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Abstract

From an interdisciplinary approach, this study aims at analysing self-reported animal fear, specifically large carnivore fear, in relation to public willingness to financially contribute to fulfil a governmental policy on large carnivore-induced costs. In a survey of 2 455 Swedes, it was found that people whose animal fear was directed particularly towards large carnivores, were less likely to be willing to pay (WTP), or were likely to be willing to pay a lower amount of money. In the prediction of WTP, the contribution of the fear variables was equally important as the socio-economic factors. From a management point of view it seems urgent to understand what kinds of measures that may reduce human fear of large carnivores. It is also suggested that further studies should include standardised measures of anxiety and fear in order to be able to closer link the results of large carnivore fear to the psychological literature on human fears.

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1. Introduction

The management and conservation of large carnivores such as the brown bear (*Ursus arctos*), wolf *(Canis lupus*), lynx (*Lynx* lynx), and wolverine (*Gulo gulo*) is heavily debated. In order to fully understand public reactions to wildlife management interventions it is suggested that affective aspects must be considered in a direct way (Roskaft, Bjerke, Kaltenborn, Linnell, & Andersen, 2003; Kaltenborn, Bjerke, & Nyahongo, 2006). This study combines the perspectives of environmental psychology, wildlife biology, and economics in the analysis of people's self-reported fear of encountering the four Swedish large carnivores (brown bear, wolf, lynx, and wolverine) in relation to public willingness to financially contribute to the fulfilment of a governmental policy on carnivore-induced costs.

Fear of large carnivores, especially wolves, is a widespread phenomenon (Kanazaki, Maruyama & Inoue, 1996; Karlsson, et al., 1999; Ericsson & Heberlein, 2003) Roskaft et al., 2003). At a fundamental level, anxiety can be described as a feeling that has no basis in an identifiable object, whereas fear includes psychological, physiological, and behavioural responses towards a specific object (Pervin, 1989; Spielberger, 2006). Human fears are determined by biological dispositions and individual personality traits, such as anxiety, on the one hand, and experiential factors including affective as well as cognitive learning experiences on the other hand (Armfield, 2006). It has been argued that trait anxiety can be expressed as a number of different specific fears. One such category of fear seems to be animal fear (Taylor, 1998, Cox, Lachlan, McWilliams, Clara & Stein, 2003; Cutshall & Watson, 2004), which in turn has been suggested to be further sub-divided into the expressions of more specific types of animal fears (Davey, 1994; Ware, Jain, Burgess & Davey, 1994; Davy et al., 1998). Based on data of public self-reported fear of animals Arrindell (2000) defined, by means of factor-analysis, four sub-categories of animal fears that were internally consistent and relatively independent from one another: fear-relevant animals, dry or non-slimy invertebrates, slimy or wet looking animals, and farm animals. Additional research also lent Arrindell (2000) to propose a fifth sub-category of high-predatory animals. Moreover he suggested that these five sub-categories may be further divided into fears of specific stimuli of animals that could induce at least mild fear. It has been suggested that the various sub-categories

of animal fears are acquired in different ways (Davey, 1994), and that fear of high-predatory animals is commonly associated with harm and pain, whereas fears of low-predation animals is associated with disgusting outcomes indicating either contamination or disease (Webb & Davey, 1992; Davey, Cavanagh & Lamb, 2003).

In studies based on factor-analysis the carnivores, bears and wolves are usually categorised together as fear-relevant (Davey et al., 1998) or high-predatory animals (Ware et al., 1994; Tucker & Bond, 1997) depending on the species included in the study. It should, however, be noted that the selection of species investigated in the research on animal fear usually has been made on psychological grounds rather than biological taxonomies. Also, in a study carried out from a biological management point of view, Roskaft et al (2003) found that the fears of wolf, brown bear, wolverine, and lynx were positively correlated, i.e. people expressing fear of one species also feared the other three. Large carnivore species with a relatively higher mean body weight were more feared than the smaller species, and more people were afraid of species that had caused a higher number of casualties. Further, the level of fear of the same species differs between socio-demographic groups. Women, for example, in general report a higher level of fear than men (e. g. Arrindell, 2000; Tucker & Bond, 1997), and older people are more afraid than younger people of wolf, brown bear, and wolverine (Roskaft et al., 2003). In Swedish studies approximately 30% of the public say that they are afraid of meeting wolves outdoors (Karlsson et al., 1999; Ericsson & Heberlein, 2003). People who are afraid of wolves restrict their outdoor behaviour (Sjölander-Lindqvist, 2008), are more negative towards wolves in their vicinity, and are less likely to accept their presence (Karlsson et al., 1999). In sum, the literature suggests that animal fear, and in turn fear of high-predatory or fear-relevant animals might be further sub-divided into fear of large carnivores, including certain attitudinal and behavioural responses towards these species. The objective threat to humans from the large carnivores in Sweden is very low, since attacks on humans are rare. Humans were killed by Swedish brown bears in 2004 and 2007. Our data was collected in 2004 but before the incident in 2004 where a human was killed by a brown bear. The last time a human was killed by a bear before those two incidents was in 1902. The last ten years, on average one human per year is seriously injured by a brown bear, most often hunters. The last time a human was killed by a wolf in Sweden was in 1821, and since then there

