The value of preserving the four large predators in Sweden: Regional differences considered[†]

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Abstract

This paper contributes with an applied policy analysis of the predator preservation policy in Sweden. We estimate the social benefits from preserving the four large predators in Sweden by applying a contingent valuation approach. The vehicle we use to fulfil our objectives is data from a survey that were mailed out in the spring of 2004. We find that the Swedish population is divided in half concerning their support for the predator policy package and that the overall mean WTP for preserving the four large predators in Sweden is approximately SEK 290. We also find that the WTP differ substantially between different regions in Sweden. Respondents in Stockholm have the highest WTP whereas the lowest WTP is found for respondents living in Wolf-territories. Finally we find that our measure of the social value is sensitive with respect to response-uncertainty. When the respondents are allowed to be uncertain about their valuation they state a higher value. The main conclusion is that the social-value of preserving the four large predators in Sweden may be negative since the stated benefits seem to be rather small.

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1. Introduction

The aim with this study is to contribute with an applied policy analysis of the predator preservation policy in Sweden. More specifically, the objective is to estimate the social benefits from preserving the four large predators in Sweden. The vehicle we use to fulfil our objectives is data from a contingent valuation survey that were mailed out in the spring of 2004. The dataset includes residing coordinates of the respondents which allow us to study differences in WTP, depending on how close to predators people are living.

The background to this study can be found in the decision taken by the Swedish parliament in 2001, concerning management of the four large predators in the Swedish fauna.[1] According to the proposition the four large predators should be managed in a sustainable manner. Among other things this means a significant increase in the wolf population, compared to its current level. According to some estimates, survival in the long run implies more than 1000 animals, which should be compared to the population during the winter 2003-2004 of approximately 58-72 animals (Wabakken et.al., 2004).[2] An intermediate goal in the policy package is that the wolf population should increase to 200 animals. Concerning the bear and lynx populations, the current levels are very close to the levels stated in the governmental proposition. For the wolverine population on the other hand, the current population is about one half of the (assumed) viable population. According to the *Swedish Species Information Centre*, the wolf is critically endangered, the wolverine endangered, whereas the bear and the lynx is vulnerable (see http://www.artdata.slu.se/home.htm).

The problem with finding the social benefits from preserving the predators can be described by a two stage process. First we need to find out the attitudes towards the predators, that is if individuals are in favour, indifferent, or against the predator policy. Secondly, given that an individual is in favour of the policy we need to know how much she would be willing to pay to implement it. Most previous studies, concerning preservation of the Swedish/Scandinavian predators, covers only the first stage in the process and have mainly focused on the wolf population. Examples of such "attitude" studies include Kaltenborn et. al. (1998, 1999), Bjerke and Kaltenborn (2002), Bjerke et. al. (1998) and Ericsson and Heberlein (2003, 2005). Similar studies on U.S. data have also been done, e.g. Kellert (1985, 1990, 1996, 1999). Ericsson and Heberlein (2003) studied differences in attitudes towards wolves between different geographical regions in Sweden, and between hunters and non-hunters. They found that hunters have the most negative attitudes, whereas the attitudes in urban areas are the most positive. They also found that the attitudes are more negative in wolf areas than in the rest of Sweden. They conclude that even if a majority of the Swedish citizens are in favour of an increasing wolf population this support is rather weak since many individuals are indifferent to how the wolf population evolves, and hence might become negative if "negative events" get medial attention.

However, a simple referendum setting in line with the first stage described above will not be sufficient to determine if the implementation of the predator policy is socially

[1] The four large predators are; wolf (Canis lupus), bear (Ursos, arctos), wolverine (Gulo gulo)), and lynx (lynx lynx).

[2] In addition there are 20-22 wolves that are characterized as borderline wolves, i.e. wolves that lives in both Norway and Sweden (Wabakken et.al., 2004).

efficient or not. Even if a minority of the Swedish population would experience a utility loss, if the populations of wolf and wolverine were about to increase, their aggregated loss might be higher than the aggregated benefits experienced by those in favour of the policy. In such case implementation will not be socially efficient even if a majority supports it. To say something about efficiency we need to take the analysis one step further and quantify the "attitudes". For this reason a contingent valuation approach (CVM) could be undertaken to estimate the willingness to pay, in terms of money, for implementing the predator policy. This type of approach has been applied by Boman and Bostedt (1996) who estimated the willingness to pay for increasing the wolf population in Sweden. They found that willingness to pay is insensitive to scope, i.e. the respondents did not value 25 animals less than 1000 animals. Hence, the respondents seemed to value what they believe to be the minimum viable population. The estimated willingness to pay for restoring a perceived viable wolf population in Sweden, based on a dichotomous choice question, ranged between SEK 700-900, depending on the distributional assumptions made.[3] Furthermore they found a difference in mean willingness to pay, depending on design, i.e. depending on whether an open ended or a dichotomous choice question were used. The open ended willingness to pay amounted to SEK 365, which was substantially lower than the mean from the dichotomous choice version. However, this is usually found in the CVM-literature.

One important aspect not discussed in Boman and Bostedt (1996) is the differences in attitudes and WTP between locals and non-locals. This is a main issue in Durrield and Neher (1996) and Chambers and Whitehead (2003). Durrield and Neher (1996) studied willingness to pay, using the CVM, for reintroducing the wolves in Yellowstone national park. They found that respondents living close to the park where less likely to support the project compared to respondents living outside the Yellowstone park region. This result highlights the importance of considering the values of non-locals in estimations of willingness to pay for endangered species. Although the locals where divided more or less in half, the annual net benefit of wolf reintroduction where estimated to lie somewhere between US $6 and US $8.9 million (dollars in 1993 years value). Chambers and Whitehead (2003) estimated the benefits from protecting the wolves in Minnesota, also using a contingent valuation approach. They mainly focused regional aspects, use value vs. non-use value and the benefits from introducing an "I don't know" option in a dichotomous choice WTP question. They found that non-locals are willing to pay more (US $21.49) than locals (US $4.77), where non-locals were defined by individuals living just outside wolf habitats. Hence, both use value and non-use value are important to consider in valuation studies of endangered species. They also conclude that uncertainty may be important to include in analysis of welfare estimates for public amenities using contingent valuation.

It should be pointed out that the project to be valued in Chambers and Whitehead (1993), valuing protection of an already viable population, is fundamentally different from the project in Boman and Bostedt (1996), Duffield and Neher (1996), and in this study, in which the project is reintroduction or creation of a viable population.

