**Balancing Stakeholder Interests**

**for a Sustainable Wolf Population Management in Sweden**

Huayi Lin1, Elena Rovenskaia2,5, Brian D. Fath2,3, and Hans Liljenström1,4

1Dept of Energy and Technology, SLU

2 IIASA, Laxenburg, Austria

3 Towson University, USA

4 Agora for Biosystems, Sigtuna

5 Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University, Russia

**Abstract**

The Swedish wolf population has increased during the past fifty years from a few individuals to a few hundreds, resulting in conflicts among different stakeholders. The Swedish EPA has struggled with ways to find a viable and acceptable size of the wolf population in Sweden, but there is still no consensus. In this paper, we have used a model with *satisfaction functions* to describe different interests of stakeholders concerned with the management of wild wolves in Sweden. Using this model with preliminary data from expert assessments and stakeholder interviews, we estimated satisfaction levels of “pro-wolf” and “anti-wolf” groups, as a function of wolf population size. The results showed that the current conditions generate a significant gap between the two conflicting groups, with no size of the wolf population that could simultaneously satisfy both groups to a high degree. We simulated three scenarios: 1) promoting economic incentives and preventative measures, 2) promoting education, dialogues and campaigns for wolf conservation, and 3) increased punishment of illegal hunting. The simulations indicated that promoting education, dialogues and campaigns for wolf conservation could best alleviate the conflict between the two groups.

**Key words**

Wolves, wild life management, stakeholders, satisfaction function, balancing conflict

1. **Introduction**
   1. ***Background***

The wolf population in Sweden was estimated as 1,500 individuals some 180 years ago (Sjölander-Lindqvist, 2011). In the 1960’s, this population almost went extinct. Following the introduction of the law for the wolf protection in the late 1960’s, the wolf population has gradually recovered to a current level of about 340 individuals (Naturvårdsverket, 2016). During the last four decades, the reappearance of wolves has induced a series of social problems and severe debates in society (Ednarsson, 2006; Ericsson & Heberlein, 2003; Eriksson, 2013; Karlsson & Sjöström; Rogers, 2014; 2007; Stohr & Coimbra, 2013). In nutshell, the question of how many wolfs should live in Sweden has polarized the country into two camps (Eriksson, 2016), one primarily concerned with the biodiversity and sustainable development (Sjölander-Lindqvist, 2011), and the other claiming to defend local traditions and livelihoods that are under the risks of wolfs spreading over XXX (Sjölander-Lindqvist, 2011; Sjölander-Lindqvist and Cinque, 2014).

The impact of wolves onto the Swedish society, economy and environment are multi-fold. Biologically, wolves are regarded as an important part of a healthy ecosystem with a rich biodiversity. W

As large predators, they prey on both large and small wild animals, including deer and moose, which are also hunted by humans (Kojola et al. 2004; Viltskadecenter, 2014). In addition, wolves may prey on livestock and reindeers, and may hurt and kill hunting dogs. Wolves are also seen as competitors to hunters for game animals. Wolves may become an attractive factor for ecotourism, however they can be dangerous to people. Culturally, hunters, farmers and Sami people argue that their traditional activity, including production, lifestyle, and social identity, can be damaged by wolves and hence the entire rural culture is threatened. Reindeer herding Samis, traditionally living in the northern part of Sweden, claim that wolfs damage their free-ranching livelihood on reindeer, as wolfs may kill or scatter the herds.

**1.2 Attitudes towards wolves**

Factors that influence the formation of people’s attitudes towards wolves may include the proximity to the territory inhabited by wolfs (Broberg & Brännlund, 2007; Ericsson et al., 2008; Heberlein & Ericsson, 2008), belonging to a certain social group (Eriksson, 2016; Naughton-Treves et al., 2003), experienced economic losses (Bostedt, 1999), education, direct experience (Johansson et al., 2012; Karlsson, 1999), owning a hunting dog, age, culture (Rogers, 2014), media, different worldviews and social ideology (Sjölander-Lindqvist, 2008), and other (Dressel et al., 2015; Ericsson et al., 2004; Johansson and Karlsson, 2011 ).

