University of Warsaw
Faculty of Economic Sciences

Working Papers

No. 14/2012 (80)

Anna Bartczak
Jürgen Meyerhoff

Valuing the chances of survival of two distinct Eurasian lynx populations in Poland – do people want to keep doors open?

Warsaw 2012

University of Warsaw
Faculty of Economic Sciences

Valuing the chances of survival of two distinct Eurasian lynx populations in Poland – do people want to keep doors open?

Anna Bartczak
University of Warsaw
Faculty of Economic Sciences
e-mail: bartczak@wne.uw.edu.pl

Jürgen Meyerhoff
Technische Universität Berlin
Institute for Landscape and
Environmental Planning

Abstract

This survey deals with valuing the social benefits of increasing chances of survival of the two main Eurasian lynx populations in Poland: the Lowland population and the Carpathian one. The populations are exposed to different risks of extinction. Using a discrete choice experiment we examined the influence of the initial degree of endangerment of those lynx populations on respondents' funds allocation. The results show that instead of investing in the option with the expected higher outcome a main driver of individuals' decisions regarding the conservation of threatened species seems to be loss aversion. Thus, people seem to try to keep options (doors) open by investing more in the more vulnerable population. Moreover, employing a scale-extended latent class model allowed to detect segments among individuals showing different types of response behavior and therefore improved the accuracy of the willingness to pay estimates considerably compared to a conditional logit model.

Keywords:
discrete choice models, loss aversion, Lynx conservation, scale-extended latent class model, threatened species

JEL:
Q23, Q51, Q56, Q57

Acknowledgements:
This study was carried out as a part of the POLFOREX project ("Forest as a public good. Evaluation of social and environmental benefits of forests in Poland to improve management efficiency."; PL0257) funded by EEA Financial Mechanism, Norwegian Financial Mechanism and Polish Ministry of Science and Higher Education. Funding support is gratefully acknowledged.

1. Introduction

Biodiversity provides a wide array of social benefits but it also becomes more and more threatened as a result of human activities. From an economic point of view, one of the key problems associated with conservation policy decisions is that the biodiversity benefits are often not directly reflected in market prices and therefore conservation is mostly viewed as a cost burden instead of an investment in social values. However, economic sciences have developed methods that allow to estimate the economic value provided by biodiversity by using either revealed or stated preferences of individuals. Recognizing the importance of the economic value of biodiversity can improve decision-making processes and use limited public financial sources in an efficient way. Recommendations that the results of non-market valuation studies should be taken into account in designing and implementing conservation policies have been made recently by the Millennium Ecosystem Assessment (MEA, 2005) or "The Economics of Ecosystems and Biodiversity" initiative (TEEB 2010).

Non-market valuation techniques and stated preferences methods have been applied to value the protection of wildlife for several decades now. Martín-López et al. (2008) reviewed sixty contingent valuation studies concerning the willingness to pay (WTP) for species conservation. Richardson and Loomis (2009) conducted a meta-study of more than forty estimates from contingent valuation studies, focusing solely on threatened and endangered species. Both reviews show that the protection of wildlife often leads to large social benefits. Recently, the application of choice experiments (CE) has become more popular to assign an economic value to wildlife conservation programs (e.g, Lew et al. 2010; Wallmo and Lew 2011, Jacobsen et al. 2012).

A problem for economic valuation studies is that conservation programs are in general long-term projects and their outcome cannot be predicted with certainty. Generally, biologists have difficulties to predict an increase in the population size of an endangered species as a result of conservation measures or to give probabilities for the chances of survival of a particular species in numerical terms; the outcomes are, in other words, uncertain *per se.* In contrast, in most valuation surveys concerning species preservation respondents are presented "certain" outcomes, mostly an increase in the number of species by X% (see Richardson and Loomis, 2009). To incorporate the uncertain nature of conservation outcomes the present valuation study follows the International Union for Conservation of Nature (IUCN) Red list classification of threatened species to measure potential benefits of a biodiversity conservation program. It shows the gradation of species chances of survival without assigning any specific numbers or species sizes to those chances.

The study, designed as a choice experiment, concerns conservation of the two main Eurasian lynx populations in Poland: the Lowland population that occupies the northeastern part of the country and the Carpathian population that is located in the south. Even though Poland is one of the few European countries where lynx populations have survived in the wild, nowadays the entire species is considered as near threatened as the result of insufficient protection programs. However, according to biologists, the two populations face different risks of extinction; the Lowland population is more endangered than the Carpathian one (von Arx et al., 2004).

The main objectives of the present study are to investigate a) whether respondents take the initial risk levels into account when valuing the outcomes of species protection and b) whether their willingness to pay (WTP) diminishes with an increasing risk reduction, i.e., higher chances of survival. From a naive, rational perspective, one would expect that a dominant strategy for respondents answering a choice experiment would be to solely improve the changes of survival of the population that has the better initial conditions. As people generally do not encounter lynx in the wild because the animals are very timid, the location of the population should not be an important motive for paying for a certain population. On the other hand, people might be afraid of losing one lynx population, and, due to aversion of loss, might try to increase the probability of survival for the population with the poorer initial conditions by "investing" more in this population. In a different context, Shin and Ariely (2004) show that people often have a tendency to keep options available. If an option is threatened to disappear, this threat brings decision makers to invest more effort and money to keep the options open. Whether this remarkable finding applies to the conservation of endangered species as well could be important information for the development of wildlife conservation programs.