Our willingness to pay data is elicited from a multiple bound questionnaire, allowing the respondents to express uncertainty. Although uncertainty is a very interesting and relatively unexplored issue in the contingent valuation literature we will not focus on

[3] 8 SEK is approximately equal to US $1 (December 2005).

that in this paper. Instead we will simplify the analysis by assuming that the response to each bid is driven by a single willingness to pay amount. As a consequence, the only interesting information lies between the highest "yes" and lowest "no" bid. The response to all other bids does not contain any additional information.[4] An alternative, otherwise, is to follow the approach taken by Wang (1997) and Alberini et.al. (2003) and estimate an ordered probit (or logit) to take uncertainty explicitly into account in the estimation. Since focus in this paper, however, is not to investigate response uncertainty we will not go into such issues in debt here.

The rest of the paper is structured as follows. In section 2 we provide a description of the data collection procedure as well as a descriptive analysis of the data. The main objective with this descriptive part is to identify general patterns, or determinants, to the attitudes towards the decided policy package. In section 3 we give a brief description of the underlying economic model, as well as the econometric specification of the willingness to pay equations. In section 4 we present the results from our econometric analysis. Finally section 5 offers some concluding comments.

2. Survey data and descriptive statistics

The empirical analysis below is based on a survey that was mailed out in May 2004 to 4050 individuals in the ages 18-84 years. In total 2455 individuals responded, which corresponds to a response rate about 60.9 percent. The individuals were randomly selected from the register over the Swedish total population. To ensure selection of individuals living in areas of specific interest a stratification procedure was necessary. Stratas were defined to distinguish individuals living in some of the three largest cities in Sweden or living inside wolf territories or wolf areas from the rest of the population.[5] Further all subpopulations, except the city stratas and one strata for individuals with uncertain coordinates, were separated into rural and non-rural stratas. In total ten stratas were specified.

The main objective with the survey was to question people about their attitudes towards the four large predators in Sweden and ultimately find out whether or not the population in Sweden is in favor of the governmental predator policy. We also wanted to study the magnitude of the support in terms of willingness to pay. All in all there were 24 questions including two standard WTP questions. In the analysis that follows we also use census data for all the respondents to control for various characteristics, e.g. gender and age.

The information contained in the first WTP question tells us whether or not the respondents are willing to pay anything at all for implementing the predator policy, i.e. willing to pay a higher annual tax under the next five years to increase the populations of wolves and wolverines to about 200 respectively 400 animals and protect the current population levels of bears and lynx. The information from the second WTP question tells us how much the respondents who are in favor of the predator policy are willing to pay for implementing it. The latter WTP question was in the form of a multiple bounded, polychotomous-choice question asking the respondent to state for nine

[4] Welsh & Poe (1998).

[5] Wolf territory is defined as regions where Wolves are more or less present all the time. Wolf area is defined as regions were wolfs are present more occasionally.

specific amount of money ranging from SEK 10 to SEK 5000 if she is willing to pay that amount. To test hypothesis regarding the degree of certainty in the respondents stated willingness to pay they were also asked how likely an actual payment would be for every specific bid. Five different categories were available: Definitely pay, probably pay, unsure, probably not pay, definitely not pay.

I am willing to pay as an annual tax	Definitely Pay	Probably pay	Unsure	Probably not pay	Definitely not pay
SEK 10					
…….					
SEK 5000					

Compared to the more frequently used payment card this format can be used to estimate hypothetical bias, but this extra information comes at the cost of making the survey more time consumptive for the respondent. Instead of answering the question by one mark the respondents' needs to set nine marks, which thus increases the burden on the respondent. If the respondent answer the multiple-bound question correctly she would ultimately be sure to pay low amounts and then get more uncertain as the bids go up, and when the bids are sufficiently high she should be sure about not wanting to pay. In such case we have full information about the uncertainty in the respondents' answer. As stated in the introduction we will not focus uncertainty in this paper. Instead we will take a very simple approach and recode "definitely yes" (DY) and "probably yes" (PY) to a "yes" response, and recode "unsure" (U), "probably no" (PN) and "definitely no" (DN) to a "no" response. This recoding is of course arbitrary. A kind of sensitivity analysis is provided in the appendix, where we present the results from alternative recodings.[6]

As we stated in the introduction the aim is to study the willingness to pay for implementing the predator policy, given that the individuals are not negative to the policy package in the first place. Unfortunately, this restriction is necessary because we do not have any information about negative WTP. However, we can in an indirect way identify individuals that ought to have negative WTP by noting that respondents that have stated that they want all the predator populations to diminish should for certain receive negative utility if the populations of wolves and wolverines were about to increase, and the current population of brown bears and lynx be maintained. It is possible that some respondents have mixed preferences for the predator populations, i.e. wanting one population to increase and another population to decrease. In such case and with full information about the respondents' preferences regarding the evolvement of each specific predator population, the answer on the first WTP question will provide us with information enough to reveal if the respondent has negative preferences for the predator policy. Respondents not willing to pay anything at all for implementing the predator policy, and who have preferences for decreasing the population of at least one of the predators have in an indirect way stated that the negative effect of the predator

[6] As it turns out in our data 57.6 percent of the respondents have answered in such a way that we can say something about uncertainty. However, there is a large group of the respondents, 41.6 percent, that have answered the question as a payment card question setting only one mark. The rest of the respondents in the sample are people that are sure they would pay all amounts or sure they would not pay any of the amounts and respondents whose answers are not interpretable.

policy outweighs the positive effect.[7] This identification is important since individuals with negative WTP would otherwise be treated as individuals with zero WTP, and hence our estimation of WTP would be biased.[8]

Table 1 show the share of the respondents who are in favor of the proposed predator policy and would be willing to pay for its implementation. As can be seen 38.7 percent are in favor and 61.3 percent are against or indifferent (answered "no"). Since our sample is stratified we need to weight the result from the sample data with the stratification weights to obtain the corresponding shares for the population. As can be seen the population is more or less divided in half, i.e. 49 percent are in favor and 51 percent against or indifferent.

Table 1. Willingness to pay or no willingness to pay for implementation of the predator policy package, frequencies.

	Frequency strat. sample	**Percent strat. sample**	**Frequency population**	**Percent population**
Yes	890	38.7	3 099 839	49.0
No	1 408	61.3	3 223 177	51.0
Total	2 298	100.0	6 323 016	100.0
Missing	144		383 986	
Total	2 442		6 720 381	

In table 2 it can be seen that there is a significant difference between stratas regarding the support for the predator policy. The support is relatively small in wolf areas, and even smaller in areas where wolves have their territory. It can also be seen that the support is smaller in rural areas, compared to non-rural areas. Concerning big cities there is no clear pattern. A majority in Stockholm and Malmö are clearly in favour, whereas a majority in Göteborg is not. One can only speculate what is behind the difference in stated attitudes between the major cities. One explanation could be differences in cultural variables which affects the attitudes towards non-local problems. Another explanation may be that Göteborg is closer to wolf territories than Stockholm and Malmö.

