt carnivores. More than 50 % of these Norwegians willing to commit illegal hunting revealed anthropocentric values, although 6 % revealed ecocentric values.

This shows that environmental value orientation may associate with expected attitudes to some extent, but that it should certainly not be used blindly as a blueprint. In my results country was a strong predictor for environmental value orientation, but the same attitudes revealed different NEP-scores dependent on what country the respondent belonged to. Hence, people having negative attitudes toward carnivores did reveal lower NEP-scores than people who were positive in their attitudes toward carnivores, but environmental value orientation

could not be compared across national cultures as Swedes were generally more ecocentric than Norwegians.

Such differences may indicate important social, cultural and national identity distinctions. Part of the explanation may be how people identify with rural cultures. In Norway, 63 % of the respondents reported that they were living in an area with strong traditions for big game hunting, whereas this was the case for only 23 % of the Swedish respondents (Paper I). However, another explanation may be found in socio-political differences. Norway has a strong tradition of being governed from the "bottom-up", where local participation rights have been central in people's minds and have contributed to changes in national laws and decision-making (Otterlei & Sande 2010). Previous studies have shown how rural Norwegian men with strong hunting traditions resist carnivore reestablishment, especially the wolf, as an act of cultural or social protest (Skogen 2001; Skogen 2003; Skogen & Thrane 2008). This was partly due to the perception by some rural inhabitants that when carnivores became protected by law in the 1970s, this was a "top-down" decision where "external forces" permitted the recolonization of Norway by large carnivores (Skogen & Krange 2003; Kleiven *et al.* 2004). This central opposition may be less important in Sweden as Swedes have a longer tradition of being governed from the "top-down" (Otterlei & Sande 2010). The Swedish tradition of central government also allows for stronger conservation of nature than in Norway (Otterlei & Sande 2010), exemplified through the Swedish protection of brown bears in 1913 and the lynx in 1927 compared to 1972 and 1992, respectively, for Norway (Swenson *et al.* 1995, www.artfakta.se).

5.3. Potential Conflict Index (PCI)

Part of the human – carnivore conflict is the social tension between humans who may disagree on carnivore management goals. This happens when people who support carnivore conservation, oppose illegal hunting and have ecocentric environmental values share neighborhoods with people who hold negative attitudes toward carnivores and support illegal hunting. This social conflict is also described with regard to large carnivore conservation as a conflict between urban – rural lifestyles. On a very general level, urban lifestyles have shown to be associated with a higher acceptance of carnivores, while rural lifestyles have shown to be more negative toward carnivores and mistrust carnivore management (Patterson, Montag & Williams 2003; Skogen & Krange 2003; Liberg *et al.* 2011).

We revealed a higher potential social conflict in areas with intermediate human population sizes, and in areas with high sheep densities (Paper I), where sheep density together with big game hunting were used as predictor variables representing rural values. Intermediate populated areas may be represented by small towns or areas with increased urbanization, young educated people move back from big cities to their home communities and bring modern urban values into a society that still is characterized by traditional rural values (Paper I).

5.4. Do attitudes in turn affect behavior (Paper II & III)?

5.4.1. Illegal hunting

Our second study shows that 36 % and 20 % of those Norwegian and Swedish respondents who strongly opposed having large carnivores in their country were actually willing to kill carnivores illegally themselves to prevent their establishment (Paper II). We still do not know if they actually would hunt illegally if they got the chance, but according to Manfredo (2008), extreme attitudes are better predictors of behavior than moderate attitudes, which makes acceptance of illegal hunting well suited to actually predict a person's behavior. When biological studies are taken into account, there is good reason to believe that illegal hunting occurs (Andren *et al.* 2006; Persson, Ericsson & Segerstrom 2009; Liberg *et al.* 2011), highly influencing the growth, distribution and development of Scandinavian carnivore populations (Morner *et al.* 2005; Andren *et al.* 2006; Persson, Ericsson & Segerstrom 2009; Liberg *et al.* 2011).