In general, urban residents appear to be more positive towards wolves, while people in rural areas, in particular, in areas inhabited by wolves, are more negative (Christopher et al., 2002; Ericsson & Heberlein, 2002; Ericsson, 2004). Environmentalists hold strong positive attitudes towards wolves, while farmers and hunters are, typically, more negative toward wolves than the general public (Dressel et al., 2015; Røskaft et al. 2007). Hunters often hold strong negative attitudes towards wolves because wolves compete with hunters for prey, reducing the amount of game animals. Also, wolfs can kill hunting dogs, which often are seen as family members (Rogers, 2014). Hunters also claim that their hunting culture is at risk, partly because of wolves. Farmers are generally negative towards wolves because wolves damage their livestock, also leaving a strong negative impact on the welfare of the prey (Creel & Christianson, 2007; Muhly et al., 2010). Since XXXX Swedish farmers receive compensation from the government for their economic losses caused by wolves. Many reindeer herders (Samis) in the north of Sweden rely on herding reindeer to maintain their lifestyle and to preserve their herding culture. Wolves attack reindeer and scatter them to a large area, causing big troubles to the reindeer herders (Rogers, 2014), who because of that also claim that their Sami culture is threatened.

Change in people’s attitudes towards wolves can be influenced by many factors, such as the increasing wolf abundance (Dressel et al., 2015; Treves et al, 2013; Williams et al., 2002), better training and education (Heberlein & Ericsson, 2005; Stohr & Coimbra, 2013; Williams et al. 2002), protection campaigns (Majić and Bath, 2010), information programs (Frank et al., 2015; Nyhus et al. 2003; Røskaft et al. 2003; Treves and Karanth 2003), social division on different attitudes (Eriksson et al, 2015), dialogues and communication (Hallgren & Westberg, 2015; von Essen & Allen, 2015), increasing number of attacked animals (Rogers, 2014), policies (Williams et al., 2002), media, amount of encounters, societal trends or generational value shifts (Inglehart 1995), urbanization, decreasing employment in agriculture, and other (Bisi et al. 2007; Ericsson & Heberlein 2003; Røskaft et al. 2007). Attitude change in three dimensions: 1) according to the wolf abundance, 2) according to the interests related to the wolf activities, and 3) the policies that bring about the changes of interests.

Recent research shows that illegal hunting of wolves is a way of showing disobedience to the conservation policy (Essen, 2016; von Essen & Allen, 2015).

Thus, a strengthened policy on illegal hunting may raise antagonistic emotions among anti-wolf groups. The polarization of attitudes between stakeholders can be viewed as a conflict of interests (Sjölander-Lindqvist et al., 2015).

Attitudes are formed based on the evaluation and trade-off of different values and interests, and are the end products of a weighing and comparing process in our mind.

++ er: this part is missing more emphasis on the existing disagreement between stakeholders. Only one sentence in section 1.1 mentioned it, but to motivate the need of this study we should give more evidence ++

the following

**2 Classification of stakeholders**

Previous studies have identified key stakeholder groups in the context of the wolf population management. People living in urban areas, not owning livestock or reindeer, and who are not hunters, have been categorized as the *general public* (Dressel et al., 2015), *urban public* (Williams et al., 2002), *urbanites* (Heberlein & Ericsson, 2005), or *urban residents* (Bruskotter et al., 2007). People associated with organizations which advocate wolf reintroduction have been categorized as *conservationists* (Bisi et al., 2010; Dressel et al., 2015; Johansson & Karlsson, 2011; Rogers, 2014), *conservation groups* (Stohr & Coimbra, 2013), *environmentalists* (Sjölander-Lindqvist, 2011), or even *ecowarriors* (Sjölander-Lindqvist et al., 2015).

People practicing hunting activities are usually categorized as *hunters, with* or *without dogs*, or simply just *hunters* (Dressel et al., 2015; Johansson & Karlsson, 2011; Sjölander-Lindqvist, 2011; Sjölander-Lindqvist et al., ‎2015; Stohr & Coimbra, 2013; Williams et al., 2002). People owning livestock and living in rural areas are categorized as *farmers* (Dressel et al., 2015; Johansson & Karlsson, 2011; Sjölander-Lindqvist, 2011; Sjölander-Lindqvist, ‎2014; Williams et al., 2002), or *farm animal owners* (Stohr & Coimbra, 2013). People involved in reindeer herding in northern Sweden are often loosely described as *Sami* *people*, or just *Samis* (Rogers, 2014; Sjölander-Lindqvist et al., 2015), although most Samis are not reindeer herders.

The stakeholder classification above is a convenient way to identify a minimal representative number of stakeholder groups in the society, without compromising the diversity of viewpoints. After thorough literature analysis and the discussion with a number of experts and stakeholders, in this paper we have decided to use the following stakeholder groups: *environmentalists, urbanites, hunters, farmers* and *reindeer herders* (Table 1). Furthermore, urbanites and conservationists having mostly positive attitudes to wolves are classified as “pro-wolf” stakeholders, while hunters, farmers and reindeer herders having generally negative attitudes to wolves are classified as “anti-wolf” stakeholders. This binary classification is of course a big simplification, as there may be many individuals in each stakeholder group who do not fit with its description, but we feel that nevertheless it reflects quite well the polarization in the Swedish society (ref?) and we will use it in this study.

