Social benefits of implementing a national strategy on biological diversity in Germany

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Abstract

The Millennium Ecosystem Assessment has drawn the attention of both economists and the public to the meaning of ecosystem services for human well-being and the role biodiversity plays in maintaining these services. In this paper we present results from a contingent valuation study determining the benefits people would derive from implementing a national strategy on biological diversity in Germany, i.e., the provision the ecosystem service maintenance of biodiversity. In an online survey respondents were presented three randomly selected conservation programmes from the following six ecosystem specific programmes: forests, arable land, pastures and meadows, peatlands, flood plains, and dry grasslands. Subsequently, respondents were presented one of two different overall programmes for Protecting biological diversity in Germany. One programme consists of all six ecosystem specific programmes, the other additionally included a climate change precaution by implementing protection measures on a 20% bigger area. Each time respondents were presented a single bounded dichotomous choice question asking for their willingness to pay (WTP) framed as a referendum. Results indicate that benefits from implementing the strategy would be substantial. Modelling results from the random effects probit reveals that the choices are significantly influenced by observable explanatory variables such as number of nature related trips and conservation activity and shows that the four choices are correlated. However, using different functional forms reveals that the results are very prone to model specification, especially when response uncertainty is taken into account. Thus, the preferred WTP estimates results from the non-parametric Turnbull lower bound estimator based on responses adjusted for response uncertainty.

Keywords: contingent valuation, ecosystem services, random effects probit model, Turnbull lower bound, willingness to pay, TEEB

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1. Introduction

The failure of society to place a value on nature has, as Jones-Walters and Mulder (2009) point out, resulted in the degradation of ecosystems, a consequent reduction in ecosystem services, and contributed to a significant decline in biodiversity. Although determining the benefits people obtain from the natural environment has been an essential topic in environmental economics for a long time (cf. Hanley & Barbier 2009), recently two initiatives have brought this issue to the attention of both economics as well as the public consciousness. The Millennium Ecosystem Assessment (2005) emphasizes the significance of ecosystem services for human well-being, i.e., the benefits that people derive from the process and functioning of both ‘natural’ and ‘managed’ ecosystems. It also accentuates the role of biodiversity in providing ecosystem services. The Economics of Ecosystems and Biodiversity (TEEB) initiative, building on the Millennium Ecosystem Assessment, aims at drawing attention to the (global) economic benefits of biodiversity and highlights the growing costs of biodiversity loss and ecosystem degradation (www.teebweb.org/). One of the ecosystem services which are said to provide benefits to society is the maintenance of species and the preservation of ecosystems. This service can provide both use values, e.g. through use for recreation, and non-use values, e.g., through knowing that animal and plant species exist (cf. Barbier et al. 2009; Heal et al. 2005).

In this paper we present results from a valuation study aiming at determining the economic value of the service maintenance of species and ecosystems in Germany. The German government has issued a “National Strategy on biological Diversity” (NBS) in 2007 (BMU). With this strategy, Germany fulfils its obligations under Article 6 of the Convention on biological Diversity (CBD) and implements the Convention at the national level. It aims at significantly minimising, and eventually halting altogether, the threat to biological diversity. The NBS defines about 330 goals and about 430 measures to realize a sustainable use of natural resources and to stop the loss of biodiversity for a range of sectors on the one hand, and a range of ecosystems on the other hand.

The present study is part of a project assessing the costs of inaction with respect to biodiversity protection under present conditions as well as changing climate. At the same time, the present study is to some extent an update of a survey undertaken 20 years ago by Hampicke et al. (1991) who have conducted the first, and to date only, investigation of nationwide benefits from nature protection in Germany. Like Hampicke et al. (1991), we employed the survey-based Contingent Valuation method (CVM) to capture the benefits that would arise from implementing a nationwide programme protecting biodiversity. It belongs to the group of stated preference methods directly asking individuals how they value environmental change. The method is well established (Carson & Haneman 2005) and has been applied several thousand times in environmental economics in order to capture the benefits that, for example, specific nature and biodiversity conservation measures would provide.

The paper proceeds as follows. The next section gives a brief overview of studies providing benefit estimates of nature and biodiversity conservation measures in Germany. Section 3 proceeds with presenting the nature conservation programmes and the survey instrument while section 4 details the econometric specification chosen. Section 5 presents the results before section 6 offers a conclusion.

2. Willingness to pay (WTP) for nature conservation in Germany – existing studies

Although environmental valuation has so far only played a minor role in environmental decision making a number of studies have investigated the benefits of nature and biodiversity conservation measures in Germany starting in the 1980' (see Meyerhoff & Elsasser 2007 or Degenhardt & Gronemann 2000 for an overview). Looking at these studies, we can differentiate four levels of scope: nationwide studies (e.g. Hampicke et al. (1991)), studies at the regional level (e.g. Küpker (2007)) or on the level of protected areas (e.g. Rommel (1998), Enneking (1999)) and studies with regard to a particular species or habitat (e.g. Bräuer (2002)).

Hampicke et al. (1991) conducted a mail survey determining the WTP of a random sample of the German population for different species and habitat protection programmes. A bundle of protection, maintenance and development measures as well as the land requirement was determined for different habitats (extensive pastures and meadows, semi-dry and calcareous grasslands, heath formations, salt meadows, arable land, traditional orchards, rivers and floodplains, bogs, forests) as well as water quality of small and medium size rivers. A detailed quantity structure was used to determine the costs of this programme for species and habitat protection. Among other things, participants were presented three programmes with different costs and benefits. Programme A would protect many species to some extent in selected, valuable areas at an annual cost of € 511 million (DM 1 billion) or € 0.77 (DM 1.50) monthly per person. Programme B would protect more species to a larger extent and in more areas at annual costs of € 1.53 billion (3 billion DM) or € 2.30 (DM 4.50) monthly per person, and Programme C would lead to a significant improvement of the state of nature that would allow bathing in lakes and rivers in a few years from then without health risks at the costs of € 4.6 billon (DM 9 billion) or € 6.9 (DM 13.50) monthly per person. Respondents were then asked which programme they would like to see implemented and which one they would be willing to pay for.