However, the link between attitude and behavior may in several cases be quite weak and is seldom described in the literature (Kaiser, Wolfing & Fuhrer 1999; Milfont & Duckitt 2010). An attitudinal survey in China showed that 88 % knew it was illegal to buy or sell tiger *(Panthera tigris)* products, 93 % agreed that tiger conservation was necessary, yet 43 % had consumed products that contained tiger products (Gratwicke et al. 2008). This case underlines how people may not behave in accordance with the attitudes expressed (Manfredo 2008; Heberlein 2012). However, another study from South Africa suggests that farmers' attitudes toward carnivores do predict that farmers are actually killing carnivores (St John *et al.* 2012). Our second study implies an association between attitude and willingness to commit the

certain behavior, but very few studies have actually revealed a strong association between attitudes toward carnivores and behaviors like illegal hunting.

5.4.2. Global perspective (Paper III)

In the literature review (paper III) we found clear spatial differences in why illegal hunting occurred worldwide, in motivation to hunt illegally, and also in which types of species were exploited (paper III, see also Vigne, Martin & Okita-Ouma 2007; Chapron *et al.* 2008; De-Franco *et al.* 2012; Mason, Bulte & Horan 2012). We reviewed the scientific literature registered in the Web of Science and categorized the rationale for illegal hunting and poaching into four main categories; Bushmeat, Trade, Recreational Hunting and Harvest, and Farming. We made some predictions about the main motivation for illegal hunting in each continent, dependent on individual emotional and group based cultural motivations, existing biodiversity and poverty.

To some extent we confirmed our expectation in that the continents with the highest biodiversity (Latin America and Asia, see also Myers *et al.* 2000) reported the highest diversity of motivation for illegal hunting due to the greater diversity of biological resources. Illegal hunting for bushmeat was expected to be related to poverty and was found in continents with the lowest per capita GDP (Gross Domestic Product). Illegal hunting in the continents with typical western cultures (North America, Europe and Oceania) were driven by emotional and cultural motivations, such as trophy hunting, hunting for recreation and surplus killing due to limited quotas in regulated hunts.

Asia and Africa were the continents most often reported in the scientific literature on illegal hunting (Paper III). Recreational Hunting and Harvesting was the most common rationale for illegal hunting reported within all continents except for Latin America and Africa. Trade was the second most highly reported motivation of illegal hunting and mostly associated with the highest biodiversity resources while Bushmeat tended to be most common in the continents with the lowest per capita GDP (Paper III).

There were also spatial differences in what types of species that were illegally hunted. Herbivores were the most commonly reported species illegally exploited on all continents, often in relation to destruction of crops or competition with livestock for food (Webber *et al.*

2011). African papers also described how both carnivores and ungulates suffered as a result of the extensive use of snaring and poisoning (Hoare & Williamson 2001; Becker *et al.* 2013). Carnivores were the second most highly reported group of species illegally killed, either due to trade of carnivore products in Asia (Kapfer *et al.* 2011; Farhadini *et al.* 2012), or because of conflicts with Farming or due to Recreational Hunting and Harvesting in Europe. Birds and reptiles were mainly reported from Latin America, often being sold to the pet industry (da Nobrega Alves *et al.* 2010), while primates was mainly reported in Asia and sea mammals and fish were evenly exploited on all continents (Agnew *et al.* 2009; Humber *et al.* 2011) (Paper III).

Historically there has been a major international focus on illegal exploitation and trade of ivory from rhinos *(Rhinocerotidae*) (Milledge 2007; Vigne, Martin & Okita-Ouma 2007; Martin, Talukdar & Vigne 2009; Zafir *et al.* 2011; Pelley 2012), and African *(Loxodonta Africana)* and Asian *(Elaphus maximus)* elephants (Jachmann & Billiouw 1997; Sukumar, Ramakrishnan & Santosh 1998; Santiapillai *et al.* 1999; Burn, Underwood & Blanc 2011; Stiles 2011) as well as tiger bones or fur (Wetton *et al.* 2004; Abbott & van Kooten 2011).