[7] Only respondents that stated the presence of wolves at their place of living are allowed to have preferences against the predator policy. In our data 33 persons living outside wolf areas have stated that they cannot accept neither wolves nor wolverines anywhere in Sweden, and when only wolves are considered 54 the number of such respondents are 54. However, it is difficult to identify respondents with negative WTP for implementing the predator policy from this information.

[8] In general the respondents seem to have answered the survey honestly. We have only found 13 observations of respondents that have not been consistent in their answers, e.g. stated that they want all predator populations too diminish but at the same time stated that they support the predator policy.

Table 2. Willingness to pay or no willingness to pay for the predator policy in different areas. Number of observations within parenthesis.

STRATUM	Yes (%)	No (%)	Missing
Wolf area, not territory rural	32.1 (86)	67.9 (182)	7 obs.
Wolf area, not territory non-rural	40.7 (46)	59.3 (67)	7 obs.
Wolf territory, rural	23.4 (124)	76.6 (407)	26 obs.
Wolf territory, non-rural	24.2 (29)	75.8 (91)	12 obs.
Stockholm	59 (46)	41 (32)	6 obs.
Göteborg	41.1 (30)	58.9 (43)	3 obs.
Malmö	51.9 (40)	48.1 (37)	9 obs.
Rest of country, rural	45.3 (293)	54.7 (354)	52 obs.
Rest of country, non-rural	49.9 (194)	50.1 (195)	22 obs.
Total	38.7 (890)	61.5 (1416)	136 obs.

Table 3 reveals that 25.3 percent of all respondents have clearly stated negative opinions about the evolvement of predator populations. From the same table we can also see that negative opinions are more common within wolf territories (51.8 percent). Furthermore we see that among those who are not willing to pay anything at all for implementing the predator policy package, 43.9 percent are clearly negative to the policy. The latter means that approximately 56 percent with stated zero WTP are indifferent. Among those who stated zero WTP the negative utility effect is largest in wolf territory areas. Compared to Bostedt (1992), who found that the share with negative preferences concerning only the wolf population was 2 percent, the share here can be considered as high. However, this difference is not surprising considering the fact that the predator populations have grown rapidly since 1992, and that the public wolf debate have become very fierce with strong opinions in both directions.

Table 3. Percentage with preferences against the predator policy.

Preference group	Total strat. sample	Wolf area	Wolf territory
Number of respondents with clearly stated negative opinions regarding the evolvement of the predator populations	25.3 % (618/2442)	33,4 % (132/395)	51.8 % (357/689)
Number of respondents with clearly stated negative opinions regarding the evolvement of predator populations among those who are not willing to pay	43.9 % (618/1408)	53 % (132/249)	71.7 % (357/498)

So far we have only presented descriptive statistics conditioned on respondents place of living. However, there are several other characteristics that are of interest and that may be important in order to understand the nature of the data. Table 4 display descriptive statistics concerning some general characteristics, such as age, gender, household decomposition, income, and education. The statistics are for the whole sample as well as conditioned on whether they are in favor or not to the policy package. Table 5 provides similar descriptive statistics, but for more specific characteristics, and also differences between different stratas.

Table 4. Descriptive statistics. Standard deviation within parenthesis.

Characteristic	Total strat. sample	Support	Do not Support	Preferences Against
Age	50.89	44.88	54.02	55.55
	(16.78)	(15.25)	(16.6)	(16.44)
Gender (female=0)	0.51	0.46	0.53	0.54
	(0.5)	(0.5)	(0.5)	(0.5)
Share with university education	0.23	0.32	0.17	0.12
	(0.42)	(0.47)	(0.38)	(0.327)
Disposable household income, SEK 1000	285.35	302.24	278.99	257.64
	(166.48)	(175.15)	(158.20)	(137.63)
Share with children in household	0.43	0.49	0.40	0.39
	(0.50)	(0.50)	(0.49)	(0.49)

Table 4 reveals that age and education may matter for the attitude towards the policy package. The average age is significantly lower in the group that supports the predator policy. Just as obvious is the education effect. There is a higher fraction of respondents with university education within the supporting group than in the other two groups. For education there is also a difference between those who do not want to pay for implementing the policy and those how have stated that they would experience a utility loss. It also seems as income matters, but one has to be careful in this interpretation since there is a positive correlation between income and education. Finally, it seems like respondents belonging to households with children are more likely to support the policy. However, this result should be handled with care due the expected correlation with age.

Table 5 reveals a number of interesting observations. First our expectation that hunters are more likely to be against the predator policy is confirmed. As can be seen the percentage of hunters and respondents living with hunters is higher for the "no" and "negative" group. This pattern is stronger in wolf areas and is further strengthened in wolf territories. The same pattern is found for owners of hunting dogs. As one also would suspect the percentage of respondents that are members of green NGO's is higher for those supporting the policy. This result seems to be stable over the studied geographical areas. Somewhat surprising, though, is the lack of obvious patterns when it comes to non-hunting dog owners and livestock owners. What seems to be clear is that there is no intra-altruism between dog owners. From the data it seems like dog owners are more likely to have more altruism for the predators than for dogs. Concerning reindeer owners and members of Sami-villages there are too few observations in order to say anything about the attitude towards the policy within the Sami-population.[9]

[9] The Sami-population is the natives of Sweden. By tradition reindeer herding is an important part of their culture. Wolves, wolverines and Lynx all prey upon reindeers and hence cause costs to the reindeer owners. For this reason it would be interesting to study the attitudes towards the predator policy among the Sami-population.

Table 5. Descriptive statistics for individual specific characteristics.

Characteristics	Total sample			Wolf area			Wolf territory		
	Support	Do not support	Preferences against	Support	Do not Support	Preferences against	Support	Do not support	Preferences against
Dog owner	27 (240)	18.8 (265)	18.9 (117)	24.2 (32)	16.0 (40)	16.7 (22)	32 (49)	20.7 (103)	20.7 (74)
Hunting dog owner	4.4 (39)	15.1 (213)	26.1 (161)	6.8 (9)	13.3 (33)	22.7 (30)	4.6 (7)	22.7 (113)	28.3 (101)
Livestock owner	15.8 (141)	14.4 (203)	19.1 (118)	18.9 (25)	12.4 (31)	17.4 (23)	19.6 (30)	17.9 (89)	18.2 (65)
Green member	15.2 (135)	4.7 (66)	3.7 (23)	15.9 (21)	6.8 (17)	4.5 (6)	17.0 (26)	3.2 (16)	2.5 (9)
Sami village member	0.3 (3)	0.5 (7)	0.5 (3)	0.8 (1)	0	0	0	0.4 (2)	0.3 (1)
Reindeer owner	0.2 (2)	0.4 (6)	0.6 (4)	0.8 (1)	0	0	0	0.4 (2)	0.3 (1)
Hunter	7.1 (63)	20.1 (283)	32.2 (199)	7.6 (10)	22.5 (56)	31.8 (42)	4.6 (7)	26.3 (131)	32.2 (115)
Hunter in household	8.7 (77)	18.1 (255)	26.7 (165)	12.1 (16)	18.9 (47)	27.3 (36)	12.4 (19)	24.7 (123)	27.7 (99)

In order to make a more formal test of the determinants to the attitudes a simple choice model on the probability of supporting the predator policy is estimated. Three logit models are estimated. *Model 1* where the dependent variable takes the value of one if the respondent is willing to pay for the proposed policy, and zero otherwise. *Model 2* and *Model 3* where the dependent variable is the response status of the respondents, i.e. if she supports, is indifferent to or is against the predator policy. *Model 3* only considers individuals living in wolf areas/territories. The independent variables are the characteristics discussed above. The result is presented in table 6.