has been no documented case of a wolf physically attacking a human in Sweden. However, the wolf population has been extremely small or absent in large areas of Sweden until 20 years ago. Lynx attacks on humans occur irregularly. During the last ten years, there has been two occasions when a startled lynx has caused minor injuries on humans. Wolverines have not been documented to attack humans.

The large carnivore populations of Sweden are estimated as follows: brown bear 2 500 individuals (Kindberg & Swenson 2006), wolf approximately 130 individuals (Aronson et al., 2005), lynx 1 200–1 300 individuals (Liberg & Andrén 2005), and wolverine approximately 420 individuals (Persson, 2006). The national population goals are set by the national parliament and supervised by the Swedish EPA. The costs for management and conservation of large carnivore are covered by the government, and hence financed by the tax payers, and include compensation for attacks on livestock and humans as well as subsidies for actions to prevent predation on livestock. There are several studies applying different econometric approaches in the analysis of public WTP for the restoration of carnivore populations in Sweden (Boman & Bostedt, 1999; Bostedt, Ericsson & Kindberg, 2008; Broberg & Brännlund, 2008a; Ericsson, Bostedt & Kindberg, 2008). In these studies a large number of factors including socioeconomic variables such as age, income, and gender as well as household characteristics and the presence of large carnivores in the participants' place of residence have been found to predict WTP for governmental policies for management and conservation of carnivores. None of these studies have however considered public fear in the analysis. In this paper we use a similar model and data from the same survey as did Karlsson and Sjöström (2007) but include a set of fear variables. Data from the survey has also been used in Broberg & Brännlund, (2008a and 2008b) and Karlsson and Sjöström (2008).

1.1 Aim and hypotheses

The study aims at analysing whether animal fear will contribute to the explanation of public WTP for the fulfilment of a governmental policy on large carnivore-induced costs. Animal fear is defined as one's self-reported fear of encountering 10 indigenous Swedish animal species. This more general animal fear is, in line with previous research, analysed for expressions of specific types of fears. We hypothesize that in the fear of indigenous Swedish animal species, fear directed towards the large carnivores is

most important to WTP, and that large carnivore fear is negatively correlated with WTP.

To our knowledge, there are no studies analysing the additional impact of fear in relation to WTP for governmental policies for management and conservation of large carnivores, and in fact WTP studies considering such emotions in relation to other environmental amenities are rare. This study is also unique in the sense that it combines self-reported data on animal fear with data from wolf, bear, lynx, and wolverine census with detailed (co-ordinate based) data on the participants' place of residence and WTP.

2. Method

2.1 Sample

The study was carried out as a postal survey among 4050 Swedes between 18 and 84 years of age. 2 455 persons responded (49% women and 51% men, mean age 51 years), response rate 60.6%. The participants were selected from the register of the Swedish total population. With the objective of obtaining a sufficient number of people who live close to carnivores, the sample was stratified in order to over-sample participants in rural areas.

2.2 Instrument and procedure.

In total, the questionnaire included 24 questions, and for the present purpose the following are analyzed: In order to grasp the participants' fear they were asked, "How much are you feared of encountering the following indigenous animals in the outdoors: Moose, brown bear, wolverine, snake, lynx, wolf, wild boar, wasp, badger, and ticks" and, "How fearful would you feel for your self and your family's safety outdoors if you knew that there were large carnivores close to your place of living?" The participants indicated their degree of fear on 4-point Likert scales 1=not fearful at all, 4= very fearful. The list of animal species was based on earlier Scandinavian management and conservation studies (Karlsson et al., 1999).