Küpker (2007) estimated the benefits of a biodiversity protection and enhancement programme including five measures (preservation of dead wood, reduction of game density, creation of protected areas in forests, conversion of coniferous to mixed forest, linking fragmented stocks). The payment vehicle was a fund, and a payment card was used, showing monetary values from 0 to above 200 Euro. He investigated a random sample of the State of Schleswig-Holstein as well as the German population using face-to-face interviews. While Küpker found a similarly high WTP of 25 Euro per household per year, only 31% of participants in Schleswig-Holstein were willing to pay for the biodiversity protection measures in contrast to 47% of the overall German population. This was explained by a limited acceptance of the measures for biodiversity enhancement.

Two studies situated at protected areas are presented by Rommel (1998) and Enneking (1999). The first examined the environmental and recreation services of the biosphere reserve Schorfheide-Chorin, asking both inhabitants of the biosphere reserve and those in surrounding area up to 8 km, as well as visitors to the area. Both groups were asked for the maximum amount they were willing to pay for a bundle of measures. The WTP of inhabitants added up to € 26.00 (DM 50.78) per person per month; visitors were willing to pay € 1.54 (DM 3.01) per visit per person. Rommel added this to an aggregated total annual WTP of 5.08 million € (DM 9.93 million). Enneking (1999) investigated the economic value of a nature conservation project on the Steinhuder Meer, a large inland lake in Northwestern Germany. He asked visitors to the lake if they were willing to pay a certain amount on a badge or, respectively, if the badge is not introduced, willing to make a voluntary payment to a fund for a planned rewetting project for the protection of ground breeders. The median value was between € 1.06 (DM 3.08) per visitor per day and € 2.67 (DM 5.23) for the one time payment to the fund. This value was not aggregated due to the uncertainty about total visitors to the area.

Bräuer (2002) focused on a single species and its habitat. He determined visitor's willingness to pay for a programme for the protection of the beaver and its floodplain habitat. The programme described measures needed (land purchase, habitat enhancement, reintroduction costs). Visitors to the northern part of the Spessart, a low mountain range in north-western Bavaria and southern Hesse, were handed a payment card with amounts between 0 and 20 DM in 0.5 DM intervals and asked if they would be willing to pay the amount as a nature tax per visitor per day. Bräuer determined a WTP of about € 0.75 per visitor per day. Karkow and Gronemann (2005) conducted two verbal interview surveys, in Berlin and in the Biosphere Reserve of southwest Rügen, to investigate the WTP for the experience and recreation value of agricultural lands rich in wildflowers. Participants were presented a programme for changing cultivation on 10% of Germany's arable land area so that a rich, typical wildflower flora can develop. These sites will be distributed evenly over the country so that every participant would have personal use of it for local recreation. If participants stated that they were generally willing to contribute to the good, they were asked the maximum amount they would be willing to pay.

3. Study design and sample

3.1 The Biodiversity Protection Programme

The National Strategy on Biological Diversity (NBS) provides a range of goals and measures to stop biodiversity loss and, in the long term, increase biodiversity. However, for the purpose of the economic evaluation, these goals and measures need to be refined and quantified. A detailed quantity structure was developed (Spielmans 2010) which complements the specifications of the NBS through more detailed requirements of existing legislation and a literature review. We focused on land based ecosystems which are influenced either by conservation efforts or agricultural and forestry management. Though mentioned in the NBS, sea and coastal as well as freshwater habitats and those habitats which are not influenced by human land use or conservation efforts, like rock formations, were left out.

Based on the quantitative structure, a generally understandable programme “Protection of biological diversity in Germany” was developed for the survey. It consists of measures for six ecosystem types, arable land, pastures and meadows, forests (excluding woodlands on peat soil and in floodplains), peatlands (including woodlands on peat soils), floodplains (including woodlands in floodplains) and dry habitats (includes heathlands, natural semi-dry and dry grassland). Table 1 shows the measures as well as the area (in hectare) on which these measures should be implemented.

3.2 Questionnaire and WTP elicitation

In the first part of a five part questionnaire, participants are informed about the aim of the study in a very general way. To warm up, they were asked a few questions regarding the environment, for example which area of environmental policy should receive more attention by the federal government in the future. Participants were also introduced to the term biodiversity, which was defined as including the diversity of species and habitats and the genetic diversity within the individual animal and plant species. The second part was designed to determine participants’ willingness-to-pay for the conservation programmes (see below). The following questions then investigated participant’s attitude and aimed to find determinants that might explain people’s willingness or unwillingness to contribute financially to the biodiversity protection programmes presented to them. Through a series of questions in the fourth part of the survey, we wanted to find out more about the role nature and landscape play for recreation in Germany. Participants were asked about day trips and short trips which were defined as trips with up to three overnight stays. If being in nature and landscape was an important motivation for this trip, participants were asked to give details on the area they visited, costs that the trip incurred and so on. Finally, socio-demographics such as age, highest education level, net household income as well as membership in an environmental protection organization were requested.