Table 1. Stakeholder classification used in this study.

|  |  |  |
| --- | --- | --- |
| Stakeholder | Definition | Attitude towards wolves |
| Environmentalists | People from organizations, which advocate wolf reintroduction | Strongly positive |
| Urbanites | People living in urban areas, not owning livestock or reindeer, and not hunters | Generally positive |
| Hunters | People practicing hunting activities | Strongly negative |
| Farmers | People owning livestock and living in rural areas | Negative |
| Reindeer herders | People involved in reindeer herding in northern Sweden (most – Samis) | Negative |

In the scope of the literature review for this paper, no studies have been found to report on the size of the different stakeholder groups and their relative influences on the policy making related to the wolf management. The conclusion that we have derived from the interviews with a number of experts, hunters constitute the biggest stakeholder group with the strongest negative attitudes in the anti-wolf camp, and are most influential in the policy making process. Following this group are the reindeer herders, while farmers are least extreme with their negative attitudes. Environmentalists are considered a small stakeholder group, although they might be influential on the policy making. Urbanites, who constitute the major part of the stakeholders, are considered most moderate and indifferent towards wolves. In fact, a majority of Swedes are supposedly indifferent, or have very little interest, in this issue.

* 1. **Towards finding a compromise on the wolf population**

***2.1 Satisfaction functions***

Utility functions have been used to study conflicting interests between different stakeholders in management of fisheries (Dankel et al., 2007), water (Randhir & Shriver, 2009), carbon storage, timber production and biodiversity in northern hardwood forests (Schwenk et al., 2012), horseshoe crab harvest (McGowan et al., 2015), food production systems (King et al., 2015). In economics, utility is a measure of the satisfaction or happiness people get from goods or services. Parada Daza (2004) designed a new utility function called *emotional well-being function,* which considers economic, instinctive, social, religious, ethical, and esthetic values. In this paper, a variation of utility functions, which we refer to as *satisfaction functions*, were designed and integrated into a novel model, which will be further discussed below.

*Attitude* is defined as an individual’s psychological tendency to evaluate a particular objective as favorable or unfavorable, and consisting of cognitive, affective and conative components (Ajzen & Fishbein 2005; Dressel et al., 2015; Eagly and Chaiken, 1993). A certain attitude may not lead to a certain behavior, but it can be a factor of rational and irrational judgment towards current policies. In this study, we assume that the stakeholders may build their attitudes upon their interests on the existence of wolves. A satisfaction level can reveal how well our attitudes fit with reality and how successful certain policies meet the requirements of the stakeholders, thus also making itself a pointer in the direction of future policy making.

To our knowledge, satisfaction functions have never been used to study human-wildlife conflict issues. Thus, it is also a novel method in the study of wolf management in Sweden. Although the satisfaction function is derived from the utility function, it differs from the utility function in the way that the utility function is based mainly on a variable expressed in monetary terms (e.g., consumption), while the satisfaction function is based on non-monetary variables, it reflects “psychological utility” which is judged personally.

In this study we (1) come up with relevant components of a satisfaction function of each stakeholder group with respect to the number of wolves; 2) suggest to aggregate these components into a single satisfaction faction for each stakeholder groups based on assigned to each component weights, different for each stakeholder group; 3) using the constructed satisfaction functions analyze feasible wolf population size delivering the same satisfaction to all stakeholders and analyze its sensitivity with respect to model parameters.

A group of experts was formed (at the International Institute for Applied Systems Analysis, IIASA) to assess and devise primitive forms of the satisfaction functions we wanted to develop. After the functional forms had been suggested, a meeting with other experts at IIASA was held to evaluate the functions. The experts included ecologists, economists and systems analysts. With the comments and suggestions from those experts, the final satisfaction functions were decided. Due to the limitation on available time and resources, no stakeholder meeting was held to design the functional forms. However, the provisional functional forms were assumed to be reasonable for the initial research and the model building. In sum, eleven interests and their corresponding functional forms were suggested.