Additionally, this study is, to the best of our knowledge, the first one aiming to determine the value of lynx protection and the first in the Central and Eastern Europe aiming at the valuation of carnivore protection. Thus, it helps to fill a significant gap with respect to the knowledge about people's preferences for conserving those species in this part of Europe. The remaining article is structured as follows: The next section briefly informs about lynx conservation in Poland. Section 3 then describes the applied methods and the survey design. Section 4 presents the results while Section 5 discusses these and proposes some implications for conservation policy as well as for future surveys.

2. Lynx protection in Poland

The Eurasian lynx (Lynx lynx) is the third largest predator in Europe, after the brown bear and the wolf. Lynx live in forests in low density populations occupying large territories. The animals prey at night, mainly on small ungulates and hares. They avoid people and are no danger to them. Encounters between lynx and humans in the wild are highly unlikely.

The current population status of the Eurasian lynx in Europe and the status of its conservation is described in detail by von Arx et al. (2004). Poland is one of the few European countries where lynx have survived in the wild. However, the number of Polish lynx living in the wild has decreased to a third over the last 20 years and is estimated to be about 180-200 individuals in total (Jędrzejewski et al. 2002; von Arx et al. 2004). Although lynx are officially protected in Poland since 1995, little has been done so far to ensure the species survival (Niedziałkowska et al. 2006). In general, their current status in Poland is considered as near threatened according to the International Union for Conservation of Nature (IUCN) Red List of threatened species.

There are two main lynx populations in Poland: the Lowland population in the northeast and the Carpathian population in the south of the country. Both populations live in border regions and are part of two major populations of this species in Europe[1]. While the lynx is in general considered as a near threatened species in Poland nowadays, the risk of extinction is not the same for the Lowland and the Carpathian population. The Polish Carpathian population is larger in number and distribution than the Lowland one. It is estimated at about 100 animals. Existing migration corridors allow exchange of the Carpathian lynx between countries. The other lynx population – the Lowland one is estimated at about 60 animals and occupies highly fragmented habitat[2]. This group is more isolated from lynx populations in other countries. These factors contribute to a higher risk of extinction of

[1] Apart from Poland the Carpathian Eurasian lynx population occurs in the Czech Republic, Slovakia and Ukraine, whereas the Lowland lynx population is present in Baltic and Scandinavian countries.

[2] In addition to the Lowland and Carpathian lynx populations and a few isolated individuals in the north of Poland, a group of 12-15 lynx lives in central Poland in the Kampinowski National Park. The lynx were reintroduced there in 1994. This reintroduction was debated very controversial as all the animals were born in captivity. Moreover, the group is isolated and cannot survive in the wild without human support.

the Lowland lynx in comparison to the Carpathian population. The detail information concerning lynx occurrence in Poland has been presented inter alia by Jędrzejewski et al. (2002), Niedziałkowska et al. (2006) or Schmidt (2008).

Niedziałkowska et al. (2006) identify the fragmentation of forest habitats as a major threat for the survival of the lynx populations in Poland. Over the last two decades the number of cars in Poland doubled, the motorways network has increased three times (GUS, 2011) and the country continues to face fast development of transportation infrastructure, mainly highways. As construction projects frequently neglect the need for sufficient number, size and proper location of wildlife passes across the highways this development contributes to habitat fragmentation and further isolation of source populations of large carnivores (Niedziałkowska et al., 2006). Other threats for lynx populations occur as a result of current forest management i.e., afforestation of open spaces and not leaving enough deadwood (Schmidt 2008). Such changes in forests disturb the lynx hunting and living conditions. Additionally, game hunting and poaching by humans cause food scarcity. If these impacts on habitat conditions continue, it is anticipated that Polish lynx population may be seriously threatened in the next decades (Niedziałkowska et al., 2006) .

3. Methods and survey design

3.1 Preference and scale heterogeneity

The choice experiment method is based on the characteristics theory of value and assumes that any environmental good, e.g., the conservation of a threatened species, can be described in terms of its characteristics or attributes (Louviere et al. 2000). A change in forest management, and therefore in forest biodiversity, for example, can be described by different levels of harvested trees, different amounts of deadwood that remain in the forest and various constrains to forest recreation (e.g., denied access to certain areas). People making choices between different bundles of attributes express their preferences. Based on the observed choices it is possible to infer which attributes significantly influence choice, and, if one of the attributes included is a price or a cost, what people are willing to pay for changing the level of one or more attributes.

Capturing heterogeneity among respondents to a CE has been an important research topic within the last decade and it is increasingly investigated whether this heterogeneity is caused by differences in taste or differences in scale variation. The multinomial logit (MNL) model assumes that respondents do not vary with respect to neither taste nor scale. Historically, efforts to overcome the limitations of the MNL model were mainly concerned with taste heterogeneity, particularly by employing the random parameter logit (RPL). In these models scale is generally normalized to one assuming that all individuals respond to the choice experiment with the same consistency, that is identical error variances.

Some researchers (e.g., Louviere and Eagle 2006), however, have stressed that scale matters and might even be more important than taking taste heterogeneity into account. As a result of this strand of research Fiebig et al. (2010) as well as Greene and Hensher (2010) have operationalized models that supposedly allow taking scale heterogeneity into account. Among them are the scale heterogeneity model (S-MNL) and the generalized mixed (GMX) logit model. The latter allows identifying both taste and scale heterogeneity separately. Whether these models allow identifying the scale parameter separately is currently debated. Hess and Rose (2012) argue that the attempts presented in the literature to disentangle the two components are misguided. They find that the various model specifications presented, for example by Fiebig et al. (2010), are different parameterizations that allow for more flexible distributions but do not capture scale heterogeneity.