The questionnaire was pretested twice. The first pretest was conducted with around 30 respondents, researchers from our institute and from the project accompanying expert group. Subsequently, the survey institute managed the second pretest with 106 participants drawn randomly from their panel (see 3.3 Sampling).

Table 1. Measures for protecting biological diversity in Germany

Forest Total land area: appr. 11 Mio. ha • Natural development on 3.9% of the forest area (430,000 ha), • Conversion to deciduous or mixed-deciduous forests on 6.3% of the woodland area (700,000 ha), • increase structural diversity through dead wood/ rotting wood areas, biotope trees and woodland edges equate to 2% of the woodland area (220,000 ha), • Conservation of all coppice, coppice with standards and wood pastures on 0.9% of forest area through promoting adapted use (near-natural silviculture, conservation-relevant traditional usage forms) (100,000 ha)	**Arable Land** Total land area: appr. 12 Mio. ha • new structural elements like hedges, groves and small water bodies in low structured areas as well as wildflower bands and buffer areas along water bodies and conservation areas on 1.5% of arable lands (180,000 ha), • protection of wildflowers and wild animals through promoting agricultural use compliant with nature protection on 3.0% of arable land (360,000 ha), • organic farming and other soil and water preservation land uses on 30,3% of arable land (3,600,000 ha)
Pastures and meadows Total land area: appr. 4.8 Mio. • conservation of species rich pastures and meadows through grazing with few animals, later or no moving, no or reduced fertilization on 18.8 % of the grassland area (900,000 ha), • development of species rich grassland to 0.9% of the existing grassland (45,000 ha), • conservation and maintenance of existing traditional orchards on 6.3% of the grassland area (300,000 ha), • establishment of new traditional orchards on an area of 0.3% of grassland (appr. 15,000 ha), • extensive use on 15.0% of the grassland (equals 20% of intensively used grassland which is currently poor in species (720,000 ha).	**Peatlands** Total land area: appr. 1.4 Mio ha • allowing and promoting of natural development on all intact peatlands, and near-natural peat forests on 5.1 % of the peatland area (70,000 ha), • regeneration, e.g. through damming drainage channels and maintenance of wet heath in peatlands through sheep grazing on 3.7% of peatland area (50,000 ha), • raising water levels on 20% of peatlands used as pastures and meadows and on 10% of peatland used for forests purposes (12.7 % of the peatland area, 173,000 ha), • abandonment of agricultural use on peat soils and establishment of adapted land uses on 11.0% of the peatland area (150,000 ha).
Flood plains Total land area: appr. 500,000 ha • species rich water meadows and riparian forests are conserved and newly established. • natural development of existing alluvial forests (16.8% of the total area, 84,000 ha), • annual mowing, and abandonment of fertilizing of species rich floodplain meadows on 1.0% of the entire floodplain area (5,000 ha), • reestablishment of flooding dynamics in selected areas on 50,000 ha (10.0% of the current retention area), • conversion of arable land to adapted uses on 6.0% of the floodplain area (30,000 ha), • new development of species rich river meadows and near-natural riparian forests amounting to 3.0% of the current total area (15,000 ha).	**Dry grassland / Dry Habitats** Total land area: appr. 160,000 ha • annual moving, or extensive grazing on 31.3% of the total area (50,000 ha), • moving or extensive grazing on 62.5% of the total area (100,000 ha) in intervals of 3-5 years • periodic maintenance of heathlands on 11.3% of the total area (18,000 ha), • one-time measures to enhance the state on 10% of the total area (16,000 ha) like impoverishment (nutrient removal) and removal of trees and shrubs, • expanding and connecting small heathlands and semi-dry grasslands amounting to 1.9% of the total area (3,000 ha).

Willingness to pay elicitation

Each respondent was presented a sequence of four protection programmes. The first three programmes were randomly chosen from the set of the six programmes regarding the different ecosystem types. They have a typical set up: the first paragraph characterises the ecosystem type, its current total area in hectare and gives examples of typical species. The second paragraph outlines causes and current threats to biodiversity relevant to this ecosystem type, and points out the need for additional measures. The third paragraph listed measures for the protection of biodiversity as well as their extent in hectare (as presented in Table 1). All paragraphs were presented on one computer screen. The fourth programme, also randomly assigned to a respondent, concerned either the comprehensive programme "Protection of biological diversity in Germany" (BIOPROG), or a version extended by a climate change precaution measure. BIOPROG+ comprises the measures for all six ecosystem types programmes. It was introduced in the survey as follows:

> *"The programme for the protection of biological diversity in Germany comprises all measures in forests and peatlands, in dry habitats, on arable land, pastures and meadows as well as in floodplains. Some of these measures you already got to know in the previous programmes. You can read and print the description of the comprehensive programme as a pdf-file* [here, a link to the pdf file was inserted]. *This programme aims at halting the loss of biological diversity in Germany and to conserve the diversity of species and habitats in the long term."*

In order to test if anticipated climate change influences participants WTP, the Biodiversity protection programme was extended. The second comprehensive programme (BIOPROG+) was summarized like the first; however, the following information was added:

> *"The anticipated climate change will quite possibly have negative effects on biodiversity. While particular species in some regions might benefit from climate change, many animal and plant species will experience a higher adaptation pressure. Therefore it is even more important that the near-natural habitats of endangered species are large enough and pathways for species exist. As a precaution, the measures should be implemented in an area that is 20% larger than intended with the comprehensive programme."*

The payment vehicle used is a contribution to a fund "Protection of biological diversity" managed by the German Federal Nature Conservation Agency. Payments are earmarked for biodiversity protection and the agency would report on the programmes implementation regularly on the internet. The bid vector (amount of money to be paid for a programme), for the sub-programmes was {1, 3, 5, 10, 15, 20, 30, 50, 75} and for the nationwide programmes {3, 5, 10, 15, 20, 30, 50, 75, 110}. Also the bid values were each time chosen randomly by the survey software. The response options were: "Yes, I agree", "No, I disagree" or "Don't know". In order to reduce incentives for strategic behaviour, the WTP question was framed as a referendum saying that the programme will only be implemented if at least half of those who faced the programme were willing to pay (implementation rule). The WTP question was worded as follows: "If you would have to make a monthly payment of X Euro, would you than vote for the programme Y? It will be implemented if at least half of the participants approve the programme. If it is not implemented, nobody needs to pay anything."