A preliminary curve was drawn for each interest group based on to demonstrate the relationship between satisfaction and the wolf population. Four features were considered: (i) what is the satisfaction of the considered stakeholder group in the absence of wolves, (ii) what is the satisfaction of the considered stakeholder group if wolf population equals to the carrying capacity, (iii) is the satisfaction function increasing or decreasing with respect to the number of wolfs, (iv) does the satisfaction function have an increasing or decreasing return to scale. Mathematical forms for the selected curves were then proposed, simplest possible functions satisfying the defined criteria (i) – (iv) were chosen. Note that more precise calibration of the satisfaction functions is not feasible at this stage as no data is available.

The satisfaction level is arbitrarily set between 0 and 1 as an equivalent to the infinite sequence of preference as a utility representation in the utility theory (Mas-Colell et al., 1995). The interval between 0 and 1 was chosen to simplify the calculation. Other intervals could also be used, but would not change the overall results.

The carrying capacity of wolves in Sweden has been estimated to be around 10,000 (Persson, 1996). However, in 1800, the wolf population in Sweden was about 1,500 and that was considered too many for the country and the wolves were taken as pests. Sand et al. (2014) suggested that the carrying capacity in Sweden is about 1200 wolves outside the reindeer herding area. We consider 1,200 wolves as a reasonable carrying capacity in our model, although it should be reconsidered as more scientific data becomes available in the future. We also assume that when stakeholders form their attitudes towards the population of wolves, they would use the same carrying capacity for all the interests, which means the upper limits of the wolf population in all the satisfaction function are set uniformly to 1,200.

Based on the literature analysis, we select the following components of the satisfaction function:

* Biodiversity
* Loss of livestock
* Loss of reindeer
* Loss of hunting dogs
* Tax
* Preventive measures
* Ecotourism
* Biophilia
* Hunting culture
* Sami culture

We assume that all stakeholder groups have the same components of their satisfaction functions, but they differ in weights, which they assign to each component. In what follows we describe the components in detail and suggest mathematical functions to model them.

***Biodiversity***

Biodiversity is one of the environmental values, which is defined as a relatively stable expression of the evaluation of the environment and contains emotional and cognitive components (Gangaas et al., 2015). Thinking of the role of wolves in relation to the biodiversity in Sweden, people may think of its carrying capacity, the functions to the local ecosystem, the meaning of existence as a wild animal, etc. Some scholars suggest the *Favourable Reference Population* (population in a given biogeographical region considered the minimum necessary to ensure the long-term viability of the species (European Commission, 2005)) in Sweden to be 500 (Bruford, 2015; Sjögren-Gulve & Hörnell-Willebrand, 2015). In our preliminary interview, some stakeholders also think that the favorable population is 500. Thus, we take 500 as a wolf population that people would think best for the biodiversity.

When the wolf population is very low, people may take it as a sign for a sub-optimal biodiversity, so the satisfaction level is very low. The satisfaction level increases when the wolf population increases, until it reaches the maximum level of 1 for the ideal population size of 500 wolves. The satisfaction level drops when the population keeps growing, because larger population means risk of interspecies competition and a potential imbalanced ecosystem. A bell-shaped function will fit to this description and we have chosen the Gaussian distribution function in the form:

Here denotes the number of wolves;parameter defines the point of maximum, so according to our assumption we set parameter determines the “breadth” of the bell, we have chosen to have the satisfaction level appr. 0.5 when the number of wolfs is about half of the ideal size.

Figure 1. Satisfaction levels regarding biodiversity as a function of number of wolves.

*L****oss of livestock***

The more wolves are out there the more livestock is attacked and killed, the satisfaction related to livestock loss takes its maximum value equal to 1, when there are no wolves, but it will decrease as the number of wolves increases. We assume the satisfaction continues to decrease to zero at an estimated number about 700 wolves. An exponential function was chosen to match the curve. The function of the form is chosen as:

where denotes the number of wolves, and *c*1 is the coefficient describing how quickly the satisfaction function decreases from zero ().

Figure 2. Satisfaction levels regarding loss of livestock against wolf population.

*L****oss of reindeer***

The rational of satisfaction regarding loss of reindeers was similar to loss of livestock. The difference between them was that the satisfaction for loss of reindeers dropped more quickly than the satisfaction for loss of livestock, reaching zero at a population of 300. Reindeer herders are assumed to be more negative than farmers, considering that reindeer herders in general depend solely on reindeer herding, and the damage caused by wolves also involves scattering of the herds, which is costly in itself. The function of the form was chosen as

to represent the satisfaction from loss of reindeer; denotes the number of wolves, *c*2  is the coefficient describing how quickly the satisfaction function decreases from zero ().

Figure 3. Satisfaction levels regarding loss of reindeer against wolf population.