An alternative approach to capture, at least partially, the effect of scale heterogeneity is to estimate scale differences among subgroups of a sample by normalizing the scale parameter in one of the groups to zero. One technique that has been applied quite often, especially in benefit transfer studies, is the grid-search procedure suggested by Swait and Louviere (2003). An alternative to this procedure is to estimate the scale parameter by using full information maximum likelihood (Campbell et al. 2008; Olson 2009).

Madigson and Vermunt (2007) propose a scale extended latent class (LC) model. The basic idea behind this model is that respondents are not only allocated to a preference class but also to a variance class. In addition to taking scale differences between subgroups into account the model allows to explain both membership in a preference and in a scale class separately through specifying covariates for each membership function. Recent applications of the scale-adjusted latent class model are Campbell et al. (2011), Flynn et al. (2010) and Mueller et al. (2010).

Generally, the LC approach assumes that c latent preference segments exist in the population, each with a different preference structure, and that an individual n belongs to one of the segments c (1, …., C). Membership to one of the classes, however, is unknown to the analyst. Within the random utility framework the utility function takes the following form:

$$U_{n|c} = \beta_c x_i + \varepsilon_{n|c} \ , \qquad (1)$$

where the utility of the n_{th} respondent belongs to a particular class c by choosing an alternative i from the set of available alternatives j, x_i are the attributes describing the good or environmental change in question, $ß_c$ are the class specific utility parameters, and an error term ε. The probability of choice under the assumption that the errors are independent and identically distributed (IID) and follow a Type I distribution is:

$$Pr_{n|c}(i) = \frac{\exp(\beta_c x_i)}{\sum_k \exp(\beta_c x_j)} \, , \qquad (2)$$

with the scale set to one for the whole sample. Following Madigson and Vermunt (2007), the extended latent class model assumes that each latent preference class may consist of different subgroups of respondents. Each of these subgroups may share the same preferences but may vary with respect to the level of uncertainty. The choice probability conditional on preference class in this case is (e.g. Campbell et al. 2011).

$$Pr_{n|c}(i) = \sum_{s=1}^{S} \pi_s \frac{\exp(\beta_c x_i)}{\sum_k \exp(\beta_c x_j)} \qquad (3)$$

Membership in both the preference and the scale class can be explained by covariates such as socio-demographics or variables describing the user status. In the present paper, the responses to the choice sets are analyzed using both the conditional logit model and the scale extended latent class model. All models were estimated with the software “Latent Gold Choice” using the LG syntax module for version 4.5. 200 starting sets with 100 iterations were used in order to reduce the probability of local maxima.

3.2 Choice attributes and experimental design

The choice experiment comprises three attributes: the status of the Lowland and of the Carpathian lynx population both in 20 years from now, and the annual cost of the particular conservation program per person.[3] Instead of employing the commonly used increase in the number of individuals as a measure of improved protection of the endangered species we decided to describe the status of the lynx populations in terms of its chances of survival. In our opinion, consulted with biologists, this form of presentation is more reliable and informative for respondents than presenting chances of survival in percentages or showing different levels of population sizes. The categories used are based on the IUCN Red List of threatened species. To make the categories easier to understand for respondents they were slightly modified, i.e., we simplified the terminology (see Table 1). The categories and the status for both lynx populations were consulted with experts from the Institute of Nature Conservation and the Mammal Research Institute at the Polish Academy of Sciences.

Table 1. Levels of threat.

IUCN Red List*	Scale adapted for the CE
Critically Endangered (CR) - Extremely high risk of extinction in the wild.	**Critically threatened** - Extremely high risk of extinction in the wild
Endangered (EN) - High risk of extinction in the wild.	**Highly threatened** - High risk of extinction in the wild.
Vulnerable (VU) - High risk of endangerment in the wild.	**Moderately threatened** - Moderate risk of extinction in the wild.
Near Threatened (NT) - Likely to become endangered in the near future.	**Lowly threatened** - Low risk of extinction in the wild.
Least Concern (LC) - Lowest risk. Does not qualify for a more at risk category.	**Stable** - Negligible risk of extinction in the wild.

Note: * The IUCN Red List includes two additional categories: extinct in the wild (EW) and extinct (EX), which were not included in the valuation survey, as they were not seen as necessary for the purpose of our study.

For the purposes of the CE, the future status of the Lowland population can take one of five levels (from critically threatened to stable), while for the Carpathian population four attribute levels are used (from highly threatened to stable). As a payment vehicle a tax is used that would go to a special fund established for lynx protection in Poland. Table 2 shows the full list of attribute levels in the experimental design.

Table 2. Attributes and levels in CE.

Attributes	Levels
Lowland lynx population	critically threatened (future Status Quo), highly threatened, moderately threatened, low threatened, stable
Carpathian lynx population	highly threatened (future Status Quo), moderately threatened, low threatened, stable
Cost per person per year[4]	0zł (future Status Quo), 15zł, 50zł, 90zł, 150zł

[3] The design of the choice experiment follows Lew et al. (2010) to some extent. They investigate the public's preferences for enhancements to the protection of the western stock of Steller sea lions (Eumetopias jubatus).