Response certainty scale

Evidence provided by Contingent Valuation studies suggests that respondents are uncertain about their responses and several approaches have been developed to incorporate the degree of uncertainty in WTP estimations (e.g., Champ et al. 1997 [Asymmetric Uncertainty Model]; Loomis & Ekstrand 1998 [Symmetric Uncertainty Model]; Akter et al. 2009; Lyssenko & Martinez-Espineira 2009). One approach, the asymmetric uncertainty model, has been used by many researchers. Directly after the WTP question respondents are presented a certainty scale ranging from 1 to 10 where 1 equals "not certain at all" and 10 equals "absolutely certain". Champ et al. (1997) recoded all responses to 'no' if the respondent has not expressed an "absolutely certain" on the scale. They argue that only in this case responses to the hypothetical WTP question would match actual WTP. Subsequently, several authors found out that this assumption is too strong. Comparing results from an actual referendum with contingent referenda Morrison and Brown (2009) find that a cut-off rating at 7 on the certainty scale produces estimates that match actual payments. As the authors point out, this adds to a number of studies that also concluded that a cut-off of either 7 or 8 is needed to equalise hypothetical and actual willingness to pay. In this survey participants were presented a certainty scale after they had responded to the fourth WTP question. The wording was as follows: "On a scale from 1 to 10, where 1 equals 'not at all sure' and 10 'very sure', how would you rank your previous answer?"

3.3 Sampling

Participants were randomly drawn from the panel of the survey institute (LINK Institut für Markt- und Sozialforschung GmbH). The panel, which is said to represent German internet users between 18 and 69 years who use the internet for private purposes at least once a week, comprises 150,000 people. It was recruited by Computer Aided Telephone Interview (CATI) interviews (no self selection bias). Those panellists selected were invited to participate in the survey via e-mail by the Link Institute by providing a link to the survey and a personalized code. For finalizing the interview respondents were rewarded with a 4 € voucher for an online bookstore. As the internet reach among people 70 years and over is smaller than 5% in Germany, this age group is underrepresented in the panel. However, due to research economic reasons, an additional recruiting of people is this group was refrained. Overall, 8662 panel members were invited[1] in four waves, a week between each wave. After five days, panellists who had not participated yet were sent an e-mail reminder. One week before the end of the survey, all interviewees who had not responded yet were reminded a second time. The field time of the survey also allowed participants who do not use the internet on a daily basis to participate. The main survey was conducted from the beginning of November to the beginning of December 2009.

[1] The reason for inviting such a high number of respondents was not only to have at least 1000 observations for each conservation programme but also to record details about a large number of nature oriented trips respondents have done within the twelve months prior to the interview. A high number of interviews should facilitate a good coverage of destinations in all regions of Germany. The approximately reported 2400 nature oriented trips are not subject of the present analysis.

4. Econometric specification

The literature shows that WTP estimates derived from dichotomous choice valuation questions can be very sensitive to the empirical model used. A common suggestion is thus to present a suite of models to deal with the underlying fragility of the welfare measure estimation (Bengochea-Morancho et al. 2005; Vaughan et al. 1999). Accordingly, we will present estimates from the Turnbull lower bound as a non-parametric approach and from a random effects probit model as a parametric approach. Both have been frequently used for estimating willingness to pay from dichotomous responses (Holmes et al. 2004; Loomis & González-Cabán 1998; Petrolia et al. 2009; Loureiro et al. 2009).

The Turnbull lower-bound estimator as a distribution-free strategy eliminates the possibility of negative WTP estimates that can be problematic in linear parametric models (Haab & McConnel 1997). It is based on the grouping of the binary responses to the WTP question in bid intervals, i.e., the bid level presented to the respondent and the next higher bid level. To ensure non-negative outcomes, the probability of WTP responses is constrained to be positive and sum to unity across bid intervals. A monotonically increasing cumulative probability density function (CPDF) is secured by pooling intervals if necessary. Mean WTP is calculated as the sum of probabilities of respondent voting times the various bid levels used, or, as in the case of the lower bound estimate, times the lower of the two prices of the interval. Thus the estimate offers a conservative lower bound on WTP for all non-negative distributions of WTP. This gives

$$E_{LB}(WTP) = \sum_{i=0}^{m+1} P_i * B_{i-1} \qquad (1)$$

where $\mathrm{E_{LB}}$ is the mean lower bound value, $\mathrm{P_i}$ is the probability of respondents replying negatively in the bid interval $(\mathrm{B_{i-1}}, \mathrm{B_i})$, $\mathrm{B_{i-1}}$ the lower bound bid level, and *m* the maximum bid level. An advantage of the Turnbull estimator is that standard errors can be computed easily and thus 95% confidence intervals can be provided. One the other hand, covariates such as demographics cannot be included when estimating WTP (Giraud et al. 2001). It is only possible to calculate mean WTP for subgroups if the sample is large enough. Thus, testing the validity of the stated WTP responses requires other approaches.