***Loss of hunting dogs***

Satisfaction levels regarding loss of hunting dogs change similarly to the satisfaction levels regarding loss of livestock and loss of reindeer. However, hunters seem, in general, to have the least acceptance of wolves, regarding their hunting dogs killed by wolves, as they are often considered family members. The loss of hunting dogs make the satisfaction level for hunters drop to zero when the wolf population is about 200. The same function is used here, as in the two previous cases, but with a different decay constant:

As before, denotes the number of wolves, *c*3 is the coefficient describing how quickly the satisfaction function decreases from zero ().

Figure 4. Satisfaction levels regarding loss of hunting dogs against wolf population.

***Tax***

If there are more wolves, taxpayers have to spend more money on protecting the wolves, but there are also expenses relating to the compensation, installing fences, etc. Hence, the satisfaction is 1 when the wolf population is zero, and decreases as the wolf population increases. Some people argue that the tax is not a major concern relating to wolves, so the upper number is above the carrying capacity of 12000 wolves~~, but it has been raised by some hunters in the empirical study (von Essen, 2016)~~. The functional form is:

As before, denotes the number of wolves, *c*4 is the coefficient describing how quickly the satisfaction function decreases from zero ().

Figure 5. Satisfaction levels regarding tax against wolf population.

***Preventive measures***

Preventive measures can be designed to protect livestock, hunting dogs and reindeers from wolf attacks, for example: electronic fencing in the farming area, radio-collars for hunting dogs and sound- and smell-based preventive measures, etc. The compensation for the losses of dead or wounded animals and the damage of infrastructure also belongs to this category, as economic means to diminish the losses. However, it appears from meetings and interviews with stakeholders and experts that the current preventative measures are far too insufficient to cover the whole loss, especially for the emotional and social perspectives. Therefore, more wolves are expected to lead to more losses, in spite of preventive actions taken and compensation to prevent or rescue the losses. With no wolves, the satisfaction level is assumed to be at maximum (1). Although there are preventative measures, the effects are not sufficient to make people fully satisfied. So when the wolf population grows, the satisfaction level would presumably decrease to zero, when the wolf population is very large. The function of the form was chosen as

to represent the satisfaction from preventative measures; heredenotes the number of wolves, is the coefficient describing how quickly the satisfaction function decreases from zero ().

Figure 6. Satisfaction levels regarding preventative measures against wolf population.

***Ecotourism***

Wolves are a potential resource for tourism which has become an important means for rural development and nature conservation. There are strong supportive attitudes towards ecotourism in Sweden (Ednarsson, 2006). Experts who participated in the review meeting for satisfaction functions also suggested the importance of ecotourism. When the wolf population is small and the chance for spotting a wolf or its tracks is low, ecotourism may make little profit. Thus, the satisfaction of the people who run the business and who enjoy the services is very low. As the wolf population grows, the satisfaction increases. However, the satisfaction level would not increase linearly because when there are too many wolves that could be easily observed or encountered, people would become reluctant to pay for ecotourism. So the marginal satisfaction will presumably decrease and the satisfaction level will remain almost constant. The exponential function can depict this change:

wheredenotes the number of wolves, is the coefficient describing how quickly the satisfaction function grows from zero ().

Figure 7. Satisfaction levels regarding ecotourism against wolf population.

***Biophilia***

Biophilia means that humans possess an innate tendency to seek connections with nature and other forms of life (Wilson, 1984). According to this concept, it is reasonable to assume that people would like to see as many wolves as possible in nature, but the marginal satisfaction would probably decrease until the wolf population reaches some limit size. The satisfaction level with regard to *biophilia* starts from zero when there are no wolves. It may increase with the growth of the wolf population, to reach the maximum level when the wolf population is very large, and then stays the same. An exponential function is chosen to describe this dynamics:

where denotes the number of wolves, is the coefficient describing how quickly the satisfaction function grows from zero ().

Figure 8. Satisfaction levels regarding biophilia against wolf population.

***Fear***

Fear of wolves is a complex combination of emotion and cognition. Frank et al. (2015) found that the fear of attacks on livestock and pets is stronger than the fear of attacks on humans, apparently due to experience and historical events, so fear links to the abundance of wolves. When wolves are absent, there is no fear and the satisfaction is highest. As the population increases, the fear of attack by wolves may increase linearly, rendering a linear decrease of the satisfaction level. The function here is chosen as

where denotes the number of wolves, is the coefficient describing how quickly the satisfaction function decreases from zero (). The value of is set arbitrarily to fit the curve.

Figure 9. Satisfaction levels regarding fear against wolf population.