The regression results in table 6 confirm the tentative conclusions drawn from the descriptive statistics above. The pattern seems to be the same for both wolf areas and non-wolf areas, although many variables that are significant in explaining negative preferences are stronger in wolf areas, e.g. hunter, hunter in household, hunting dog and age. Concerning differences between regions we surprisingly find that respondents in Göteborg are less likely to support the predator policy compared to respondents in wolf areas. One important difference though is that individuals in wolf areas tend to be against the policy whereas individuals in Göteborg are indifferent.[10] Another interesting feature of the regression results is that there seems to be a difference between rural and non-rural areas only for respondents outside wolf territories. The probability of supporting the predator policy is lower for respondents living in rural areas. It should also be noted that although it looks like respondents living in Stockholm and Malmö are more likely to support the predator policy than respondents living in the reference region, "rest of non-rural areas", this result is not significant.

[10] Only respondents that stated the presence of wolves at their place of living are allowed to be against the predator policy. Some of the results will partially be driven by this fact. See note 5.

Table 6. Preferences and WTP status. t-values within parenthesis.

	Model 1	**Model 2**		**Model 3**	
	"Yes or No"	**Indiff.**	**Against**	**Indiff.**	**Against**
Constant	1.481	-1.495	-3.761	-1.269	-2.626
	(7.57)	(-7.18)	(-11.88)	(-3.45)	(-6.58)
Age	-0.071	0.03	0.04	0.028	0.044
	(-10.93)	(9.04)	(9.76)	(4.79)	(7.79)
Male	-0.033	0.166	-0.139	0.065	0.093
	(-0.69)	(1.5)	(-0.96)	(0.34)	(-0.49)
Hunter	-0.777	0.319	1.432	0.809	1.729
	(-4.3)	(1.55)	(6.72)	(2.23)	(5.3)
Semi hunter	-0.62	0.468	0.855	0.469	0.98
	(-3.67)	(2.44)	(4.29)	(1.61)	(3.7)
Hunting dog	-0.55	0.163	0.828	-0.383	0.741
	(-2.41)	(0.62)	(3.26)	(-0.87)	(2.064)
Dog	0.373	-0.345	-0.428	-0.494	-0.372
	(3.17)	(-2.66)	(-2.69)	(-2.19)	(-1.79)
Green ngo	1.214	-1.056	-1.549	-0.956	-1.798
	(7.01)	(-5.53)	(-5.72)	(-3.12)	(-5.17)
Livestock	0.067	-0.211	0.178	-0.164	0.072
	(0.46)	(-1.27)	(0.98)	(0.61)	(0.3)
Education	0.55	-0.446	-0.865	-0.392	0.843
	(4.87)	(-3.68)	(-4.98)	(1.72)	(-3.61)
Rural wolf territory	-0.891	-0.013	2.413	-0.055	1.031
	(-5.49)	(-0.07)	(9.8)	(-0.2)	(3.42)
Non-rural wolf territory	-0.878	0.122	2.375	0.074	1.002
	(-3.49)	(0.42)	(7.34)	(0.21)	(2.74)
Rural wolf area	-0.594	0.082	1.867	0.001	0.474
	(-3.25)	(0.41)	(6.94)	(0.004)	(1.48)
Non-rural wolf area	-0.385	0.01	1.383		
	(-1.644)	(0.41)	(4.09)		
Göteborg	-0.713	0.753	-0.285		
	(-2.54)	(2.68)	(-0.37)		
Malmö	0.883	-0.009	-29.956		
	(0.32)	(-0.03)	(0)		
Stockholm	0.668	-0.068	-0.341		
	(0.24)	(-0.25)	(-0.53)		
Rest of rural areas	-0.12	0.097	0.496		
	(-0.83)	(0.65)	(1.97)		
NOBS	2258		2258		1010
R2_ML	0.185				
Pseudo R2	0.15		0.193		0.144
LogL^{UR}	-1284.13		-1980.93		-912.44
LogL^{R}	-1510.20		-2454.86		-1066.11

Model 1: Lhs variable is 1 if the respondent is willing to contribute, zero otherwise. Reference group for the stratas is the strata "rest of non-rural areas".

Model 2 and 3: Lhs variable 0 if respondent is willing to contribute, 1 if indifferent, 2 if against the predator policy. Model 3 only include respondents within wolf areas and wolf territories

It should be stressed here that the results in table 6 may be influenced by multi-collinearity. This is probably prevalent in the hunting variables, but does not appear to be too serious since all coefficients for the hunting variables are significant and have the expected signs. The problem seems to be more serious in the education-income case. Education is highly significant in table 6. When income is included in the regression and education excluded the coefficient for income becomes positive and significant but very small. From this and from knowing that education determines income more than education is explained by income, one might suspect that it is far more important to include education than income in the model.

In conclusion we can say that there seems to be some very clear patterns concerning the attitudes towards the Swedish predator policy package. The most significant pattern can be found in the regional, or geographical, dimension in the sense that respondents living in wolf areas are less willing to support and more likely to be against the policy package, which is also true for respondents living in rural areas compared to respondents in non-rural areas. It is also clear that hunters and respondents with hunters in their household are more likely to be against and also more likely to be indifferent.

3. Willingness to pay model

As pointed out in the introduction, an analysis of attitudes is not sufficient for determining the efficiency of the policy. To do this we need to know the "strength" of the attitudes, i.e. the values. To estimate the values, or benefits, we employ the following basic modelling framework. To start with, denote an individual's indirect utility function as $V(y, z)$, where y denotes income, and z is the (public) good we want to value. Furthermore, let z^0 denote the pre-project level of z, and z^1 the post-project level. Following Hanemann (1984) we assume that the individual knows his utility function with certainty, but that it may contain components that are unobservable for the researcher. These unobservable components are treated as stochastic. Given this the individual will reject the project, offered at bid A, if

$$V_i(y_i - A_i, z^1) + \varepsilon_i^1 \le V_i(y_i, z^0) + \varepsilon_i^0, \qquad (1)$$

where ε^0 and ε^1 i.i.d. random variables with zero mean.