WTP was estimated in a 2 step procedure using the following question in the first step: "Suppose that a government policy for the large carnivores is important for a sustainable survival of the large carnivores in Sweden. Would you consider financially supporting measures to fulfill the governmental policy on carnivore-induced costs?"

Possible answers were “yes” and “no”. The procedure then continued with a second step for those respondents replying yes in the first step: “Below we list several amounts of an annual tax that you will have to pay for the next five years for carnivore induced costs, which covers wolves, bears, lynx and wolverines. Mark for each amount how certain you are about paying that amount. The bids were 1 Euro, 5 Euro, 10 Euro, 20 Euro, 40 Euro, 80 Euro, 150 Euro, 300 Euro and 500 Euro, and possible answers were “definitely yes”, “probably yes”, “unsure”, “probably no”, or “definitely no”. In the first step (yes/no) we use a logit model and in the second step we use a logistic model with a double-bounded format where the respondent’s WTP is bounded by the highest bid the respondent accept and the lowest bid she does not accept. For a more detailed description of this approach see Broberg and Brännlund (2008b).

Moreover, a few questions controlling for individual background factors that previously have been shown to influence acceptance of large carnivores (i.e. education, if one lives on a farm, if there is a hunter in the household, if one has a hunting dog and domestic animals, if one is a member of an organisation working for conservation of nature) have been analysed (Karlsson & Sjöström, 2007) as well as census data for gender, age, and income. These variables are fully described in relation to the WTP analyses in Table 2.

The questionnaire was sent by post in May 2004. After about two weeks a simple reminder was sent to those who had not responded to the first survey. At the beginning of June, the questionnaire was sent again to those who had not yet responded, and at the end of June the data collection was closed.

The survey and census data were combined with GIS information on whether or not the participants lived in an area where one or more large carnivore species occur on a regular basis. For brown bear, this was defined as the area in which 95% of females are shot during the autumn bear hunting season, for wolves, as inside or outside known wolf territories (wolf territories are monitored each year by the county administration boards), for lynx and wolverines as a minimum convex polygon around the documented lynx wolverine reproduction areas respectively.

2.3 Data treatment

In the analyses of the survey data, missing data for single items and don’t know responses have been excluded, therefore N varies. Due to the skewed distribution of the

responses for the participants' fear of encountering individual species, both non-parametric statistics (Spearman rho) and parametric statistics (factor analysis) were used when identifying the dimensions of fear. The results did not differ in any essential way and therefore only the parametric analyses are reported. The internal reliability of the computed indices was tested by Cronbach's alpha, and the face validity was tested in correlational analyses (Pearson r) and discriminant analyses (one-way ANOVA).

2.4 Willingness to pay model

The econometric specification of our models is basically derived from a random utility framework. The first model, or first step, is a simple choice model on the probability of supporting the predator policy as discussed above. The hypothesis here is that a relative high degree of fear implies a relative low WTP for the policy package securing the existence of predators, which then affects negatively the probility for saying "yes" to the proposal. The specification is a simple logit model (see Greene, 1993). In the second model, or step, we consider only those respondents who are willing to contribute financially (the "yes" answers) to the policy package. Thus, in this second step we can take advantage of the multiple-bounded format in our data, by adopting the same approach as Welsh and Poe (1998) and Broberg and Brännlund (2008a). This means that we recode the data such that "definitely yes" and "probably yes" means "yes", and "uncertain", "probably no" and "definitely no" means "no". After recoding the data the MB data can be treated in the same way as ordinary payment card data.

The payment card format implies that the respondent is presented with a number of bids, and she is then supposed to check the amount that corresponds to his/her maximum WTP. Given this assumption we only have to consider the highest bid the respondent accepts, and the lowest bid she doesn't accept. So, if we define A^L to be the highest "yes" bid, and A^U to be the lowest bid with a "no" (the bid after the checked one), the maximum WTP is $A^L \leq WTP < A^U$. Then, given a distribution function F for WTP we can write the likelihood as (see also Broberg & Brännlund, 2008a):

$$\ln L = \sum_1^N \left[\ln\left(F(A^U) - F(A^L) \right) \right] \qquad (1)$$

Here we will assume a log logistic distribution, which means that $F(A^U) = (1 + e^{\boldsymbol{\delta}\mathbf{X} - \alpha \ln(A_i^U)})^{-1}$ and $F(A^L) = (1 + e^{\boldsymbol{\delta}\mathbf{X} - \alpha \ln(A_i^L)})^{-1}$, where $\mathbf{X}$ is the vector of

covariates, including carnivore fear, and δ is the corresponding parameter vector. The parameter α corresponds to the bid and can then be interpreted as the marginal utility of money.