***Hunting culture***

Hunting is a traditional activity in Sweden, not only for entertainment but also for getting food from the game. Nowadays, hunting has become an important part of many people’s lives in Sweden. There are nearly 300,000 hunters in Sweden (which is approximately 3% of the population). Through hunting, hunter communities establish and uphold social relationships and networks. The feelings of fellowship, solidarity and relationship building are also established through hunting activities, thus creating a sense of belonging (Sjölander-Lindqvist, ‎2011). Wolves in the forest compete with hunters on game and may kill hunting dogs, which are often considered as family members. Therefore, the hunters claim that their hunting activity is strongly disturbed by wolves and if the wolves keep increasing, the rural identity and hunting culture will be at risk of disappearing (Essen, 2016; von Essen et al., 2015).

The hunting culture would be best preserved when there is no disturbance, i.e. with no wolves in the vicinity. Thus, the satisfaction level regarding hunting culture is highest when there are no wolves. The satisfaction level drops when the number of wolves increases. When the wolf population is very large, the satisfaction gradually becomes almost zero. The function of the form is chosen as

where denotes the number of wolves, is the coefficient describing how quickly the satisfaction function decreases from zero ().

Figure 10. Satisfaction levels regarding hunting culture against wolf population.

***Sami culture***

Reindeer herding is a traditional activity of Samis. Samis have been herding reindeers for about two hundred years in the north of Sweden. (Previously, they were hunting wild reindeer, which eventually became extinct, due to hunting). While most Samis live in cities and have other occupations, the preservation of the traditional Sami culture is considered to depend on the preservation of reindeer herding. Since many Samis have been used to an environment without wolves in the past century, they are not willing to accept any damage on their herds by wolves. According to Swedish law, they have the right to protect their herds by hunting wolves, and in principle, no wolves are allowed to exist in a large part of Northern Sweden where reindeer herding may occur. The Samis have claimed that if the wolf population expands to some large extent, it may threaten the existence of the Sami culture. Hence, the satisfaction level for the Sami culture would decrease as the wolf population increases (as the wolves may occasionally enter the reindeer herding areas), reaching zero satisfaction at a much larger population than the present. The satisfaction function is here chosen as

where denotes the number of wolves, was the coefficient describing how quickly the satisfaction function decreases from zero ().

Figure 11. Satisfaction levels regarding Sami culture against wolf population.

Table 1 summarizes the satisfaction functions regarding the different interests discussed above.

Table 1. Summary of satisfaction functions for different stakeholders

|  |  |  |  |
| --- | --- | --- | --- |
| Biodiversity | Loss of livestock | Loss of reindeer | Loss of hunting dogs |
| Tax | Preventative measures | Ecotourism | Biophilia |
| Fear | Hunting culture | Sami culture |  |

***2.2 Satisfaction functions for different stakeholders***

Based on stakeholder interactions and expert assessment, weights of different interests, expressed through the satisfaction functions, are given in Table 2. The relative weights given here are conceptual (low, medium, high), which roughly correspond to the importance of the interests rating by stakeholders. The qualitative weights are translated to quantitative numbers, as Low = (between 0 and 0.33), Medium = (between 0.34 and 0.66), and High = (between 0.67 and 1). For each stakeholder, the sum of the weights are 1.

Table 2.The weights of interests of stakeholders.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Interests  Stakeholders | Biodiversity | Loss of hunting dogs | Loss of livestock | Loss of reindeer | Tax | Preventative measures |
| Environmentalists & Urbanites | High | 0 | 0 | 0 | Low | 0 |
| Hunters | Low | High | 0 | 0 | Low | 0 |
| Farmers | Low | 0 | High | 0 | Low | Medium |
| Reindeer Herders | Low | 0 | 0 | High | Low | 0 |
| Interests  Stakeholders | Ecotourism | Biophilia | Fear of wolves | Hunting culture | Sami culture |  |
| Environmentalists & Urbanites | 0 | High | High | 0 | 0 |  |
| Hunters | Low | Low | High | Medium | 0 |  |
| Farmers | 0 | Low | Medium | 0 | 0 |  |
| Reindeer Herders | 0 | Low | Medium | 0 | Medium |  |

By summing the weights of the different interests, a general satisfaction function for each stakeholder with respect to the size of the wolf population, is formed.