Tadier and Fisher (2013) describe how (illegal) big game hunting (e.g. lions *Panthera leo* and buffalo *Syncerus caffer*) in Ethiopia is part of a cultural tradition that creates a long-term bond between a hunter and another person or family. The hunting act is performed by men, but motivated by women and looked upon as prestigious and building social connections between humans, rather than being connected to any ideas of nature (Tadie & Fischer 2013). In this case illegal hunting is part of a human – human relationship, and not a human – wildlife concept (Tadie & Fischer 2013).

These examples emphasize how important it is to address the underlying motivation for the illegal hunting problem and implement policy and management interventions at the appropriate scale. Over-coming illegal hunting stretches from the understanding of local culture and hunting traditions (e.g. Moss & Bowers 2007; Tadie & Fischer 2013), the need for bushmeat due to poverty, fighting international demands of bushmeat by luxury food chains, to combating rare species being collected by wealthy collectors or ivory commissioned by international illicit trade networks. As such it is a multi-scale challenge, involving institutions and policies from household values and attitudes, to the regional, national and international levels.

We need to deal with disagreements between local people and conservationists about how and why to protect vulnerable species or habitats (Dickman, Macdonald & Macdonald 2011), strangle illegal markets and allow international cooperation and law enforcement to enable sanctions across national borders.

5.5. How does the spatial scale affect management (Paper IV)?

In my last paper (Paper VI) we estimated the variance components of attitudes derived from questionnaires at the municipality, county and country level, and found that attitudes related to specific carnivore species e.g. fear of the brown bear or the wolf, were best described at a small scale (i.e. municipality), while general questions related to environmental attitudes (measured by NEP; Paper II) had the largest variance components at the largest spatial scale (country). Attitudes towards illegal hunting were expected to give highest variance at a small scale (municipality level), but instead we found that also illegal hunting gave the highest variance at the largest scale (country level; Paper VI).

Except for fear, which is a basic human response mostly linked to individual experiences at a local scale, the spatial scaling of environmental attitudes seemed disconnected from the ecological processes, and rather linked to large scale socio-spatial structures (Treves & Karanth 2003; Bisi *et al.* 2007; Johansson *et al.* 2012). If the spatial scale of management is increased beyond the scale of the highest attitudinal variance components, it will increase environmental and social conflicts.

Environmental attitudes are frequently studied with questionnaires at one given spatial scale, e.g. at a national or regional level (Bjerke, Reitan & Kellert 1998; Kaltenborn & Bjerke 2002; Butler, Shanahan & Decker 2003; Roskaft et al. 2007; Heberlein & Ericsson 2008; Kaltenborn et al. 2008; Ardahan 2012a; Heberlein 2012), while attitudinal variation in space has received less attention (Pate et al. 1996; Merrill et al. 1999; Morzillo et al. 2007).
The feeling of fear is a personal perception of a specific situation that affect a person's attitude, while the acceptance of illegal hunting may be related to a political stance reflecting whether people or groups of people actually can accept having carnivores or not. Management may thus make decisions at a scale that fits public opinion, but not necessarily the ecological system. Consequently social conflicts may increase while sustainability is reduced.

5.6. Predicting favorable areas for carnivore establishments

It is important to understand and take into account human attitudes in management involving controversial species such as carnivores. A better understanding of the spatial distribution of attitudes may help decide which areas are most suitable for instance for carnivore recolonization. Tentatively, I have used our spatial models of acceptance of illegal hunting and potential human-human conflict (PCI) to describe the most favorable areas for carnivore establishment in Scandinavia. The estimated acceptance for illegal hunting and PCI in each municipality is derived from statistical models in Paper I; that is:

- Acceptance illegal hunting = Big game hunting + Age + Gender + Education level
- PCI= Sheep density + Human population density + (Human population density)^2

Sheep density was only valid for Norway.

For each municipality I found the mean age of the inhabitants, proportion of men/women, and the number of residents in the municipalities distributed on a 4-scale education level from Statistics Norway (www.ssb.no) and entered into the models. I also used hunting statistics for moose and red deer (*Cervus elaphus*) as an index of big game hunting, and sheep density for the Norwegian model. I standardized maximum acceptance of illegal hunting, and maximum PCI to 1, and used the sum of these two estimates as a description of favorable areas for carnivores.