Condition (1), expressed in terms of utility difference, can then be written as

$$\Delta V \le \eta, \qquad (2)$$

where $\Delta V = V(y - A, z^1) - V(y, z^0)$ and $\eta = \varepsilon^0 - \varepsilon^1$. Denoting the cumulative distribution function of η as F, the probability for rejecting the project at bid A can be written as

$$\Pr(\text{"No"}) = \Pr(\Delta V \le \eta) = F(\Delta V)$$

The probability for accepting the project at bid A is then

$$\Pr(\text{“Yes”}) = 1 - \Pr(\Delta V \leq \eta) = 1 - F(\Delta V) \tag{3}$$

Assuming a logistic distribution and a linear utility function, $V = \alpha + \beta y$, we have

$$F(\Delta V) = (1 + e^{\Delta V})^{-1} = (1 + e^{(\tilde{\alpha} - \beta y)})^{-1}, \tag{4}$$

where $\tilde{\alpha} = \alpha^1 - \alpha^0$, which can be interpreted as the utility implied by the project.
It is now straightforward to estimate the parameters in the model by maximizing the log likelihood for the entire sample (N), i.e.

$$\ln L = \sum_{i=1}^{N} \left[S_i \cdot \ln\left(1 - (1 + e^{\tilde{\alpha} - \beta A_i})^{-1}\right) + (1 - S_i) \ln\left((1 + e^{\tilde{\alpha} - \beta A_i})^{-1}\right) \right], \tag{5}$$

where $S_i = 1$ if respondent i have answered “yes”, and $S_i = 0$ otherwise.

Given estimates of $\hat{\tilde{\alpha}}$ and $\hat{\beta}$ the expected maximum willingness to pay can be calculated by solving for WTP in the equation $\hat{\tilde{\alpha}} - \hat{\beta} \cdot WTP = 0$, i.e.

$$WTP = \frac{\hat{\tilde{\alpha}}}{\hat{\beta}} \tag{6}$$

It should be noted that WTP is independent of income in this case. The reason is the assumption of a linear utility function.

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 willingness to pay. In our case this means that we would just instruct the respondent to check the box which corresponds to his/hers maximum willingness to pay. Implicit in this “instruction” is the assumption that the response to each bid is driven by a single WTP amount, which means that the multi-bounded format collapses into a simple payment card.

Thus it is clear that under 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), then the maximum WTP is $A^L \leq WTP < A^U$.

As before, let $1 - F(A)$ be the probability for saying “yes” to bid A, and $F(A)$ the probability for “no”. The probability that WTP is between A^L and A^U can then be written as:

$$P(WTP > A^L) - P(WTP > A^U) = 1 - F(A^L) - (1 - F(A^U)) = F(A^U) - F(A^L)$$

The log likelihood is then:

$$L^{PC} = \sum_{i=1}^{N} \ln\left[F(A_i^U) - F(A_i^L)\right] \tag{7}$$

Assuming a logistic distribution we get:

$$\ln L^{PC} = \sum_{i=1}^{N} \ln\left[\left(1+e^{\hat{\alpha}-\beta A_i^U}\right)^{-1} - \left(1+e^{\hat{\alpha}-\beta A_i^L}\right)^{-1}\right] \quad (8)$$

Econometric model and data considerations

From the descriptive statistics in the previous section we saw that approximately 50 percent of the respondents are not willing to pay anything for implementing the policy package. Furthermore, approximately 44 percent of those "no sayers" revealed clear preferences against preservation. Concerning the zero willingness to pay issue, we will employ the spike model (Kriström, 1997). The spike model seems to be well suited in this case since it allows non-zero probabilities for zero WTP. To account for the stated negative preferences for the policy package we simply exclude them from the estimation, hence estimating the WTP for those who has zero or positive WTP.[11]

Allowing for non-zero probability at zero (or even negative) WTP can be accomplished by using the model which was proposed by Kriström (1997).[12] Suppose that there are three types of individuals; those who dislike the project (and thus would need a compensation), those who are indifferent (WTP=0), and those who likes it (WTP>0). Given this we can express the distribution of WTP as consisting of four parts:

$$\begin{aligned} F(A) &= F_{-}(A) \quad \text{if } A < 0 \\ &= p^{-} \quad \text{if } A \to 0^{-} \\ &= p^{+} \quad \text{if } A \to 0^{+} \\ &= F_{+}(A) \quad \text{if } A > 0 \end{aligned}$$

$F_{-}(A)$ is the distribution for those with a negative WTP, those who dislike the policy package, and $F_{+}(A)$ is the distribution for those with a positive WTP, those who are in favour. The p's are the probability that WTP equals zero (see figure 1).

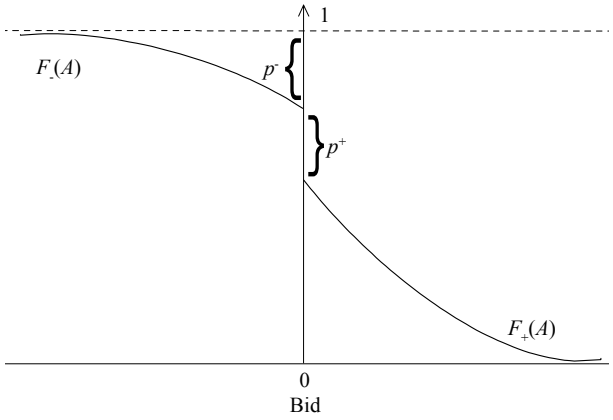

Figure 1. Survival function for the extended spike model.

[11] In the data set there is no information on willingness to accept. With such data the spike model can be extended to take this into account, see Kriström (1997).

[12] Yoo & Kwak (2002) extend the DC spike model in Kriström (1997) to the case with double bounded DC. Recent applications of the spike, and extended spike, model include Garcia & Riera (2003), Nahuelhual-Munoz et.al. (2004).

Here, however, we cannot obtain an estimate of the left side of the distribution (willingness to accept), $F_-(A)$, since the questionnaire didn't include any question concerning compensation for those who dislike the policy package. As a consequence we are forced to use a simple spike model on those who do not dislike the policy package. The information we have is whether or not they are willing to pay anything, and if so how much. If we let Q_i be an indicator variable for individual i such that $Q_i = 1$ if she is willing to pay a positive amount, and S_i as before an indicator of whether they say yes to the bid, we can write the spike version of the likelihood in the payment card case as:

$$\ln L^{PC_{spike}} = \sum_1^N \left[Q_i \cdot \ln\left(F(A^U) - F(A^L)\right) + (1 - Q_i) \cdot \ln F(0) \right], \tag{9}$$

Where

$$F(A) = (1 + e^{\tilde{\alpha} - \beta A_i})^{-1} \tag{10}$$

Since we have a stratified sample we will estimate two versions of (9):[13]

Model I: $\tilde{\alpha} = \alpha_0$

Model II: $\tilde{\alpha} = \sum_{s=1}^{9} \alpha_s D_s$, where D_s = 1, if an observation belongs to strata s, and 0 otherwise.