3. Results

3.1 General animal fear and sub-dimensions

In line with previous research on animal fears (Davey et al., 1998), the general animal fear was computed as an overall index. In our case this meant adding the individual's ratings of the 10 animal species and dividing the sum by 10. The mean values and standard deviation of the ratings of the 10 different species are shown in Table 1.

Table 1. Number of respondents, means and standard deviations for fear of the 10 species (N = number of observations, M = mean, SD = standard deviation).

Animal	N	M	SD
Moose	2399	1.41	0.69
Brown bear	2377	1.92	1.23
Wolverine	2328	1.39	0.84
Snake	2405	1.93	1.01
Lynx	2375	1.46	0.86
Wolf	2384	1.79	1.10
Wild boar	2362	1.69	0.97
Wasp	2392	1.54	0.82
Badger	2374	1.36	0.70
Tick	2393	2.11	1.02

The mean value of animal fear 1.64 (SD=0.62, N=2253), shows that the participants' level of fear in general was rather low i.e. most people was only a little feared of encountering the indigenous animal species outdoors. The value of Cronbach's alpha=0.87 indicates that the index of animal fear is internally consistent.

Possible sub-dimensions of the fear of encountering indigenous animal species were investigated by an exploratory factor analysis (principal component, orthogonal rotation according to the varimax criterion). The analysis resulted in a two-factor solution, explaining 63% of the variance. The first factor encompasses mammals accounting for 41% of the total variance. The animals loading the highest (above .80) were the four

large carnivores. The second factor accounted for 22% of the variance and seems to mirror disgust relevant animal species, with tick, wasp, and snake loading the highest (between .63 and .80). Based on the outcome of the factor analysis indices for the sub-dimensions of animal fear was constructed. In the index of large carnivore fear the participants' ratings for brown bear, lynx, wolf, and wolverine were added and then divided by four (M=1.62, SD=0.84, N=2313, Cronbach's alpha=0.90). Large carnivore fear was significantly and positively correlated with age, but the coefficient was low in magnitude (Pearson r=.14, p=.000, N=2313). Moreover, women expressed a higher level of large carnivore fear than did men (women: M=1.76, men: M=1.48, F(1, 2252)=59.60, p=.000). In the index of fear of disgust relevant animals the participants' ratings for snake, wasp and badger were added and divided by three (M=1.85, SD=0.74, N=2357, Cronbach's alpha=0.68). Fear of disgust relevant animals was uncorrelated with age (r=-.03, n.s., N=2357). Also in this sub-dimension of animal fear women (M= 2.08) reported a higher level of fear than did men (M=1.63) (F(1, 2355)=232.49, p=.000). General animal fear was strongly correlated with both the sub-dimensions (large carnivore fear: r=.88, p=.000, N=2253, fear of disgust relevant animals: r=.70, p=.000, N=2253). Large carnivore fear and fear of disgust relevant animals was positively correlated, but the correlation was rather low in magnitude (r=.35, p=.000, N=2284).

There was no differences in general animal fear between participants' who live in areas with or without the four carnivore species present. There was however differences in the two sub-dimensions. Participants who live in areas without presence of carnivores (M=1.93, N=660) reported a significantly higher fear of disgust relevant animals than did those who live in areas with two (1.81, N=611), or more (1.74, N=161) carnivores present (F(3, 2353)=4.45, p=.004). There was also a difference in large carnivore fear between people with a different amount of carnivores species present in the vicinity of where they live (F(3, 2313)=16.20, p=.000). Participants' who live in areas without (M=1.51, N=649) or with only one of the large carnivores (M=1.56, N=906) expressed a lower level of fear directed towards carnivores than those who live in areas with two carnivore species (M=1.78, N=597) or three or four species of large carnivores (M=1.83, N=161). Moreover, the level of large carnivore fear was significantly

correlated with how fearful the participants said they would feel if there were large carnivores close to where they lived (Pearson r=.58, p=.000, N=1893).