A parametric alternative to the Turnbull estimator is the probit model. Hanemann (1984) showed how responses from a dichotomous valuation question can be used to obtain social welfare measure (mean and median of the WTP). In a random utility model, which assumes that the utility function has some components which are unobservable to the researcher and are treated as stochastic, the probability of an individual (*i*) voting YES can be expressed as

$$\text{Prob(paying)} = \text{Prob}[\mathrm{V_1(z^1, y-P, s)} + \varepsilon_1 \geq \mathrm{V_0(z^0, y, s,)} + \varepsilon_0], \qquad (2)$$

where V is the observable component of utility and ε the random component, the subscripts 1 and 0 indicate the situation with and without conservation programme, y represents income, P the additional costs that would arise because of the conservation programme, and s is a vector of individual characteristics. Rewriting Eq. (2) gives

$$\text{Prob(paying)} = \text{Prob}[\mathrm{V}_{\mathrm{i0}} - \mathrm{V}_{\mathrm{i1}} \geq \varepsilon_{\mathrm{i0}} - \varepsilon_{\mathrm{i1}}]. \tag{3}$$

If it is assumed that the difference between both random terms follows a standard normal CDF, the probability that an individual pays for the conservation programme corresponds to a standard normal probit model. In order to constrain WTP to be non-negative, we used a logarithmic transformation of the bid amount. In this case the mean WTP is computed from the parameter estimates of the probit model as in Eq. (4):

$$\text{Mean WTP} = \exp\left(\frac{-\overline{\mathrm{X}}\beta'}{\beta_{\mathrm{bid}}} + 0.5\sigma^2\right) \tag{4}$$

where β_{bid} is the coefficient on the bid variable, $\overline{\mathrm{X}}$ is either the estimated constant or the "grand" constant computed as the sum of the estimated constant plus the product of the additional explanatory variables, β' is the column vector of corresponding coefficients, and σ^2 the variance.

As respondents were asked to evaluate all four options in the same survey, it is likely that the errors across the four choices are correlated. Thus, a panel model is used to address this correlation, i.e., the random portion of the utility function consists of two error terms. The random effects model is written as

$$Y_{it}^* = X_{it}\beta + \mu_i + \varepsilon_{it}, \tag{5}$$

where Y_{it}^* is an unobserved latent variable, X_{it} is a $1 \times k$ vector of exogenous variables and β a $k \times 1$ vector of coefficients. The remaining two terms represent error components. The first, μ_i, represents an unobservable characteristic specific to the individual i that does not vary among the t observations from i. The second term, ε_{it}, varies among individuals and across the t observations from each individual. Both terms are normally distributed with zero means and independently of one another. In the random effects model the correlation ρ is equal to the ratio of the variance of the individual specific component to the overall variance:

$$\rho = \frac{\sigma_\mu^2}{\sigma_\varepsilon^2 + \sigma_\mu^2}. \tag{6}$$

As in dichotomous choice models it is generally assumed that $\sigma_\varepsilon^2 = 1$, the value of ρ increases as the variance of the individual specific component increases relative to the variance of the random component. If no correlation exists, $\rho = 0$ and the standard probit model would be appropriate. If

$\rho \neq 0$ the standard probit would result in biased standard errors of the coefficients and the random effects model must be considered.

5. Results

5.1 Descriptive statistics

Overall, 2326 useable interviews were achieved. This corresponds to a response rate of 26.9%, a rate that is lower than those reported in many CV studies. Comparing the response rate to other web-based CV studies reveals that the present study is not an outlier. For example, Bateman et al. (2009) report a response rate of 12% and Bliem at al. (2009) report rates of 25.6% and 23.3% for web-based surveys. Table 2 displays the socio-demographics for both the used sample and the German population. The figures indicate that on a number of social and demographic variables our sample reflects German households quite well, for example the percentage of woman or mean age. However, the sample deviates especially with respect to education showing on average higher educated respondents. As the median of year of education at school is 13 the majority of respondents have finished high school. Accordingly, the mean income is higher as well. The share of respondents who live in a city with more than 100,000 inhabitants is also higher. The shift towards higher educated and higher-paid households is likely to be the results on the survey method. Although access and use of the web has increased constantly over the last years higher educated people are still better represented.

Table 2. Socio-demographics of the sample and the German population

	Sample (2009)				Germany (2008)[1]
	Mean	Median	Min	Max	Mean
Age (in years)	41.42	42	18	75	43.00
Gender (1 = female)	0.52	1	0	1	0.51
People per household	2.56	2	1	12	2.05
Education (in years)	11.68	13	7	13	9.67
Net household income in €[2)]	2398.00	2250	250	6250	2122.00
Nature oriented trips	6.24	2	0	210	7.20[3)]
Member of environmental organisation (1 = yes)	0.05	0	0	1	.[4)]
Urban[5)] (1 = YES)	0.32	0	0	1	0.29
Number of households	2326				40,076,000

Note: N = 2.326; 1) If not stated otherwise the figures for Germany originate from the Statistical Yearbook 2009 for the Federal Republic of Germany; 2) Due to missing values this figure is based on 1941 observations; 3) this figure is based on the study by Maschke (2007) and applies to 2006; 4) no data are available for membership in environmental organisations on the national level; 5) urban is defined as living in a city with 100,000 inhabitants or more.