Mean WTP can then be written as:

$$WTP^{\text{Model I}} = K \cdot \ln\left[1 + e^{\alpha_0}\right] / \beta \tag{11}$$

$$WTP_s^{\text{Model II}} = K_s \cdot \ln\left[1 + e^{\alpha_s}\right] / \beta, \qquad s = 1,...,9 \tag{12}$$

$$MWTP^{\text{Model II}} = \sum_{s=1}^{9} (N_s / N) \cdot WTP_s^{\text{Model II}} \tag{13}$$

Where $K = n_{\text{pos}}/n$, and n_{pos} is the number of individuals in the sample that are non-negative to the policy package, K_s is the corresponding number for strata s, and N_s and N are the population in strata s and the total population respectively. Equation (13) specifies the stratification adjusted overall mean.

4. Results

The results from the estimation of equations (9) and (10) are presented in table 7. PC refers to the "payment card" specification, equation (9). The distributional assumption is given by equation (10), the logistic distribution.

[13] PC I will give a biased estimate of aggregate WTP since the sample is stratified random sample and not a random population sample.

The results in table 7 reveal that the differences in the point estimates between the two basic modelling approaches are rather small, although a slightly higher WTP for the model where stratification is considered. According to the results the overall mean WTP ranges between SEK 236 and 291. The lower WTP, however, is a biased estimate of the overall mean since respondents within an area with relatively lower WTP are overrepresented, compared to the population.

Table 7. Estimates of mean willingness to pay. Standard deviations are given within the parenthesis.

	PC I	**PC II**
α	-0.081 (0.052)	0.217 (0.22)
β	0.00207 (0.00004)	0.00207 (0.00004)
WTP[a]	236 (8.60)	291 (15.4)
WTP_1 territory rural		151 (14.26)
WTP_2 territory non-rural		139 (30.65)
WTP_3 Wolf area rural		184 (22.70)
WTP_4 Wolfarea non-rural		240 (38.94)
WTP_5 Göteborg		233 (45.59)
WTP_6 Malmö		301 (52.47)
WTP_7 Stockholm		375 (55.63)
WTP_8 rest rural		284 (17.05)
WTP_9 rest non-rural		294 (23.24)
NOBS	1674	1674
LogL	-3107	-3103.0

WTP for implementing the predator policy package seems to differ substantially between the different regions.

Figure 1 displays the confidence intervals for each strata (95%). Here we can see that the WTP within wolf territories and the rural wolf area are significantly lower than WTP for the Stockholm strata, confirming to some extent the latter conclusion. In Stockholm mean WTP is SEK 375 whereas the mean WTP in non-rural wolf territories is SEK 139.

An illustration of the estimated WTP function is provided in figure 2 where we have drawn the survival function for three different stratas for the PC II model, Stockholm, non-rural wolf territory, and rural wolf territory. From figure 2 it is clear that WTP for residents in Stockholm differs substantially from WTP in wolf territories. Furthermore

we see that the median WTP is zero within wolf territories, whereas the median is slightly positive in Stockholm.

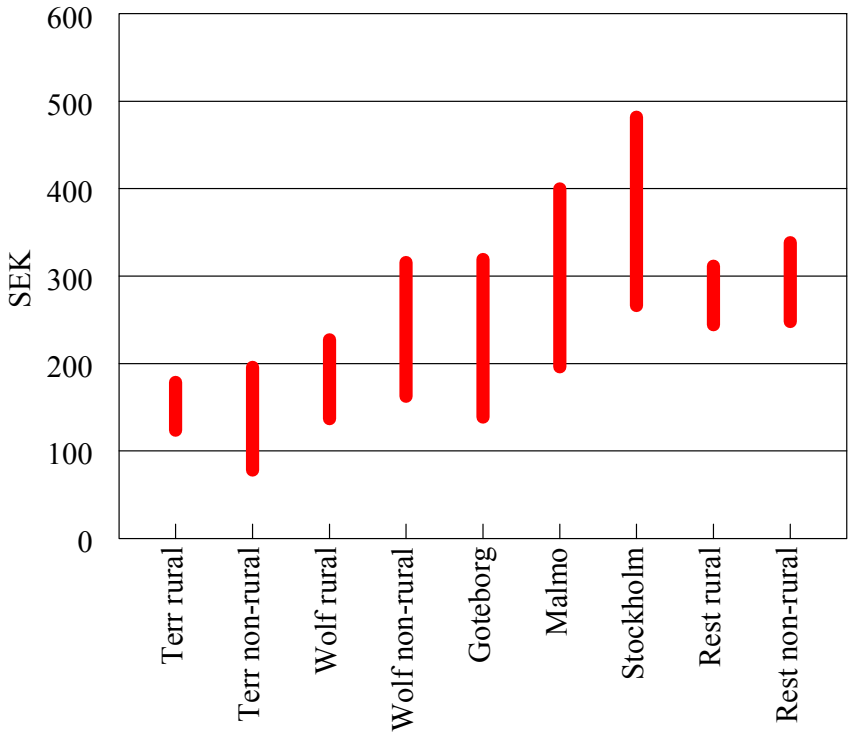

Figure 1. Willingness to pay, 95% confidence interval.

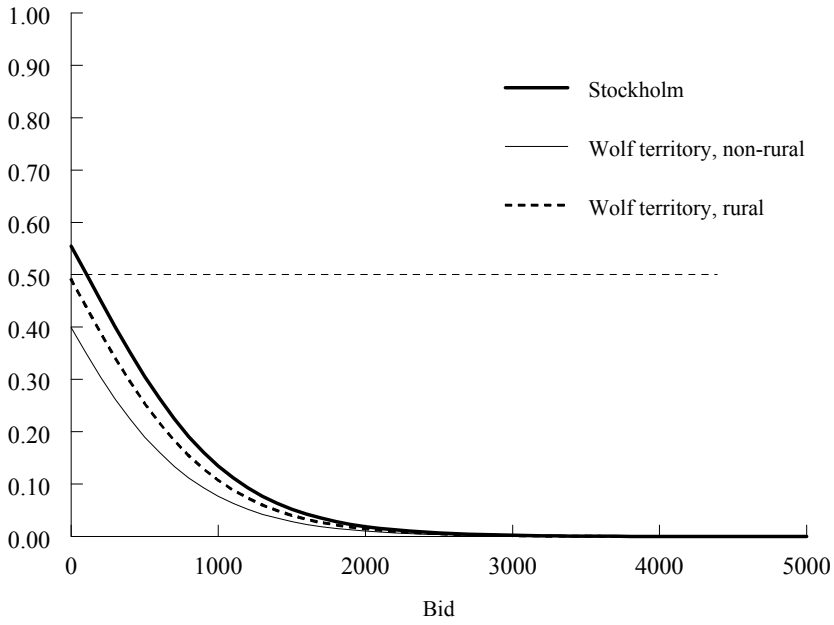

Figure 2. Survival function for different stratas, payment card model (PC II).