3.2 Willingness to pay

In the estimation of the participants' WTP, basically three groups of predictor variables were analysed i) socioeconomic variables such as age, income, and gender, etc ii) the presence of large carnivores in the participants' place of residence, and iii) two variables to capture the participants' fear. The predictor variables are assumed to be independent. The variables in the first two groups of predictors were chosen since they previously have been shown to significantly contribute to the prediction of WTP for management and conservation of large carnivores (Karlsson & Sjöström, 2007). The fear variables chosen were the two identified sub-dimensions of animal fear, that is large carnivore fear and fear of disgust relevant species. Table 2 describes the predictor variables more in detail and offers some descriptive statistics.

It may be suspected that that there is a correlation between the fear variables and the other predictor variables. However, a correlation analysis shows no strong correlations between them. The correlations was all below Pearson r=.30 and most of them below r=.20. In the first step of the WTP analysis the sample is reduced to N=2077, due to missing data in individual items.

As shown in Table 3, among the socioeconomic variables, income, having a hunter in the household, living on a farm, and owning a dog used for hunting have a negative impact on whether the participant was willing to contribute financially to large carnivore conservation or not, in the first step (yes/no). A high educational level, being a member of a nature conservation NGO, and having a dog (not used for hunting) have a positive impact on the respondents willingness to contribute financially to large carnivore conservation or not. The presence of at least one of the four carnivores at one's place of residence had a negative impact as well as self reported fear of large carnivores. In total the fraction of correct predictions was 71%. The marginal effects show that being a hunter, being a member of a nature conservation NGO, income, having a hunting dog and degree of fear of large carnivores where the strongest predictors of willingness to contribute financially or not. The estimate of the marginal effect for the large carnivore fear index is -0.16. Hence, a unit marginal increase in the

large carnivore fear index will decrease the probability of being willing to contribute financially with 0.16 units. Evaluating the impact of large carnivore fear on the willingness to contribute financially to the conservation project at the mean implies that a one percent increase in the index for large carnivore fear will decrease the probability by 0.63 percent.

Table 2. Definition and descriptive statistics of the variables in the WTP analysis.

Variable	Definition	Mean	Stdv	Min	Max
WTP	1 if the participant is willing to pay for conservation of the four large carnivores in Sweden.	0.405	0.491	0	1
AGE	Years of age.	50.4	16.4	19	85
FEMALE	1 if the participant is a woman.	0.48	0.50	0	1
INCOME	Total income in the participant's household (x 100 000 euro).	0.28	0.16	0	1.660
EDUC	Level of education: 1 if compulsory school, 2 if upper secondary school and 3 if university or university college.	1.91	0.75	1	3
FARM	1 if the participant lives on a farm.	0.26	0.44	0	1
TAME	1 if the participant's household has a domestic animal.	0.15	0.36	0	1
HUNTER	1 if someone in the participant's household is a hunter.	0.26	0.44	0	1
DOG	1 if the participant's household owns a dog which is not used for hunting.	0.23	0.42	0	1
HUNTDOG	1 if the participant's household owns a dog which is used for hunting.	0.11	0.31	0	1
MEMBER	1 if the participant is a member of an organisation working for conservation of nature.	0.09	0.29	0	1
RURAL	1 if the participant lives in an rural area.	0.62	0.48	0	1
CARNIVORE	1 if at least one of the large carnivores at the participant's place of residence.	0.72	0.45	0	1
CARNIFEAR	The participant's fear of large carnivores.	1.59	0.82	1	4
DISGUSTFEAR	The participant's fear of the disgust relevant species (tick, wasp, and snake).	1.84	0.73	1	3

In the second step of the WTP analysis we analysed how much those respondents who had indicated yes in the first step (N=824) were willing to pay for large carnivore conservation. In this step three variables came out as significant. How much the participants were willing to pay was positively affected by membership in a nature

conservation NGO, and negatively correlated with being a female and the level of large carnivore fear (Table 3). The parameter estimate for large carnivore fear is -0.22. Evaluating the impact of large carnivore fear on the willingness to pay at the mean implies that at one percent increase in the index for large carnivore fear will decrease the willingness to pay by 0.35 percent. For respondents with a very high fear of large carnivores, in our case with a fear index close to four, the response of a one percent increase in the fear index implies a decrease in willingness to pay with approximately 0.88 percent.