The acceptance of illegal hunting and potential social conflict (PCI) are unevenly distributed spatially throughout the Scandinavian Peninsula, showing large national differences (Figure 7). Together they show that the least favorable areas for large carnivores to establish are most parts of Norway and northern and eastern parts of Sweden.

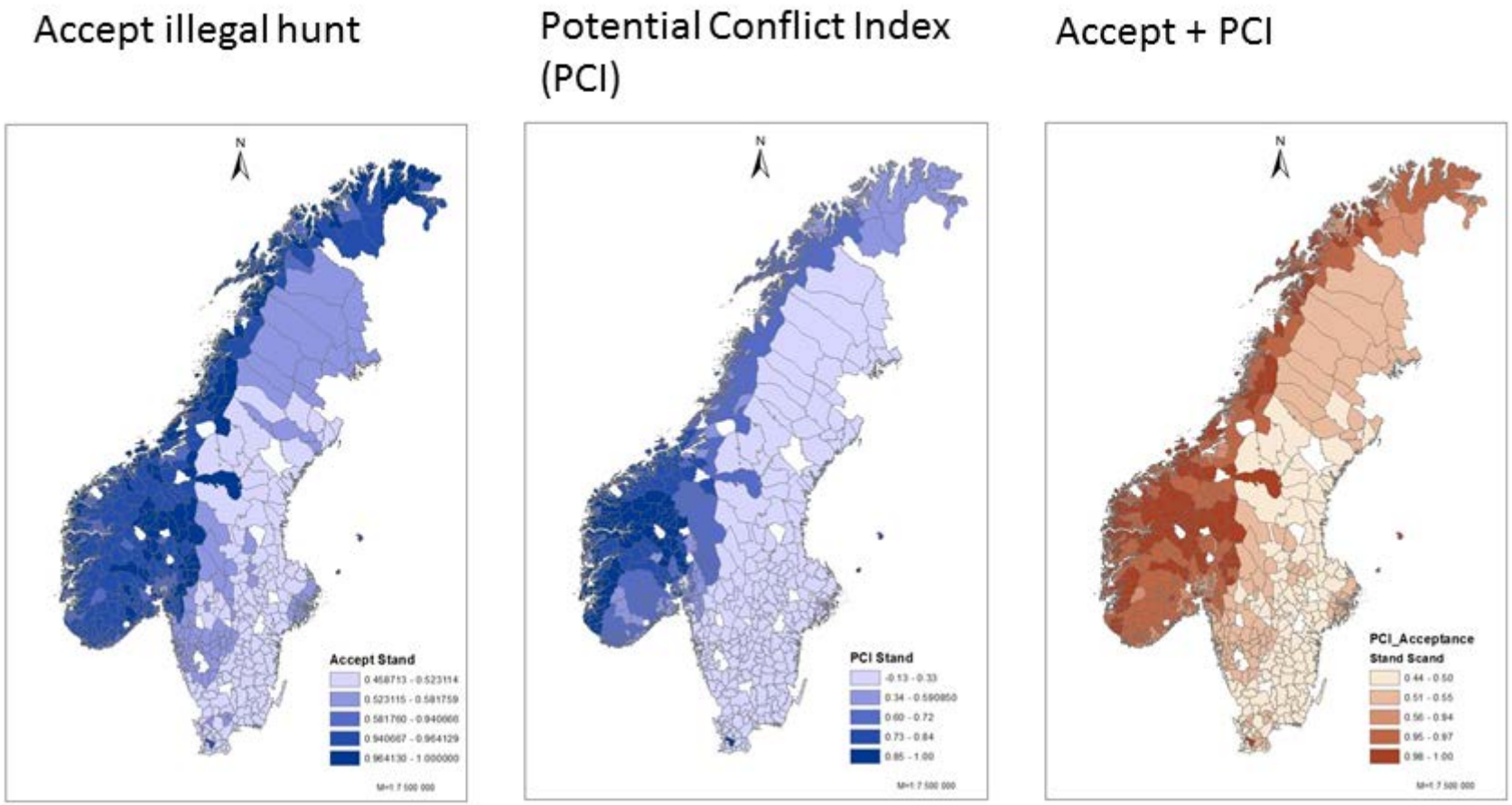

Figure 7. Maps showing unfavorable areas for carnivores to establish within the Scandinavian Peninsula based on A) Acceptance of illegal hunting (standardized maximum = 1), B) the Potential Conflict Index (human-human conflict with a standardized maximum = 1) and C) the sum of the standardized acceptance of illegal hunting and the conflict level merged. The darker the areas the less favorable they are for carnivores to establish.