Concerning the uncertainty issue it is obvious that our WTP estimate will depend on how we define "yes" in our data. The results in table 4 and figure 2 are based on the assumption that "definitely yes" and "probably yes" can be interpreted as "yes", whereas "unsure", probably no", and "definitely no" can be interpreted as "no". To make a sensitivity analysis of this assumption, and to obtain lower and upper bounds on WTP, we present in appendix A the results from two alternative assumptions. As expected the results in appendix A shows that mean WTP differs substantially between the different assumptions. If we define "yes" as "definitely yes", and all other responses as "no" overall mean WTP is SEK 186, which should be compared to SEK 291 in table 4. On the other hand, if we define "yes" as all responses but "definitely no" we obtain a mean WTP amounting to SEK 746. Thus we can view SEK 186 as a lower bound and SEK 746 as an upper bound. If we calculate the median the differences are much less pronounced, which to some extent is illustrated in figure A1 in appendix A, where the survival function for the Stockholm strata, which is the only strata with a nonzero median, is plotted.

5. Concluding comments

The purpose of this study was to contribute with an applied policy analysis of predator preservation policy in Sweden. The policy package under consideration implies an increase in the number of wolves and wolverines, and a population of bears and lynx at the current level. Concerning this objective we find that the Swedish population seems to be divided in almost two equal parts in their attitudes towards the policy. That is, almost 50 percent of the population supports implementation of the predator policy package. Furthermore, the results show that there is a clear "not in my backyard" effect since the majority of the supporters to the policy is residing in big cities, far away from the predators. In wolf territories, on the other hand, two thirds of the population reveals non-positive preferences for the policy in the sense that they are not willing to contribute economically for its implementation. Furthermore, almost one half of those with non-positive preferences clearly states that they have negative preferences for the policy. A quantitative analysis, using a ordinary logit model on the probability of supporting the predator policy, reveals that other factors than place of living are important determinants of the attitudes towards the predator policy. Hunters and individuals living in the same household as hunters are more likely to be against or indifferent to the predator policy, whereas members of green ngo's are more likely to be in favour.

Concerning the estimate of our welfare measure we find that it lies in the interval SEK 236-291, as a mean for the whole population, but that there are substantial differences between different parts of the country. The highest willingness to pay is found for those living in Stockholm, whereas the lowest is found for those living in wolf territories. Here it should be pointed out that our willingness to pay measure is flawed with upward bias, since we can't access the willingness to accept for those with clearly negative preferences. In this paper we just set their willingness to pay equal to zero. Thus, we can't rule out that the mean willingness to pay in fact is negative, i.e. the social-value of implementing the predator policy is negative. Furthermore it is interesting to note that the median willingness to pay exceeds zero only in the Stockholm strata. For a median citizen in any other region of the country willingness to pay is at most zero. Finally we can conclude from the sensitivity analysis, concerning uncertainty, that the results are fairly sensitive to how we interpret those who are uncertain. If we assume that everyone

who do not say “definitely no” will pay, then the mean willingness to pay will be more than three times higher than if we assume that those who pay is only those who say “definitely yes”. Thus we can conclude that our “mean estimate” is subject to uncertainty also due to some kind of “preference uncertainty”.

From our results we conclude that there is a strong significant difference in WTP between people living in wolf territories and Stockholm, whereas there seems to be a difference also between other stratas, but at a much lower level of significance. However, it seems clear that while almost all the costs fall upon the local population the benefits from implementing the predator policy will be distributed unequally between locals and non-locals in favour of the later group. The compensation system prevalent in Sweden today, which only compensates for losses of domesticated and semi-domesticated animals, does not seem to be enough for equalizing winners and losers. One important problem for the politicians to solve then is that of how to compensate individuals others than owners of livestock and reindeers that are negative towards the predator policy, e.g. hunters who lost their hunting dog. This problem will be important to focus if the intension is to further increase the wolf population to about 1000 animals.

The present study highlight, at least, three important issues that have to be considered further in future research. The first issue is the necessity to reveal how much individuals that are against the predator policy would need to be compensated to accept increasing predator populations. The second is the “design issue”, i.e. the multiple bound versus payment card format. The third is preference uncertainty and how to include this into our theoretical framework. One motivation for using the multiple bounded, polychotomous-choice format is that the possibility for respondents to express uncertainty easily can be incorporated. However, this can also be incorporated in the payment card format by using a follow up question that considers the respondents “degree of certainty”. Thus our final conclusion would be that as long as we have not been able to incorporate preference uncertainty directly into the utility maximization framework the payment card, or dichotomous choice, may be a robust elicitation format, and much less burdensome for the respondents than the multiple bound format.

6. **References**

Alberini, A., Boyle, K. and Welsh, M. (2003). Analysis of contingent valuation data with multiple bids and response options allowing respondents to express uncertainty. *Journal of Environmental Economics and Management*, 45, p40-62.

Bjerke, T., Reitan, O. & Kellert, S. R (1998). Attitudes toward wolves in Southeastern Norway. *Society and Natural Resources* 11, 169-178.

Bjerke, T & Kaltenborn, B. P (2002). The Relationship of General Life Values to Attitudes Toward Large Carnivores. *Human Ecology Review, Vol. 9, No. 1, 55-61.*

Boman, M & Bostedt, G (1999). Valuing the Wolf in Sweden: Are Benefits Contingent on the Supply? In Boman, M., Brännlund, R. and Kriström, B. (eds.) *Topics in Environmental Economics*, 157-174, Kluwer Academic Publishers.

Chambers, C.M. & Whitehead, J.C (2003). A Contingent Valuation Estimate of the Benefits of Wolves in Minnesota. *Environmental and Resource Economics* **26:** 249–267, 2003.

Duffield, J.W & Neher, C. J (1996). Economics ofWolf Recovery in Yellowstone National Park. *Transactions of the 61st North American Wildlife and Natural Resources Conference*, 285–292.

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

Garcia, D. and Riera, P. (2003). Expansion versus Density in Barcelona: A valuation Exercise. *Urban Studies*, 40, 1925-36.

Hanemann, W. M. (1984). Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. *American Journal of Agricultural Economics*, 332-341.