Considering only those interests with non-zero weights, the satisfaction function for *environmentalists* and *urbanites* (the “pro-wolf” group) is summed up as:

The satisfaction function for *hunters* is:

The satisfaction function for *farmers* is:

The satisfaction function for reindeer herders is:

The satisfaction function for the entire “anti-wolf” group (hunters, farmers, and reindeer herders) is:

1. **Results**

Figure 12 shows the satisfaction functional forms of different stakeholders with regard to the wolf population. According to the functions, the pro-wolf group may increase their satisfaction from 0 to a peak level close to maximum (with a normalized value of 1) when the wolf population increases from zero to about 500. The satisfaction is supposed to decrease as the wolf population continues to grow, and is close to 0 when the wolf population becomes very large (here expected to be around 1200 wolves). The anti-wolf group has a maximum satisfaction level when there are no wolves (although in reality the satisfaction can vary within the groups), which decreases when the wolf population grows, until the satisfaction drops to a very low values, approaching 0. The point where both the satisfaction curves cross shows that the two groups have the same satisfaction level of about 0.4 when the wolf number is about 200. However, this point does not indicate a compromise, because even though the stakeholders reach the same satisfaction level, the level of 0.4 is still low, where neither group is satisfied. The current wolf population of about 340 individuals, indicates that the pro-wolf group may have a higher satisfaction level than 0.5, while the anti-wolf group would have a much lower one. The big gap between the two satisfaction levels may shed some light on the current conflict in the society, where some people want to have more wolves while others strongly oppose it.

Figure 12. Satisfaction level of different stakeholders. For the pro-wolf group, the satisfaction level increases as the wolf population increases from 0 to a high level at about 500. The satisfaction level decreases as the population continues to increase. For the anti-wolf group, the satisfaction level decreases continuously when the wolf population increases.

Figure 13 depicts the satisfaction level of the pro-wolf group against the satisfaction level of the anti-wolf group. The pro-wolf group has the highest satisfaction level of about 1 when the anti-wolf group has a very low satisfaction of about 0.2. When the satisfaction of the anti-wolf group increases, the satisfaction of the pro-wolf group drops continuously until it is very low, at about 0.1, where the anti-wolf group has the highest level at about 1. The dotted line indicates equal satisfaction levels. The intersection of the satisfaction line and the equal satisfaction line is about 0.4, indicating that if the government wants to have an equal satisfaction level for both groups, the satisfaction level is not high. There is no range of satisfaction level where both groups are satisfied to a high degree (see the “desired area” in the figure), which means that under the current relationships between the satisfaction levels and the interests, there is not a win-win strategy.

desired area

Figure 13.Satisfaction level of anti-wolf group against pro-wolf group.

**3.2 Scenario analysis**

In this study, we look at three scenarios regarding implementation of different policies. The differences between different scenarios mainly affect the anti-wolf group, so only the change of attitudes of this group was simulated.

*Scenario 1*

In the first scenario, we simulate the implementation of policies on economic incentives and preventative measures. The policies are assumed to boost acceptance of wolves and can be revealed by changes of functional forms of the interests of loss of livestock, loss of reindeers, loss of hunting dogs and increased weights of preventative payment in the satisfaction functions, showing a shift of attention from economic losses to gains.

*Scenario 2*

In the second scenario, we simulate implementation of policies to promote education, dialogues and campaigns for wolf conservation. Weights of biodiversity and biophilia increase and weights of fear, hunting culture and Sami culture decrease, representing an increased attention to biodiversity, decreased fear to wolves and more tolerance to the losses of hunting culture and Sami culture.

*Scenario 3*

In the third scenario, we simulate a strengthened policy on punishing illegal hunting. Previous studies (Pohja-Mykrä, 2016) indicate that tightened criminal sanctions may have negligible or negative effect on deterring illegal hunting and relieving the tense between the pro and anti-wolf groups. In accordance to these findings, weights of biodiversity and biophilia decrease and weight of fear increases.

The results of the scenario simulations comparing to the current situation is shown in Figure 14. The anti-wolf group has the highest satisfaction level in Scenario 2, where the intersection of pro- and anti-wolf groups occurs at a satisfaction level of about 0.44. This indicates that promoting education, dialogues and campaigns for wolf conservation could be most effective in relieving conflict. Scenario 2 shows mild increase of satisfaction of anti-wolf group than the current level. However, the intersection point of the pro- and anti-wolf groups remains low. This implies that the policy with increased economic compensation might play limited role in conflict resolution. In the model, Scenario 3 shows that the satisfaction becomes lower due to the strengthened policy on illegal hunting. This would imply that increased punishment may not help in relieving the tension between the two groups and even exacerbate the tension.

Figure 14. The satisfaction level of pro- and anti-wolf groups in comparison of the current level and the level in simulation of scenario 1, 2 and 3.