Among all respondents 60 per cent answered that they have heard the term biodiversity before and that they know the meaning of it. Another 25 per cent answered that they have heard the term but do not know the meaning of it. Only 11 percent stated that they have never heard this term while 4 percent answered don't know. The high percentage of those who have heard the term before might be biased because of significantly higher educated respondents. Asked towards which environmental topics the national government should turn to in the future revealed that climate change is for a majority the most important issue in environmental policy (Table 3). Protection of endangered plant and animal species follows on third rank after water and marine protection. The question concerning priorities of environmental policy opened the questionnaire and respondents did not know at this point in time that the main focus of the survey was on biodiversity.

Table 3. Priorities in environmental policy

Policy area	Frequency	% of responses	% of respondents
Climate change	1594	35.19	68.53
Water and marine protection	942	20.79	40.50
Extinction of animals and plants	716	15.81	30.78
Air pollution	695	15.34	29.88
Noise	271	5.98	11.65
Urban sprawl of the landscape	264	5.83	11.35
Other issues	48	1.06	2.06
Total	4530	100.00	194.75

Note: Number of respondents is 2326, respondents could select up to two policy areas

5.2 Estimation results

The programmes and bid levels were assigned randomly to respondents by the survey software. In order to check whether this actually happened randomly, a multivariate approach was used. If the assignment of the bids is truly random then all characteristics of the respondents should be completely orthogonal to the bi values. Results from a multinomial logit and an ordered probit model show that the observed characteristics of the respondents are not correlated with a conservation programme or the bid variable. Thus, randomisation was successful. The number of respondents per programme is reported in Table 6. Each programme was presented to more than 1.000 respondents, a number seen as sufficiently large enough for get confidence intervals of a reasonable size when using the single-bounded dichotomous choice format (Haneman & Kanninen 1989). The "don't know"-responses to the valuation questions were recoded to "NO" in order to calculate conservative measures.

Table 4. Random effects probit model regression results (log-logistic)

	yes-responses not recoded			yes-responses recoded *certainty > 6*		
Variable	Coefficient	|Z|		Coefficient	|Z|	
LnBid forests	-0.594	13.57	***	-0.623	10.49	***
LnBid arable land	-0.671	14.57	***	-0.722	11.30	***
LnBid grassland	-0.593	12.44	***	-0.613	9.64	***
LnBid peatlands	-0.604	14.32	***	-0.617	10.81	***
LnBid floodplains	-0.549	11.54	***	-0.586	8.56	***
LnBid dry grassland	-0.626	13.85	***	-0.716	-12.14	***
LnBid BIOPROG	-0.658	11.87	***	-0.683	-8.59	***
LnBid BIOPROG+	-0.635	12.25	***	-0.583	-7.85	***
Constant forests	-2.220	3.19	***	-6.802	5.28	***
Constant arable land	-2.454	3.54	***	-7.081	5.48	***
Constant grassland	-2.692	3.87	***	-7.365	5.70	***
Constant peatlands	-2.795	4.02	***	-7.400	5.71	***
Constant floodplains	-2.661	3.84	***	-7.251	5.59	***
Constant dry habitats	-3.072	4.44	***	-7.613	5.90	***
Constant BIOPROG	-1.944	2.77	***	-6.381	-4.91	***
Constant BIOPROG+	-2.047	2.90	***	-6.763	5.20	***
Age (Ln)	0.159	1.64		0.189	1.09	
Gender	0.113	1.74	*	-0.047	0.40	
Eduyears (Ln)	0.946	4.47	***	2.110	5.31	***
NatureTrips (Ln)	0.244	8.21	***	0.436	7.95	***
Conservation activity	0.650	8.89	***	1.081	8.47	***
Urban	0.072	1.01		0.210	1.67	*
ρ	0.617	39.07	***	0.842	79.57	***
LogLikelihood_0	-5489			-4760		
$\text{LogLikelihood}_{\text{Model}}$	-4821			-3508		
McFadden-R^2	0.12			0.26		
Correctly predicted	63.75%			73.91 %		

Note: ***. **. * = significant at 1%. 5%. 10% level; N = 2326

Table 4 reports the results from two Random Effect Probit (REP) models. As explanatory variables the bid values, programme specific constants and observable individual specific characteristics are used. Moreover, the log-logistic functional form was fitted to the WTP responses because it provided, compared to, for example, the log-linear form, a much better fit and more plausible results (i.e., non-negative estimates). In one model presented in Table 4 all yes-responses are left as they were stated by respondents while the other model (right column) displays the results from the model where yes-responses have been recoded if the score on the certainty scale was less than 7. In both models all bids have the expected negative sign and are highly significant. The same applies to the programme specific constants. All are significant. Among the explanatory variables both times the number of years a respondent stayed at school (EDUYEARS), the number of nature related trips during the last twelve months (NATURETRIPS), and membership in an environmental or nature conservation organization (CONSERVATION ACTIVITY) positively influence peoples WTP. In contrast, respondents AGE does not show any influence while each GENDER or living in a city with more than 100.000 (URBAN) affects WTP responses significantly in one of the models but only at a 10% level. Finally, the correlation coefficient ρ is significantly different from zero in both model with a value of 0.62 respectively 0.84. This indicates that preferences among respondents are heterogonous after controlling for the effects of the explanatory variables.

5.3 Response certainty

Figure 1 shows the responses to the 10-point certainty scale separately for both those who are not willing to pay and those who are willing to pay for the BIOPROG and the BIOPROG plus climate change risk premium. On average, those who are willing to pay for one of these programmes are more certain about their decision with a mean value of 7.11 and 6.32 respectively. Among those who are not willing to pay the majority reported to be somewhat uncertain (214 respondents chose the value 5) and among those who are willing to pay the majority chose the value 8 on that scale (272 respondents).