Table 3. Parameter estimates.

	yes/no model			WTP model	
Variable	Coef (odds ratio)	P-value	Marginal effects	Coef	P-value
AGE	-0.03	.000	-0.01	-0.01	n.s.
FEMALE	0.12	n.s.	0.03	-0.29	.039
INCOME	-0.87	.009	-0.20	0.15	n.s.
EDUC	0.37	.000	0.09	0.14	n.s.
FARM	-0.49	.001	-0.11	-0.12	n.s.
TAME	0.29	n.s.	0.07	0.07	n.s.
HUNTER	-0.85	.000	-0.18	0.40	n.s.
DOG	0.32	.010	0.08	0.23	n.s.
HUNTDOG	-0.77	.000	-0.16	0.07	n.s.
MEMBER	1.07	.000	0.26	0.77	.000
RURAL	-0.11	n.s.	-0.02	0.17	n.s.
CARNIVORE	-0.37	.001	-0.09	-0.15	n.s.
CARNIFEAR	-0.69	.000	-0.16	-0.22	.033
DISGUSTFEAR	0.02	n.s.	0.01	-0.01	n.s.
Number of observations	2077				824
-LogL	1155.7				1646.2

The results in Table 3 can now be used to evaluate the effect on willingness to pay (WTP) as a result of a change in the index of large carnivore fear. Table 4 displays the WTP for a representative individual as well as the effect on WTP due to three different changes in the index of large carnivore fear for a representative individual in the

sample.[1] The results in Table 4 show that willingness to pay for a representative individual (i.e. a hypothetical subject, defined on the basis of means values of the relevant variables) amounts to Euro 111.3. Furthermore, an increase in the index of large carnivore fear with one unit (from the average) implies a decrease in WTP with Euro 18.9. The last two columns illustrate the effect on WTP due to a change from the average level to maximum and minimum levels of the index of large carnivore fear. As can be seen in Table 4, if fear increases to the maximum level, WTP decreases with Euro 40.5.[2]

Table 4. Willingness to pay (WTP) for the Swedish predator policy for a representative individual, and effect on WTP due to changes in the index of large carnivore fear. Euro per year.

WTP^0	$\partial WTP/\partial fear$	$WTP^1 - WTP^0$	$WTP^2 - WTP^0$
111.3	-18.9	-40.5	6.7
WTP^0 = Willingness to pay for a representative individual WTP^1 = Willingness to pay for a representative individual with maximum large carnivore fear (index=4) WTP^1 = Willingness to pay for a representative individual with minimum large carnivore fear (index=1)			

4. Discussion

In the prediction of WTP the self-reported fear of large carnivores significantly reduced the individual's tendency to be willing to contribute financially to a governmental policy on carnivore-induced costs. The self-reported fear of disgust relevant animals did however not impact on the WTP. The present results corroborates Kaltenborn's et al (2006) conclusion that human affective aspects will influence the public's response towards wildlife management. Moreover the results confirm the importance of analysing animal fear at more specific levels.

[1] Mean WTP is calculated as: $WTP = e^{\boldsymbol{\delta}\mathbf{X}/\alpha+(\alpha^{-1}/2)^2}$, where $\mathbf{X}$ is the vector of covariates, $\boldsymbol{\delta}$ the corresponding parameter vector, and α is the "bid parameter". $1/\alpha$ is thus the marginal utility of money (see Broberg & Brännlund, 2008b for details). The derivative of WTP with respect to "fear" is then: $\partial WTP / \partial X_{fear} = (\delta_{fear}/\alpha) e^{\boldsymbol{\delta}\mathbf{X}/\alpha+(\alpha^{-1}/2)^2}$, which can be interpreted as the change in WTP due to a one unit change in the fear index.

[2] It should be noted that the effects of non-marginal changes of the fear index should be interpreted carefully.

The exact distinction of the specific types of animal fears is still unclear due to certain variations as to what animal species have been included in various studies (Davey, 1994; Ware et al., 1994; Davey et al., 1998; Tucker & Bond, 1997; Arrindell, 2000). In this study, people's fears could be categorised into fear of mammals, overlapping with low- and high-predatory animals, and what previously has been named disgust-relevant animals. Within the category of mammals, even stronger relationships were identified between how much people feared encountering the four large carnivores. This study thereby points to the existence of a specific sub-category of fear of high-predatory animals, expressed towards large carnivores in particular (Roskaft et al., 2003).