Heberlein, T & Ericsson, G (2005). Ties to the Countryside: Accounting for Urbanites Attitudes toward Hunting, Wolves, and Wildlife. *Human Dimensions of Wildlife*, 10, 213–227.

Kaltenborn, B. P., Bjerke, T. and Strumse, E. (1998). Diverging attitudes towards predators: Do environmental beliefs play a part? *Human Ecology Review* 5 (2), 1-9.

Kaltenborn, B. P., Bjerke, T and Vittersø; J. (1999). Attitudes toward large carnivores among sheep farmers, wildlife managers, and research biologists in Norway. *Human Dimensions of Wildlife* 4, 57-73.

Kellert, S. R. (1985). *The public and the timber wolf in Minnesota*. New Haven, CT: Yale University.

Kellert, S. R. (1991). Public views of wolf restoration in Michigan. *Transactions of the North American Wildlife and Natural Resources Conference* 56, 152-161.

Kellert, S. R. (1996). *The value of life. Biological diversity and human* society. Washington, D.C.: Island Press.

Kellert, S. R. (1999). The Public and the Wolf in Minnesota. International Wolf Center.

Kriström, B (1997). Spike Models in Contingent Valuation. *American Journal of Agricultural Economics*, 79, 1013-1023.

Nahuelhual-Munoz, L., Loureiro, M. and Loomis, J. (2004). Addressing Heterogeneous Preferences Using Parametric Extended Spike Models. *Environmental and Resource Economics*, 27, 297-311.

Vossler, C. A. and Poe, G. L. (2005). Analysis of contingent valuation data with multiple bids and response options allowing respondents to express uncertainty: a comment. *Journal of Environmental Economics and Management*, 49, 197-200.

Wabakken, P., Aronsson. Å, Sand, H. Strømseth, T. H. and Kojola, I. (2004). Ulv i Skandinavia: Statusrapport for vinteren 2003-2004. Høgskolen i Hedmark. Oppdragsrapport nr. 5.

Wang, H. (1997). Treatment of 'dont know' responses in contingent valuation survey: A random valuation model. *Journal of Environmental Economics and Management*, 32, 219-232.

Welsh, M. and Poe, G. L. (1998). Elicitation Effects in Contingent Valuation: Comparisons to a Multiple Bounded Discrete Choice Approach. *Journal of Environmental Economics and Management*, 36, 170-185.

Yoo, S-H. and Kwak, S-J., (2002). Using a spike model to deal with zero response data from double bounded dichotomous choice contingent valuation surveys. *Applied Economics*, 9, 929-932.

Appendix A

Table A1. Estimates of mean willingness to pay

	Lower bound	**PC II**	**Higher bound**
α	0.195 (0.22)	0.217 (0.22)	0.18 (0.074)
β	0.00318 (0.00005)	0.00207 (0.00004)	0.0008 (0.00002)
WTP[a]	186 (15.4)	291 (15.4)	783 (41.62)
WTP_1 territory rural	96 (9.2)	151 (14.26)	406 (37.59)
WTP_2 territory non-rural	93 (19.81)	139 (30.65)	379 (81.59)
WTP_3 Wolf area rural	117 (14.97)	184 (22.70)	479 (60.25)
WTP_4 Wolf area non-rural	151 (25.53)	240 (38.94)	665 (103.69)
WTP_7 Göteborg	150 (30.35)	233 (45.59)	618 (126.55)
WTP_8 Malmö	195 (33.80)	301 (52.47)	773 (141.55)
WTP_9 Stockholm	241 (36.30)	375 (55.63)	995 (148.82)
WTP_5 rest rural	181 (11.10)	284 (17.05)	755 (45.29)
WTP_6 rest non-rural	186 (15.12)	294 (23.24)	788 (62.28)
NOBS	1674	1674	1673
LogL	-3182.0	-3103.0	-3285

Lower bound = ”definitely yes” is taken as a ”yes” answer, whereas ”probably yes”, ”unsure”, ”probably no” and ”definitely no” is taken as a ”no” answer.

Higher bound = ”definitely yes”, ”probably yes”, ”unsure”, and ”probably no” is taken as a ”yes” answer, whereas ”definitely no” is taken as a ”no” answer.

PC II = ”definitely yes” and ”probably yes” is taken as a ”yes” answer, whereas ”unsure”, ”probably no” and ”definitely no” is taken as a ”no” answer.(see table 4).

[a] WTP = $\sum_i WTP_i \cdot (N_i/N)$, $i = 1,\ldots, 9$, N_i is population i stratum i.

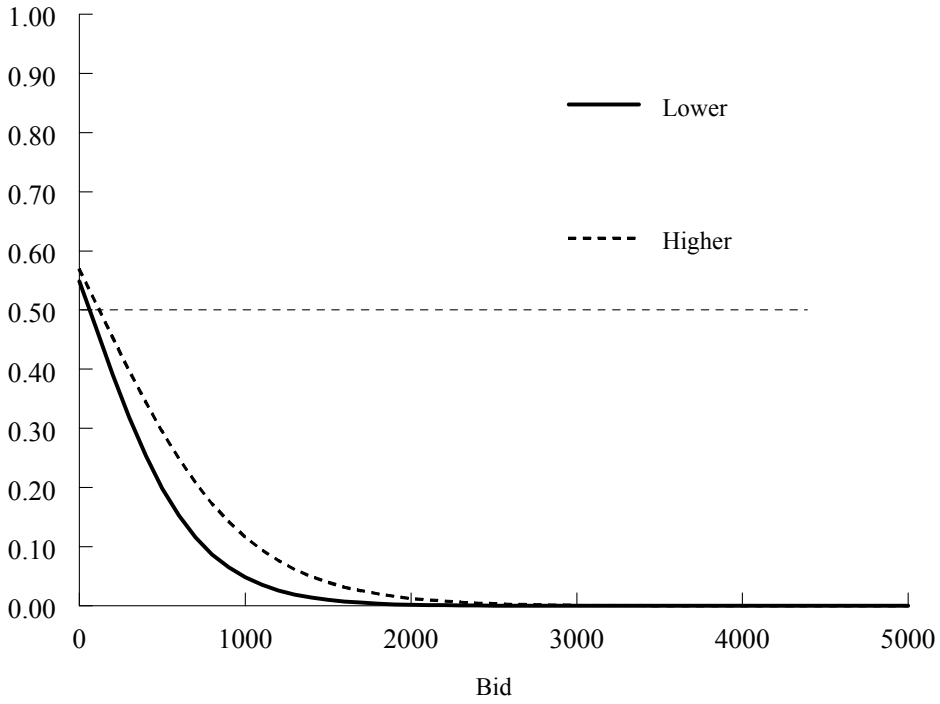

Figure A1. Survival function for the Stockholm strata, lower and higher bounds.