6. General discussion

Human population growth is exerting escalating pressure on existing natural resources. The need for agriculture and food production increasingly conflict with biodiversity conservation goals and land set aside for wildlife protection (Balmford, Green & Scharlemann 2005; Meadows 2011; Tscharntke et al. 2012). Today approximately 12-13 % of the world's land surface is protected areas, but preservation of both habitats and viable populations of species remain a worldwide challenge (Brook, Traill & Bradshaw 2006; Traill et al. 2010). Many protected areas are far too small to actually protect species that require huge areas such as large carnivores or migratory species (Thirgood *et al.* 2004; Mora & Sale 2011; Ripple *et al.* 2014), and most species are therefore managed in a multiuse landscape that conflicts with human activities (Linnell et al. 2001; Rutledge et al. 2010; Crooks et al. 2011; Athreya et al. 2013).

When areas come under protection and conservation regimes, or wildlife are being protected, locals often experience restrictions on their hunting or hunting traditions (Muth & Bowe 1998), increases in crop raiding and/or livestock depredation and hence, the tendency for illegal hunting may increase (Weladji & Tchamba 2003). Local communities may therefore have a negative perception of the need to protect vulnerable species or areas and/or they have direct economic incentives to engage in illegal hunting (Vandergeest 1996; Kaltenborn, Nyahongo & Tingstad 2005). So, even though protection of wildlife and land areas may have initially been supported locally, this will change unless there are clear local benefits derived from the protection policy and measures (Weladji, Moe & Vedeld 2003; Dickman, Macdonald & Macdonald 2011), and large carnivores may even be perceived as pest species locally.

By comparison, the wider society may wish to conserve these species because they see them as highly valuable in non-consumptive terms (Skogen & Krange 2003; Sodhi *et al.* 2010; Dickman, Macdonald & Macdonald 2011; Tscharntke *et al.* 2012). This may fuel the social conflict, and illegal hunting may continue as part of the social protest against government carnivore policy (Chapron *et al.* 2008; Liberg *et al.* 2011).

Many countries have chosen to protect threatened species like tigers, wolves or bears by law, or preserve certain areas as national parks or protected areas (Balmford et al. 2004; Brooks et al. 2004; Craigie et al. 2010; Mora & Sale 2011). Nonetheless all these species still exist in small populations, many of which are not considered sustainable (Swenson *et al.* 1995; Wabakken *et al.* 2001; Singh *et al.* 2004). Only 23 % of habitats prioritized by tigers are defined as protected areas, and even within some of these tiger reserves, illegal hunting has wiped out entire tiger populations (Gratwicke 2007). Gratwicke (2007) argues that saving animals like tigers can only be achieved by a reduction in the illegal trade for tiger products and improving landscape-level conservation.

Huge efforts have been made to ease the human – carnivore conflict. In developed countries in Europe and in North-America, compensation has been used in an attempt to increase the support for protected areas, tolerate inconvenient species, or ease the cost of human - wildlife conflicts e.g. large carnivores killing livestock (Ogra & Badola 2008; Agarwala *et al.* 2010; Andren *et al.* 2011; Pechacek *et al.* 2013). In Scandinavia, compensation for loss of livestock (Bostedt & Grahn 2008; Mattisson *et al.* 2011) has been accompanied by information and spread of knowledge to the public (Svenningsen & Skogen 2003) additional to creation of certain wolf zones (Woodroffe, Thirgood & Rabinowitz 2005). None of these efforts have succeeded to ease or end the conflict (Naughton-Treves, Grossberg & Treves 2003; Skogen, Mauz & Krange 2006).