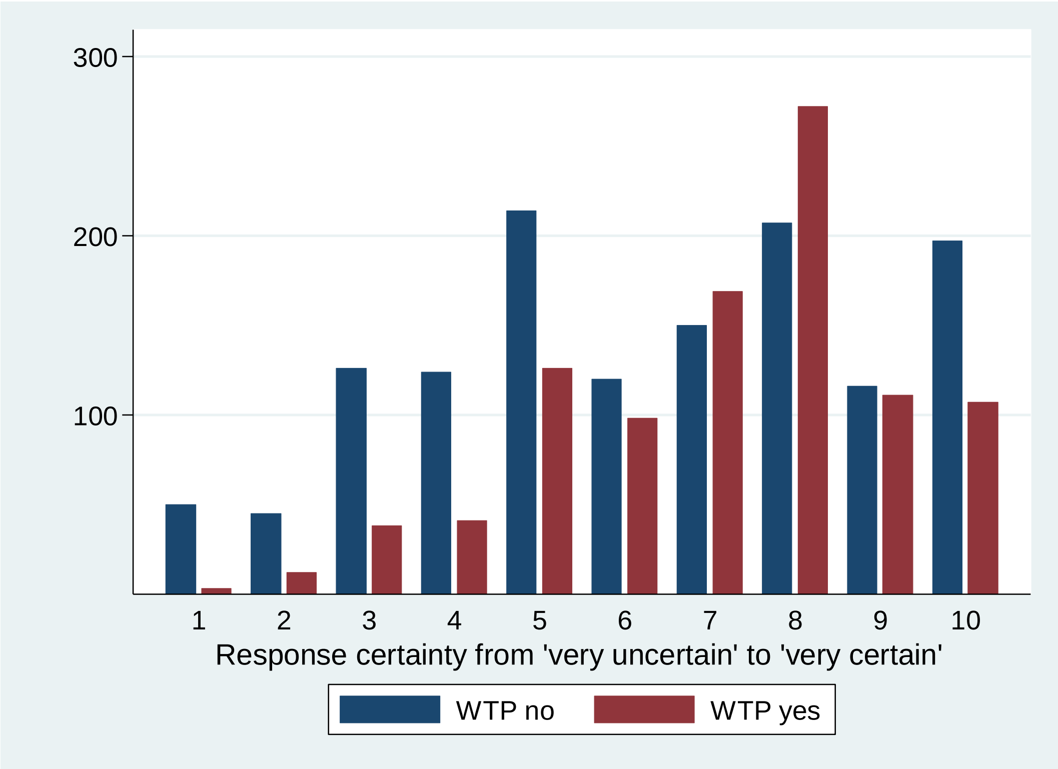

Figure 1: Response certainty with respect to both complete programmes

The results from an ordered probit regression on determinants of response uncertainty are displayed in Table 5. The coefficients here have qualitative meaning. A change of the explanatory variable by one unit influences the certainty level positively if the sign is positive and vice versa. In addition to the respondent specific explanatory variables used in the REP model the variable self reported knowledge of the concept biodiversity and the bid level as well as the squared bid level is included. Loomis and Ekstrand (1998) show that knowledge and bid levels influence respondent's uncertainty. Apart from URBAN all variables appear to be associated with response uncertainty. AGE, EDUCATION, NATURE TRIPS, CONSERVATION ACTIVITY as well as having heard of the term biodiversity prior to the interview and knowing what it means (BIODIVERSITY KNOWLEDGE) influence response certainty positively while GENDER affects it negatively. The bid level and the squared bid level affect certainty negatively respectively positively, indicating that respondents are more certain of their responses at extremely low or high bids and less certain at intermediate bid levels. This finding corresponds to the results presented by Loomis and Ekstrand (1998).

Table 5. Ordered probit regression results for stated uncertainty level

Variable		Coefficient	|Z|	
Age	(years)	0.0046	2.87	***
Gender	(1 = female)	-0.1134	2.65	***
Education	(years)	0.0357	2.65	***
Urban	(1=yes)	0.0097	0.21	
Nature trips	(number)	0.0058	3.75	***
Conservation activity	(1 = yes)	0.1530	3.21	***
Biodiversity knowledge	(1 = yes)	0.2594	5.80	***
Bid level		-0.0067	2.90	***
Bid level squared		0.0001	3.39	***

N = 2326; LR Chi^2 114.87; Log-Likelihood = -4933.31

5.3 Willingness to pay estimates

Table 6 reports the mean WTP estimates[2] based on the Turnbull estimator and the random effects probit model (REP). The Turnbull lower-bound is calculated based on the original responses and additionally based on recoded responses ("yes" to "no") when the reported uncertainty is lower than 7. For the REP three different estimates are presented. First, for each programme the WTP is calculated based on the original responses using the sample values for the covariates. Secondly, instead of the sample values the population values are used (cf. Table 2) except for CONSERVATION ACTIVITY as for this covariate no population values are available. Thirdly, WTP estimates are calculated again based on the recoded yes responses with a cut-off rating of 7 and using population values for the covariates. The response certainty scales was only presented to respondents after the fourth valuation question. Thus, adjusting all WTP estimates according to this scale assumes that uncertainty was constant across all choices for each respondent.

[2] As an alternative to presenting mean estimates some authors rely on median estimates, especially when the WTP question was framed as a referendum. The main argument in favour of the median is that this measure is less influenced by outliers in the tails of the distribution. However, the mean is the appropriate measure if a cost-benefit analysis is an objective and the Kaldor-Hicks criterion is applied. As the results from this survey will be used in a cost-benefit analysis for the conservation programmes we calculated mean WTP estimates.