[4] The nominal exchange rate from February 2011: 1 € = 3.9 zł

The choice sets are created using a Bayesian D-efficient design with fixed priors. Each set comprises two policy options and a business-as-usual option. Each option describes the effect the protection measures would have on the lynx populations' chances of survival in future. Additionally, the sets provide information about the current number of individuals of each population. To illustrate the differences between the hypothetical threat levels, colors following the idea of traffic lights are used to mark attribute levels, i.e., each attribute levels was accompanied by a pictogram of a lynx colored according to the threat level. Each respondent faced seven choice sets in total, including one with a dominant alternative; the latter choice sets are not used in the present analysis. An example choice card set is presented in Figure 1.

	Program A No additional protection measures Expected results in 20 years	**Program B** Additional protection measures Expected results in 20 years	**Program C** Additional protection measures Expected results in 20 years
LOWLAND LYNX POPULATION Current number: 60 animals	**CRITICALLY THREATENED** **Extremely high** risk of extinction 	**STABLE POPULATION** **Negligible** risk of extinction 	**CRITICALLY THREATENED** **Extremely high** risk of extinction 
CARPATHIAN LYNX POPULATION Current number: 100 animals	**HIGHLY THREATENED** **High** risk of extinction 	**HIGHLY THREATENED** **High** risk of extinction 	**MODERATELLY THREATENED** **Moderate** risk of extinction 
Cost per person per year	**0 zł**	**90 zł**	**90 zł**
I prefer **the most**	☐	☐	☐

Figure 1. Example choice set.

3.3 Survey and sampling

The valuation survey consists of six main sections. The first section provides respondents with general information about forests in Poland and collects data concerning individuals' recreation patterns. Subsequently, the state of lynx in Europe is introduced. Additionally, a detailed depiction of the two main lynx populations in Poland is provided. This information includes the physical description of lynx, its customs, its places of occurrence in Poland and the main threats. Section 3 is devoted to potential management actions that could increase chances of survival of the two main lynx populations in Poland. The most important among those actions is creating corridors and passes across roads and railway tracks enabling the lynx to migrate between forest complexes. In section 4 the choice sets are presented to respondents. After each choice set respondents are asked to state their level of response certainty on a ten-point response scale. The next section is devoted to elicit respondents risk attitude using a lottery based on Laury and Holt (2002). Finally, section 6 presents attitudinal statements to determine respondents' environmental awareness and requests standard socio-economics.

A random sample of survey respondents was drawn from Warsaw inhabitants. It was a quota sample representative of the Warsaw population in terms of gender, age and education. The survey was carried out in February 2011. A total of 300 interviews were conducted by a professional polling agency using the computer-assisted personal interviewing (CAPI) system. The questionnaire was pretested with 50 students from the Faculty of Economics at the University of Warsaw.

4. Results

4.1 Descriptive statistics

Table 3 reports socio-demographics of the analyzed sample. 56% of respondents were women, and the average age of a respondent was 47 years. Around 40% had a higher education and the average net monthly individual income was 2265zł (581€). 27% of respondents reported that they visited a forest on a weekly basis during the last 12 months prior to the interview. Another 32% went to a forest one to three times a month and 40% stated that they visited a forest less than once a month or not at all during that time period.

Table 3. Descriptive statistics of the analyzed sample

	%	Mean	Median	Min	Max
Women	56				
Age		46.79	47	20	90
Education					
- Primary	11				
- Secondary	49				
- High	40				
Net monthly household income in zł		4192	3500	500	22500
Net monthly individual income in zł		2265	2500	0	9500
Forest visits in the last 12 months					
- More than 3 times a week	12				
- 1 to 2 times a week	15				
- 1 to 3 times a month	32				
- Less than once a month	36				
- Not visited	5				

N = 300

4.2 Estimation results

Table 5 reports the estimation results for all models. A first step in the analysis of the responses to the choice sets is the multinomial logit (MNL) model. The MNL model is overall highly significant and shows a good fit with a pseudo-R^2 of 0.19. The signs of the parameters are generally as expected. The price parameter is negative as well as the sign of the alternative specific constant (ASC) parameter indicating the anticipated situation of lynx in Poland without changes in conservation policy. Next, each coefficient for an increased level of chances of survival is statistically significant and valued positively. Respondents are clearly in favor of lowering the risk levels for both lynx populations and would experience a disutility if the current lynx protection policy would be maintained.

Estimating a LC model usually starts with estimating a series of models with an increasing number of classes. For each model the log-likelihood and various information criteria are calculated in order to determine the suitable number of classes. Applying this procedure we found that each model contained a class for which the cost parameter was statistically and positively significant. Further investigations revealed that a group of respondents had chosen the alternative with the highest costs on all choice sets regardless of the levels of the other two attributes. Therefore, this behavior is seen as a form of protesting. Instead of excluding these respondents from further analyses they were specified as members of a particular preference class. All models presented in Table 4, which shows the criteria used to determine the appropriate number of remaining segments, thus include one pre-defined segment.[5] As the criteria reveal, a larger number of segments corresponds to smaller log-likelihood values and information criteria. The LC model with four classes outperforms the other models (see Table 4).

Table 4: Criteria for number of segments

Segments		Parameters	Log-likelihood (LL)	BIC	AIC3	CAIC
Taste	Scale					
1		9	-1586,2741	3223,88	3199,55	3232,88
2*		19	-1552,2306	3212,83	3161,46	3231,83
2*	2	22	-1389,7193	2904,92	2845,44	2926,92
3*		29	-1299,0593	2763,53	2685,12	2792,53
3*	2	34	-1283,6616	2761,25	2669,32	2795,25
4*		39	-1195,7447	2613,94	2508,49	2652,94
4*	2	43	-1191,5720	2628,41	2512,14	2671,41

Note: * indicates that a subgroup of respondents was assigned to a known-class

Several studies, however, have shown that selecting the number of classes solely based on the information criteria will not always result in sound models. Selection of the number of classes thus often requires using additional information such as size of segments and signs of parameters (Bacher and Vermunt 2010; Scarpa and Thiene 2011). We therefore opted for a model with three preference segments including the one with known members, and two scale classes. Table 5 presents the estimation results for this model alongside the estimates from the MNL.