The marginal effects in the first stage of the WTP analysis showed that the impact of self reported large carnivore fear on WTP was as high as the impact of other variables commonly shown affecting human attitudes towards large carnivores (e.g. age, sex, income, education, membership in NGO:s). Thus, it can be concluded that self-reported fear of large carnivores will act as a constraint on public WTP for management and conservation measures of large carnivores. Interestingly fear of large carnivores was significantly affecting not only if the respondents were willing to contribute financially to support a governmental policy on carnivore-induced costs, but also (together with membership in a nature conservation organisation and gender) how much money the respondents was willing to spend on the issue. Hence, fear of large carnivores plays an important role in shaping intentions to support governmental polices towards large carnivores also among people that actually are willing to pay. Consequently, omitting the fear of large carnivores may cause a bias in the estimates of WTP as well as other instruments for assessing public intentions to support the conservation of large carnivore. Considering that our analyses were based on a large sample of the Swedish public, the result also calls for a deeper understanding of what implications non-clinical degrees of large carnivore fear will have on public support of management and conservation of wildlife.

The participants' general animal fear did not differ between people who lived in areas with our without large carnivores. However fear of large carnivores was higher in areas with a higher number of large carnivore species, whereas fear of disgust relevant animals was higher outside large carnivore areas. This suggests that the likelihood that one actually would encounter a species in the outdoors might direct and augment

people's general animal fear in certain ways. The effect of large carnivore fear on WTP is thus likely partly due to the fact that people in carnivore areas might have more direct and indirect experiences of these species (Armfield, 2006).

According to Shivik (2006), decision-makers and wildlife managers need to have a toolbox of different mitigation measures in their work to achieve public tolerance of large carnivores. While there have been several studies on the effectiveness of different mitigation measures e.g., removal of carnivores and fencing of livestock (see Linnell et al., 1996 for an extensive review), there are almost no studies evaluating and comparing the effects of management measures aiming at reducing human fear of large carnivores. A suitable theoretical base would be Armfield's (2006) recent model of cognitive vulnerability. This model suggests that a person's fear related to a particular animal species will depend on the degree to which the animal is perceived as dangerous, disgusting, uncontrollable, and unpredictable. Thus, the model makes it possible to develop more sensitive instruments that can measure the extent to which human fear of large carnivores is attributed to the different dimensions. This knowledge might in turn indicate what would be an efficient approach to meet public fear of the species. We also suggest that further studies on the human dimension of large carnivore management should include standardised measures of self-reported anxiety and fear, as well as measures of physiological and behavioural fear responses, in order to be able to closer link the results to the psychological literature on human fears.

References

Armfield, J. M. (2006). Cognitive vulnerability: A model of the etiology of fear. *Clinical Psychology Review, 26*, 746-768.

Aronson, Å., Wabakken, P., Sand, H., Steinset, O.K. & Kojola, I. (2005). The Wolf in Scandinavia: status report of the 2001-2002 winter. *Report 2*. Hedmark: University of Hedmark.

Arrindell, W. A. (2000). Phobic dimensions: IV. The structure of animal fears. *Behavior Research and Therapy, 38*, 509-530.

Boman, M. & Bostedt, G. (1999). Valuing the wolf in Sweden: Are benefits contingent on the supply? In M. Boman, R. Brännlund & B. Kriström (Eds.). *Topics in Environmental Economics*, 157-174. Dordrecht: Kluwer Academic Publishers.

Bostedt, G., Ericsson G. & Kindberg J. (2008). Contingent values as implicit contracts – estimating minimum legal willingness to pay for wild carnivores in Sweden. *Environmental and Resource Economics*, 39, 189-198.

Broberg, T. & Brännlund, R. (2008a). The value of preserving the four large predators in Sweden: Regional differences considered. *Journal of Environmental Management*, 88, 1066-1077.

Broberg, T. & Brännlund, R. (2008b). An alternative interpretation of multiple bounded WTP data – Certainty dependent payment card intervals. *Resource and Energy Economics*, 30, 555-567.

Cox, B. J., McWilliams, L. A., Clara, I. P. & Stein, M. B. (2003). The structure of feared situations in a nationally representative sample. *Anxiety Disorders, 17*, 89-101.

Cutshall, C. & Watson, D. (2004). The phobic stimuli response scales: a new self-report measure of fear. *Behaviour Research and Therapy, 42,* 1193-1201.

Davey, G. C. L. (1994). Self-reported fears to common indigenous animals in an adult UK population: The role of disgust sensivity. *British Journal of Psychology, 85*, 541-555.