1. **Discussion**

Previous studies on the wolf issue in relation to stakeholders in Sweden have touched a broad span of perspectives. Some studied the positive and negative attitudes of the people on wolf population (Frank et al., 2015; Gangaas et al. 2015; Heberlein & Ericsson, 2008; Karlsson & Sjostrom, 2007). Some studied the ecological condition of wolves to survive and thrive within the natural and social limitation in the rural area (Sjögren-Gulve & Hörnell-Willebrand, 2015). Some studied the communication and deliberation between the stakeholders and the decision makers and gave suggestions from a communicative and political perspective (von Essen, 2016; von Essen, & Allen, 2015; von Essen et al., 2015). Some pointed at the entangled complexity of culture, history, politics and ethics underneath the issue and the deficiency of decision makers to sufficiently address these aspects in the conflicts (Sjölander-Lindqvist, 2008; Sjölander-Lindqvist & Cinque, 2014; Sjölander-Lindqvist et al., 2015). Some researched on economic impact which the wolves caused to the people affected (Naughton-Treves et al., 2003; Nyhus et al., 2003; Treves et al., 2009). However, none of these studies has developed a systematic framework that take into account the ecologic, economic and social perspective at the same time. Lacking of a systematic framework, people may find it hard see the whole picture with all the perspective being considered all together.

This paper presents a novel model for systematic analysis of the attitudes of conflicting stakeholders with different interests relating to the wolf management issue in Sweden. With a satisfaction function as a tool, one can observe in one figure the changes of the satisfaction level of different stakeholders in relation to the size of the wolf population. The model also simulates and compares scenarios with different policies, providing political implications. As a result, the model in this paper is a complementation and a synthesis tool for analyzing the aspects presented in other studies in this field.

Our model can be seen as a useful tool for communication and collaboration. During the process of designing and modifying the functions, meetings, workshops, interviews and other forms of unofficial dialogues can be held. Through these forms of communication and collaboration, stakeholders and experts can get together and discuss around the same issue. Being aware of the satisfaction functions of each other, people may come to understand each other in a more objective and rational way than in traditional meetings, which so far have failed to bring about agreement in the Swedish society. Useful information and knowledge from experts and the government can spread among stakeholders.

Research on human-wildlife conflicts seldom focuses on building a systematic framework to analyze the decision making mechanism among the different stakeholders with an emphasis on interests and effects of potential policies. This model with satisfaction functions is a pilot example of such a systematic framework. More systematic methodologies are called for in the future, especially models to simulate the interaction between stakeholders. Furthermore, the frameworks can be applied to other social issues with conflicting interests among stakeholders, not only concerning natural resources management.

The limitation of this study is mainly lack of empirical data for calibration, validation and verification. The functional forms, the interests of the stakeholders and related weights, and the relationships between satisfaction levels and the wolf population, were drawn and inferred from the limited meetings and discussions we held with experts and stakeholders. The scope of these meetings and interviews is constrained and no sufficient representation at a national level is provided. The size of the stakeholder groups were also neglected in the calculation of the satisfaction function of the lumped pro- or anti-wolf stakeholders and in the comparison of the satisfaction levels of the two camps in the same figure (e.g. Figure 12).

However, as a methodology study, the model is a simplified abstraction of the actual situation, without exhaustion of complete reality. The model is sufficient to demonstrate a systematic framework as a direction for analyzing the existing issue and it is a tool to promote understanding and dialogue between stakeholders.

1. **Conclusion**

This paper presents a systematic framework to analyze the attitudes of stakeholders with conflicting interests regarding the wolf management issue in Sweden. The framework is based on a model with *satisfaction functions* as analytical tools for understanding relationships between the attitudes, the interests of stakeholders, and the wolf population. With a theoretical basis from the literature, we developed the satisfaction functions in dialogue with experts and stakeholder representatives. The model shows that the current attitudinal gap on wolves between the two main stakeholder groups (here lumped as “pro-wolf” and “anti-wolf”, respectively) is quite large, and that the conflict between the two groups cannot be solved by simply regulating the wolf population size.

Through three scenario simulations, the model shows that if policies on promoting education, dialogue and campaigns for wolf conservation are effective in changing the attitude of anti-wolf stakeholders, then this can help alleviate the conflict between the stakeholders. Enhancing economic incentives and preventative measures were assumed to have less effect. Strengthening policy on punishing illegal hunting may render counter-effect on relieving the tension.

We believe that this kind of modeling approach, at least in principle, can be used as an analytical tool for studying the attitudes and the effects of different policy measures on changes of stakeholder attitudes. It could also serve as a basis for discussion and dialogue between stakeholders, where different viewpoints can be expressed and discussed, with the aim of reaching a more balanced and acceptable solution.

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