[5] Flynn et al. (2010) report that they assigned respondents with counter-intuitive choices not only to known preference segments but also to a known scale segment. In the present case assigning these respondents also to a know scale class resulted in non-significant scale differences. Therefore, we refrained from assigning respondents to an a priori known scale class.

Table 5. Multinomial logit and scale extended latent class model

	MNL			LC Class 1		LC Class 2		LC Class 3		
	Coeff.	**|z-value|**	**Wald**	**Coeff.**	**|z-value|**	**Coeff.**	**|z-value|**	**Coeff.**	**|z-value|**	**Wald**
Preference classes										
Class size	1.00			0.04		0.85		0.11		
Lowland highly	0.749	5.18	117.28	-0.889	-1.344	0.449	3.817	-0.015	-0.078	63.71
Lowland moderate	0.738	5.41		-0.647	-0.353	0.737	5.158	-0.464	-1.067	
Lowland low	1.227	9.69		1.126	1.193	1.088	6.757	-0.435	-0.839	
Lowland stable	1.131	8.84		1.279	1.734	1.039	5.660	-0.828	-0.932	
Carpathian moderate	0.363	3.33	31.73	-2.140	-3.034	0.333	3.387	0.317	0.704	66.56
Carpathian low	0.475	4.72		0.045	0.063	0.553	6.126	-0.037	-0.118	
Carpathian stable	0.463	4.32		-1.540	-0.593	0.461	5.066	0.042	0.151	
Cost	-0.006	7.93	24.70	0.050	5.050	-0.008	7.982	-0.020	2.788	108.14
ASC_{pA}	-0.793	4.92	15.14	-1.057	1.015	-2.386	10.400	0.215	0.490	126.32
Scale classes										
			Class size							
Scale (class 1)			0.76	1.000	fixed	1.000	fixed	1.000	fixed	
Scale (class 2)			0.24	5.540	4.11	5.540	4.35	5.540	4.35	
Covariates membership scale class 2										
Response certainty				0.160	2.013					
Education				0.227	2.098					
LL_0	-1977.50									
LL_{model}	-1586.27			-1283.66						
McFadden R2	0.19			0.35						

N = 300

The LC model selected shows a highly increased fit over the multinomial logit model. Moreover, this three-segment model with two scale segments performs significantly better than a three class model without scale segments (χ=30.79; d.f.=5, p<0.01). The classes in the chosen model vary significantly with respect to segment size. The largest class comprises 85% of all respondents. In this segment the signs and significance levels are similar to those in the conditional logit model. The parameters for the highest risk levels are significant and have a negative sign. All attribute parameters indicating an improvement in lynx protection are highly statistically significant and have the expected positive sign. Respondents who are likely to be a member of this segment would be better off if conservation measures leading to better lynx conserving would be implemented.

The next class gathers 11% of the sample. It is characterized by the fact that individuals with a high predicted membership probability to this class do not care about the risk status of the two lynx populations but solely focus on the cost of programs. None of the attributes describing the risk levels of the two populations are significant while the price parameter is highly statistically significant and has a negative sign. Further analysis reveals that all respondents who always chose the status quo option across all six choices (n = 15) are members of this class. Finally, the segment with the known members comprises 4% of the sample. As reported in table 5, the cost parameter in this class is statistically significant but has a counter-intuitive positive sign.

The two scale segments are of very different size as well. Class 1 with the scale normalized to one for the purpose of identification is the larger segment with 76%. In contrast, those individuals that are assigned to scale class 2 (24%) have a much larger scale than the other respondents indicating a substantially lower error-variance. Two covariates significantly influence membership in one of the two classes: on average, individuals who reported higher levels of response certainty over the course of choice tasks as well as individuals who have a higher education are more likely to be members of the second scale segment.

Overall, the specification search using the LC model resulted in three classes, two with specific types of response behaviors and one class comprising respondents with well-behaved preferences. Respondents who always choose the option with the highest price regardless of the other attribute levels (4% of all respondents) were assigned to one class as they reveal a counter-intuitive response behavior. Their behavior is interpreted as a form of serial nonparticipation (von Haefen et al. 2005) as those individuals do not make any trade-offs among the attributes. An explanation for this kind of choice behavior could be protesting against the valuation approach, for example.

Respondents who are likely to be members of the second class (11% of respondents) obviously do not care about lynx conservation. None of the parameters for the different population statuses are statistically different from zero. In contrast, the cost parameter is negatively significant, indicating that these individuals are strongly concerned with the costs they would face if conservation programs were implemented. The MNL model does not show these types of response behavior. Of course it would be possible to exclude all those respondents from further analysis who always choose the current situation, another form of serial non-participation. This has been done in a couple of other studies (see e.g. Glenk and Colombo 2011; Wallamo and Lew , 2011; Jacobsen et al., 2012). However, proceeding like this would be an ad hoc measure and not justified by theory as individuals are allowed to not buy anything in a market. The LC model enabled us to separate response behaviors that reveal different kinds of serial nonparticipation from classes with well-behaved preferences.