Davey, G. C. L., McDonald, A. S. , Hirisame, U., Prabhu, G. G., Iwawaki, S., Jim, C. I., Merchelbad, H., de Jong, P. J. Leung, P. W. L. & Reimann, B. C. (1998). A cross-cultural study of animal fears. *Behaviour Research and Therapy, 36*, 735-750.

Davey, G. C. L., Cavanagh, K. & Lamb, A. (2003). Differential aversive outcome expectancies for high- and low-predation fear relevant animals. *Journal of Behavior Therapy and Experimental Psychiatry, 34*, 117-128.

Ericsson, G., Bostedt, G. & Kindberg, J. (2008). Wolves as a symbol for people's willingness to pay for large carnivore conservation, *Society and Natural Resources, 21*, 294-309

Ericsson, G. & Heberlein, T. A. (2003). Attitudes of hunters, locals, and the general public in Sweden now that the wolves are back. *Biological Conservation, 111*, 149-159.

Green, W. H. (1993). *Econometric Analysis*. Second edition, Macmillan.

Kaltenborn, B. P., Bjerke, T. & Nyahongo, J. (2006). Living with problem animals-self reported fear of potentially dangerous species in the Sergengeti Region Tanzania. *Human Dimension s of Wildlife, 11*, 397-409.

Green, W. H. (1993). *Econometric Analysis*. Second edition, Macmillan.

Kanazaki, N., Maruyama, N & Inoue, T. (1996). Japanese attitudes towards wolves and its recovery. *Journal of Wildlife Research, 1*, 268-271.

Karlsson, J., Bjärvall, A. & Lundvall, A. (1999). Svenskarnas inställning till varg – en intervjuundersökning [Swedes attitudes towards wolf – an interview study]. Report 4933. Stockholm: The Swedish Environmental Protection Agency.

Karlsson, J & M. Sjöström (2007). Human attitudes towards wolf conservation, a matter of distance. *Biological Conservation,* 137, 610-616.

Karlsson, J & M. Sjöström (2008). Direct use values and passive use values: implications for conservation of large carnivores. *Biodiversity Conservation*, 17, 883-891.

Kindberg, J. & Swenson, J. E. (2006). Results from the genetic analyses performed on feces samples from bears in Västerbotten County, Sweden. Part II Population estimate. *Report 2006-3 from the Scandinavian brown bear project*. Ås: Norweigan University of Life Sciences.

Liberg, O. & Andrén, H. (2005). Lodjursstammen i Sverige 1994-2004. En utvärdering av inventeringsresultat och metodik. [The lynx population in Sweden 1994-2004. An evaluation of results and census methods]. Grimsö: Swedish University of Agricultural Sciences.

Linnell, J. D. C., Smith, M. E., Odden, J., Kaczensky, P & Swenson, A. J. E.(1996). Rovvilt og sauenæring i Norge [Carnivores and sheep farming in Norway]. *Report nr 5*. Trondheim: Norweigan Institute for Nature Research.

Persson, J. (2006). Järvens status och ekologi i Sverige. [Status and ecology of wolverines in Sweden]. Report to the Swedish government committee on large carnivore management.

Pervin, L. A. (1989). *Personality. Theory and Research*. New York: John Wiley & Sons Inc.

Roskaft, E., Bjerke, T., Kaltenborn, B., Linell, J. D. C. & Andersen, R. (2003). Patterns of self-reported fear towards large carnivores among the Norweigan public. *Evolution and Human Behavior, 24*, 184-198.

Shivik, J. A. (2006). Tools for the edge: Whats new for conserving carnivores? *Bioscience, 56*, 253-259.

Sjölander-Lindqvist, A. (2008). Local identity, science and politics invisible. *Journal of Environmental Policy and Planning, 10,* 71-94.

Spielberger, C. D. (2006). Cross-cultural assessment of emotional states and personality traits. *European Psychologist, 11*, 297-303.

Taylor, S. (1998). The hierarchic structure of fears. *Behavior Research and Therapy, 36,* 205-214.

Tucker, M. & Bond, N.W. (1997). The roles of gender, sex role, and disgust in fear of animals. *Personality and Individual Differences, 22*, 135-138.

Ware, J., Jain, K., Burgess, I. & Davey, G. C. L. (1994). Disease-avoidance model: factor analysis of common animal fears. *Behavior Research and Therapy, 1,* 57-63.

Webb, K. & Davey, G. C. L. (1992). Disgust sensitivity and fear of animals: Effect of exposure to violent or repulsive material. *Anxiety, Stress & Coping, 5*, 329-335.