7. Conclusion and management implications

To be successful, carnivore conservation should allow large carnivore populations to persist in predictable areas and in adequate numbers to be both robust and viable. This requires a much better understanding of the mismatch between the social and ecological scales involved. The ecological requirements of large carnivores are in many cases insufficient in matching peoples' acceptance of having carnivores in their neighborhood. For several decades it has been evident that environmental management requires integration of natural and social sciences, but this is complicated by the fact that the social sciences typically operate with concepts that are difficult to define in spatial terms.

As conservation requires large areas I have taken an approach typical in applied ecology and mapped attitudes in the same way as we map presence of carnivores or other organisms. My

spatial approach may be used to find optimal areas for carnivore protection, taking both human tolerances and spatial ecological descriptors of carnivore sustainability into account (as shown in Figure 7). As the understanding of the scale mismatch is crucial, I highly recommend an increased scientific focus and further research into how attitudes vary across different social scales compared to ecological spatial scales. Multi-scale studies are needed to unravel the relationships between local, regional, national, and international responses to carnivore conservation and expanding carnivore populations. Wildlife management authorities should manage carnivores at the largest scale possible to ensure ecological sustainability, but at the same time bear in mind that the potential for social conflicts increases beyond the scale of highest attitudinal variation (Figure 8). Building resilience into social-ecological systems is demanding, but benefits conservation of species and habitats by increasing longitudinal predictability and stability (Folke et al. 2002; Folke 2006).

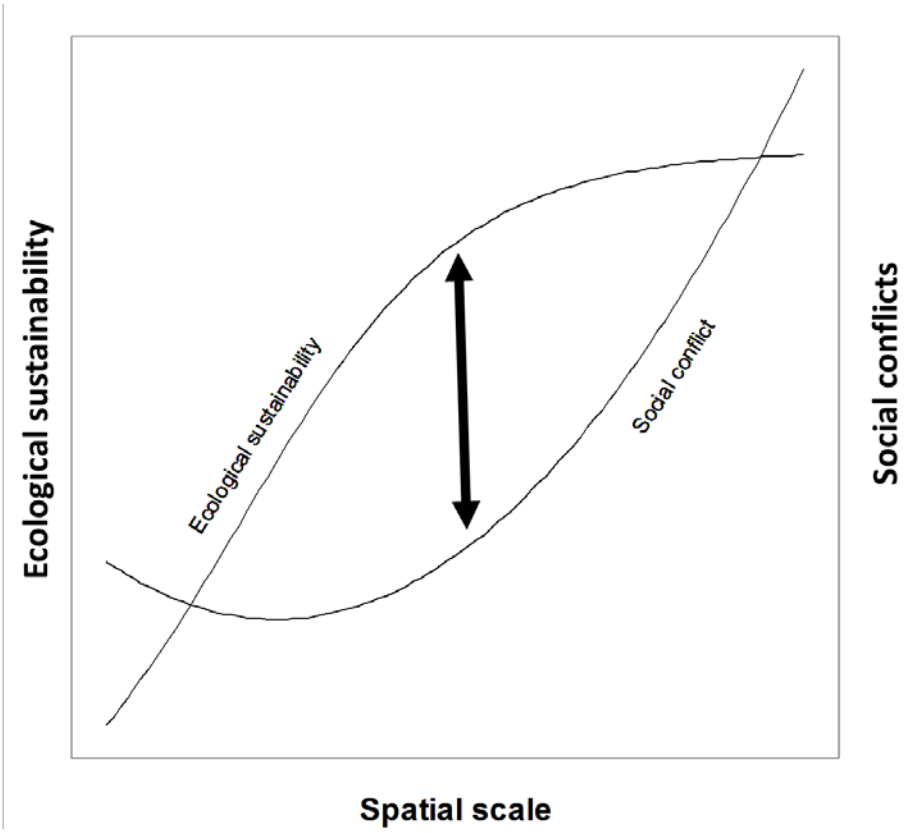

Figure 8. Environmental management authorities should manage as large ecological units as possible to maintain ecological sustainability, but at the same time keep conflict levels as low as possible. The optimal solution is shown here by the arrow.

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