Table 6. Marginal willingness to pay in zł

Attribute	MNL model Mean WTP	MNL model 95% confidence interval	LC model (Class 2: 85%) Mean WTP	LC model (Class 2: 85%) 95% confidence interval
Lowland baseline: critically threatened in 20 years				
critically -> highly	125.41	55.19 – 194.53	57.99	25.44-90.55
critically -> moderately	122.60	68.00 – 177.21	95.15	56.37-133.93
critically -> low	202.49	131.93 – 273.12	140.48	100.37-180.60
critically -> stable	186.16	123.79 – 248.52	134.10	88.00-180.20
Carpathian baseline: highly threatened in 20 years				
highly -> moderately	60.08	21.33 – 98.83	42.98	18.57-67.39
highly -> low	78.38	44.00 – 112.74	71.37	49.76-92.97
highly -> stable	74.53	39.99 – 109.07	59.48	43.41-75.53

Note: confidence intervals were estimated applying the Delta Method.

Table 6 reports the marginal WTP estimates from the LC model for those respondents who are predicted to be a member of the largest class, the one with members making trade-offs among attributes, as well as the MNL model estimates. In comparison with the estimates from the MNL model, the mean willingness to pay of this class is lower for both lynx populations and the confidence intervals are significantly tighter . Thus, by separating respondents who reveal serial nonparticipation from respondents who made trade-offs as intended by the choice experiment method we gained accuracy in estimating WTP.

A remarkable finding of this study is that the WTP estimates for the Lowland population are much higher than those for the Carpathian population. This shows that respondents are willing to pay significantly higher amounts for the population that faces the higher risk of extinction. In other words, respondents do not decide to go for the safer investment, i.e., to allocate more funds to the Carpathian population that has currently higher chances of survival. We also find a decrease in the marginal utility when we compare the two highest survival levels. For both populations respondents are willing to pay less for moving towards the stable level than for moving towards the second highest level, lowly threatened; similar findings are presented by Lew et al. (2010) and Jacobsen et al. (2012).

5. Conclusions and discussion

In this study we investigated the influence of the baseline degree of endangerment of two distinct populations of the same species on the individuals' funds allocation using the choice experiment method. Recently, as the meta-studies by Martin-Lopez et al. (2008) and by Richardson and Loomis (2009) show, stated preference surveys have been frequently applied to determine preferences for the conservation of rare species. In most of these studies the environmental outcomes are presented as certain, e.g., as an increase in the number of species in a population by X%. In practice, however, environmental policies and programs aimed at improvements for wildlife species involve very long time horizons and their results are subject of substantial uncertainty. In our survey which focuses on the preservation of two main Eurasian lynx populations in Poland, we therefore decided to present benefits of conservation programs in the form of uncertain outcomes, i.e., increases in the chances of populations' survival, guided by the IUCN Red List classification. In our opinion, such a measurement of benefits is preferable as it does not suggests a false sense of security to respondents.

To examine how information about the baseline levels of the risk of extinction influences peoples' choices, we designed a choice experiment that offered three alternatives: continuing the current lynx protection policy and two programs where additional protection measures which would result in increased chances of survival for at least one lynx population compared to the status quo. The outcomes of the programs were framed in terms of benefits in 20 years.

The results of the CE show that most respondents are willing to invest in the conservation of two main lynx populations in Poland. The obtained estimates, however, should be treated as an upper bound of individuals' WTP for the following reasons. First of all, the survey was carried out among the Warsaw population whose net income per capita is higher by one-third than the average income in Poland (GUS, 2012). Secondly, the survey is focused on the non-use value of lynx. Karlsson and Sjöström (2008) show that urban people in particular are motivated by existence value arguments when they express support for the conservation of carnivores. Additionally, Kaltenborn et al. (2006) point out that people have positive attitudes towards animals in the context of abstract existence values but if the presence of the species is associated with economic costs in their surroundings this attitude quickly becomes negative. Even though lynx do not cause a significant threat to livestock, a study by Bath et al. (2008) shows that farmers living in an area where lynx is present display a negative attitude towards the species. Results reported by Richardson and Loomis (2009) also indicate that visitors are likely to invest more in conservation programs for threatened and endangered species than local people. This suggests that WTP for lynx conservation by farmers is probably lower, or even negative, than for the rest of society in Poland.

The results of our survey reveal that the willingness to pay for the Lowland population is higher than for the Carpathian population, i.e. that people prefer to invest more in those conservation programs that protect the population with the higher risk of extinction. As the results of the LC model show (class 2 comprising 85% of respondents) people are willing to pay almost twice as much to achieve a low risk of extinction for the Lowland lynx population in 20 years from now than for the Carpathian one (around 35 and 17.7 Euro per year, respectively). The baseline levels of risk for those populations in 20 years (i.e., if the current conservation policy is continued) are assumed as critically threatened for the Lowland population and highly threatened for Carpathian lynx.

Taking into account the different baseline risk levels of both populations, one could expected that in accordance with the theory of expected utility, people might rather express a higher willingness to pay for the Carpathian lynx. Even though both populations are exposed to a risk of extinction, people who are interested in the survival of the lynx in Poland could see an investment in conservation measures for the Carpathian population as a safer option. The current situation, i.e., a higher number of animals, bigger size of occupied area and better migration possibilities, makes the survival of this population more likely. The results, however, seem to tell a different story. Rather than investing more in the population with slightly higher chances of survival and at the same time increasing the risk of extinction for the other population, people seem to prefer allocating resources corresponding to the baseline risk levels. The population that is more threatened gets more resources in order to compensate for poorer initial conditions.

This behavior could be explained with the concept of loss aversion (Kahneman et al. 1991). It refers to people's tendency to strongly prefer avoiding losses to acquiring gains. Instead of acting in favor of the population that has the better chances of survival and caring less about the more endangered population, people seem to be afraid of losing the latter population. Shin and Ariely (2004) find similar decision behavior when they investigate how people respond to the threat of disappearance.. Using four experiments in a neutral context they demonstrate that threat of future unavailability makes less desirable options more appealing and causes individuals to overinvest in these options. Thus, investing more in the more vulnerable lynx population can be interpreted as an attempt to keep options – doors – open by trying to preserve both through responding with higher expenses.

With respect to the valuation method, the LC model allowed us to identify overall three classes, among them two with specific types of serial nonparticipation. Individuals identified as members of one class responded in a way that is not compatible with the basic assumptions of CE methodology, i.e., that respondents make trade-offs between the attributes and their levels. Instead, they choose the option with the highest price on each choice set. Consequently, the price coefficient for this group was positive. We interpret this behavior as a kind of protest against the survey. Respondents who acted in this way were all assigned to one class and kept inside the model instead of dropping them from the sample as invalid. The latter is a common approach in valuation surveys but leads to reduced information on preference heterogeneity among respondents. Unfortunately, it was not possible to explain class membership for respondents with a high predicted membership probability based on covariates[6] in the model.

For another class we found that the only significant coefficient was the one associated with the price attribute. Individuals likely to be members of this class seemed to not take into account the compositions of proposed conservation programs, instead they just focused on the financial burden connected to these programs. This class also comprises all those respondents who have chosen always the status quo, a continuation of current conservation policy which will not incur costs to them. This adds to the findings presented in the literature that the LC model is an interesting modeling tool for investigating the so called "status quo effect" i.e. analyzing respondents who in CE always chose the status quo or a current situation (Burton and Rigby 2009). Although we have not pre-specified classes based on decision heuristics as it has been done recently by others (e.g., McNair et al. 2012; Campbell et al. 2011), the LC model helped identifying groups of respondents who revealed certain response behaviors i.e. always choosing the option with the highest price or always choosing the current situation. Using, for example, solely the MNL model would have covered some of this behavior and thus would have resulted in biased WTP estimates.

Moreover, the LC model allocated respondents not only to preference but also to scale classes. Two groups of respondents that vary in terms of scale variations were identified. The scale class with respondents who seemed to have a "higher ability to choose" (Christie and Gibbons 2011) where characterized by a higher education and a higher level of self-reported certainty of choices. The applied modeling approach, however, is restrictive as it assumes the independence of scale and preference classes, i.e., that the same probability of scale class occurs in each preference class (Rose and Scarpa, 2011).

[6] The covariates might have indicated what lies behind such an irrational behavior (e.g. respondents age or level of skepticism towards decision makers) and make the findings more interesting from a methodological point of view.

Finally, an important finding of this study is that individuals prefer to invest more in the conservation of the lynx population with initially lower chances of survival. Confirming the robustness of this finding can provide useful information to policy makers about people's preferences towards wildlife conservation and species valuation as, taking into account limited finance resources, prioritizing one of the two threatened populations might be unavoidable in practice. However, the results clearly indicate that people are not willing to give up one lynx population for the other one and for decision makers this means that conserving both populations should be the goal. Aggregate figures would show to what extent the societies' willingness to pay covers the costs for conserving both populations. As this study could only be conducted with people living in Warsaw it is not possible to provide a figure for the Polish population.

In future studies concerning the conservation of endangered and threatened species it would be interesting to find out whether loss aversion is really the main driver for stating a higher willingness to pay for a population that faces a higher risk of extinction. This can be done, for example, by applying so called "think-aloud" techniques. A better understanding of human attitudes towards biodiversity is an essential element for obtaining support for protection programs from the public. The other interesting finding of this study is that people prefer to pay less for reaching a stable population level than for reaching a lowly threatened one. Lew et al. (2010) and Jacobsen et al. (2012) found similar results of marginal WTP for wildlife conservation programs. Lew et al. suggest that this behavior can be explained by higher levels of uncertainty imposed on respondents in the case of large-scale improvement in species protection in combination with the long-term character of such projects (smaller improvements have higher chances to occur during respondents' lifetime). The other reason could be that people "*may only wish to get the species back on track in the near-term, as opposed to "fixing" the whole problem all at once*" (Lew et al., 2010). To our knowledge, no study was devoted so far to examine underlying motives behind these declarations.

References

Bacher, J. and Vermunt, J.K. (2010). Analyse latenter Klassen, in Wolf, C., Hennig, H. (eds), Handbuch der sozialwissenschaftlichen Datenanalyse. VS Verlag, Wiesbaden, pp. 553–574.

Bath, A., Olszanska, A., Okarma, H., (2008) From a human dimension perspective, the unknown large carnivore: Public attitudes toward Eurasian Lynx in Poland. Human Dimensions of Wildlife 13, 31-46.

Campbell, D., Hensher, D. A., Scarpa, R. (2011). Non-attendance to attributes in environmental choice analysis: a latent class specification. Journal of Environmental Planning and Management 54(8), 1061-1076.

Campbell, D., Hutchinson, W. G., Scarpa, R. (2008). Incorporating Discontinuous Preferences into the Analysis of Discrete Choice Experiments. Environmental and Resource Economics 41(3): 401-417.

Christie, M., Gibbons, J. (2011) The effect of individual 'ability to choose' (scale heterogeneity) on the valuation of environmental goods. Ecological Economics 70, 2250-2257.

Glenk, K., Colombo, S. (2011). How Sure Can You Be? A Framework for Considering Delivery Uncertainty in Benefit Assessments Based on Stated Preference Methods *Journal of Agricultural Economics 62(1)*, 25-46.

Główny Urząd Statystyczny, GUS (2012). http://www.stat.gov.pl/

Główny Urząd Statystyczny, GUS (2011). Transport - wyniki działalności w 2010 r., GUS, Warszawa

Fiebig, D.G., Keane, M.P., Louviere, J., Wasi, N. (2010). The Generalized Multinomial Logit Model: Accounting for Scale and Coefficient Heterogeneity. Marketing Science 29, 393-421.

Flynn, T. N., Louviere, J. J., Peters, T. J., Coast, J. (2010). Using discrete choice experiments to understand preferences for quality of life. Variance-scale heterogeneity matters. Social Science & Medicine 70, 1957-1965.

Greene, W.H., Hensher, D.A. (2010). Does scale heterogeneity across individuals matter? An empirical assessment of alternative logit models. Transportation 37, 413-428.

Hess, S., Rose, J. M. (2011). Can scale and coefficient heterogeneity be separated in random coefficient models? Working Paper, University of Leeds.

Holt, C. A., Laury, S. K. (2002) Risk aversion and incentive effects: New data without order effects. The American Economic Review 95(3), 1644-1655

Jacobsen, J., Lundhede, T., Jellesmark Thorsen, B. (2012). Valuation of wildlife populations above survival Biodiversity and Conservation 21, 543–563

Jędrzejewski, W., Nowak, S., Schmidt, K., Jędrzejewska, B. (2002), The wolf and the lynx in Poland – results of a census conducted in 2001. Kosmos 51, 491–499 (In Polish with English summary).

Kahneman, D., Knetsch, J.L., Thaler, R.H. (1991). The Endowment Effect, Loss Aversion and Status Quo Bias, Journal of Economic Perspectives 5, 193-206.

Kaltenborn, B., Bjerke, T., Nyahongo, J., Williams, D. (2006). Animal Preferences and Acceptability of Wildlife Management Actions around Serengeti National Park, Tanzania. Biodiversity and Conservation 15 (14): 4633-4649

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

Lew. D. K., Layton, D. F., Rowe, R. D. (2010). Valuing enhancements to endangered species protection under alternative baseline futures: The case of the Steller Sea Lion. Marine Resource Economics 25(2): 133-154.

Magidson, J., Vermunt, J. K. (2008). Removing the scale factor confound in multinomial logit choice models to obtain better estimates of preferences. In Paper presented at the swatooth symposium conference prodeedings, Sequim (WA).

Martín-López, B., Montes, C., Benayas, J. (2008). Economic Valuation of Biodiversity Conservation: the Meaning of Numbers. Conservation Biology 22(3): 624–635

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

McNair, B. J., Hensher, D. A., Bennett, J. (2012) Modelling heterogeneity in response behaviour towards a sequence of discrete choice questions: a probabilitic decision process model. Environmental and Resource Economics, DOI: 10.1007/s10640-011-9514-6

Mueller, S., Lockshin, L., Saltman, Y., Blanford, J. (2010). Message on a bottle: The relative influence of wine back label information on wine choice. Food Quality and Preferences 21, 22-32.

Niedziałkowska, M., Jędrzejewski, W, Mysłajek, R.W., Nowak, S., Jędrzejewska, B., Schmidt, K. (2006), Environmental correlates of Eurasian lynx occurence in Poland – Large scale census and GIS mapping, Biological conservation 133, 63-69.

Olsen, S. (2009) Choosing between Internet and mail survey modes for choice experiment surveys considering non-market goods. Environmental and Resource Economics 44(4), 591-610.

Richardson, L., Loomis, J. (2009) The total economic value of threatened, endangered and rare species: an updated meta-analysis. Ecological Economics 68(5), 1535-1548.

Rose, J., Scarpa, R. (2011) The role and estimation of scale heterogeneity in choice models. The Centre for the Study of Choice (CenSoC)/The University of Technology, Sydney.

Scarpa, R., Thiene, M., (2011). Organic food choices and Protection Motivation Theory: addressing the psychological sources of heterogeneity. Food Quality and Preferences 22, 532-541.

Schmidt K. (2008). Factors shaping the Eurasian lynx (Lynx lynx) population in the north-eastern Poland. Nature Conservation 65: 3-15.

Shin, J., Ariely, D. (2004) Keeping doors open: The effect of unavailability on incentives to keep options available. Management Science 50(5), 575-586.

Swait, J. D., Louviere, J. (1993). The role of the scale parameter in the estimation and comparison of multinominal logit models. Journal of Marketing Research XXX(August): 305-314.

TEEB (2010). The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

Von Arx M., Breitenmoser-Würsten C., Zimmermann F., Breitenmoser U. (2004), Status and conservation of the Eurasian lynx (Lynx lynx) in 2001. KORA Report No 19.

Von Haefen, R. H., Massey, D. M., Adamowicz, W. L. (2005). Serial nonparticipation in repeated discrete choice models. American Journal of Agricultural Economics 87 (4): 1061-76.

Wallmo, K., Lew, D. K. (2011). Valuing improvements to threatened and endangered marine species: An application of stated preference choice experiments, Journal of Environmental Management 92, 1793-1801.

Faculty of Economic Sciences
University of Warsaw
44/50 Długa St.
00-241 Warsaw
www.wne.uw.edu.pl