Table 6. Mean WTP estimates in € per month for all programmes (95% intervals in parenthesis)

Programme	Respondents (N)	WTP yes/no - responses not recoded			WTP yes/no-responses recoded to certainty > 6	
		Turnbull *lower bound*	Random effects probit *Sample*	Random effects probit *Population*	Turnbull *lower bound*	Random effects probit *Population*
Forest	1192	24.76 *19.54 / 29.98*	44.47 *34.44/ 54.51*	35.09 *26.74 / 43.44*	17.18 *13.99 / 20.37*	3.12 *1.27 / 4.98*
Arable land	1164	16.45 *13.70 / 19.59*	11.09 *8.46 / 13.72*	14.34 *10.93 / 17.75*	10.34 *7.89 / 12.79*	1.56 *0.69 / 2.43*
Grassland	1179	16.41 *13.62 / 19.21*	20.30 *15.08 / 25.52*	16.01 *11.69 / 20.33*	10.40 *6.55 / 14.25*	1.30 *0.36 / 2.24*
Peatlands	1177	16.38 *13.55 / 19.20*	15.80 *11.67 / 19.95*	12.52 *9.10 / 15.94*	12.48 *9.58 / 15.38*	1.22 *0.31 / 2.12*
Floodplains	1148	18.18 *15.02 / 21.32*	30.91 *22.46 / 39.36*	23.91 *16.91 / 30.93*	9.12 *6.58 / 11.66*	1.70 *0.26 / 3.15*
Dry habitats	1208	12.51 *8.72 / 16.29*	8.84 *6.33 / 11.34*	7.05 *4.88 / 9.23*	8.45 *5.18 / 11.72*	0.75 *0.27 / 1.23*
BIOPROG	1167	28.94 *24.61 / 33.27*	41.47 *32.63 / 50.31*	33.47 *25.74 / 41.21*	19.24 *15.29 / 23.19*	4.72 *1.58 / 7.87*
BIOPROG+	1188	29.10 *22.86 / 35.34*	42.20 *32.71 / 51.69*	33.80 *25.64 / 41.97*	20.17 *14.46 / 25.88*	3.98 *0.84 / 7.13*

Note: Total number or respondents is = 2326; each faced four WTP questions; total number of observations = 9344; the confidence intervals for the random effects probit model are calculated by the Krinsky & Robb method as implemented in NLOGIT 4.0, the mean lower Turnbull estimates as their variance were calculated using the Turnbull ado-file for STATA provided by Azevedo (2010).

Two results from Table 6 are striking. First, the WTP estimates for the BIOPROG and the BIOPROG+ do not differ. The mean values are very similar and the confidence intervals overlap strongly. People do not seem the value these two programmes differently. Second, the WTP estimates for the forest programme and the two complete programmes do not differ either. The mean estimates from the Turnbull and the calculations for the recoded yes/no responses due to certainty vary at a first glance but again the confidence intervals strongly overlap. This indicates that the programme to achieve nature protections in the forests in seen as very valuable by respondents.

Aggregation of WTP estimates for Germany

To calculate the total willingness to pay of the German population, four different estimates for the BIOPROG programme are multiplied by the number of households in Germany. We use both WTP estimates from the lower Turnbull estimate and from the REP model. According to the Federal Statistical Agency (2009) the number of households in 2008 in Germany was 40,076,000. However, it has to be taken into account that the majority of selected panellists did not respond. Only 26.9% of those invited actually participated and finished the questionnaire. Thus, around 73% were non-responding and thus their willingness to pay is unknown and aggregation across the whole population requires some assumptions about their willingness to pay. On the one hand, all non-responding households could be treated as if they are not willing to pay because they have not participated in the survey. This might indicate that they are not interested in biodiversity conservation at all. On the other hand, and at the other end of the range of possible outcomes, all non-respondents could be treated as having on average the same WTP as those who participated. Table 7 reports in the upper part the WTP estimates when all non-responding households would have a zero WTP and in the lower part the WTP estimates when all non-responding households would on average have the same willingness to pay as survey respondents.

6. Discussion and conclusion

The goal of this paper was to present the benefits that would result from implementing a national strategy on biological diversity in Germany. Thus, six ecosystem specific conservation programmes were developed and offered to participants of an online survey. During the survey each respondent faced four conservation programmes accompanied by a willingness to pay question. The first three conservation programmes were randomly drawn from the six programmes. The fourth programme, also randomly chosen, was either a comprehensive programme “Protection of biological Diversity in Germany” consisting of all six programmes or a comprehensive programme plus a climate change risk premium of a 20% increased area where measures would be implemented.

Table 7. Aggregated WTP for overall programme

	€ per household per month	€ per household per year	Σ WTP in €
Only the responding households are willing to pay (26.9% of all households)			
Turnbull total	7.78	93.42	3,743,832,592
REP total population values	9.00	108.04	4,329,857,528
Turnbull certainty	5.43	65.11	2,609,298,666
REP certainty population values	1.27	15.24	610,604,348
All non-responding households are willing to pay the same as those who responded			
Turnbull total	28.94	347.28	13,917,593,280
REP total population values	33.47	401.64	16,096,124,640
Turnbull certainty	20.17	242.04	9,699,995,040
REP certainty population values	4.72	56.64	2,269,904,640

Note: number of households in Germany 2008 = 40,076,000

Overall, the results show that implementing the comprehensive programme would create significant benefits. More than 60% of the all respondents were at least willing to pay for one of the offered programmes. Looking at the single conservation programmes, the mean WTP estimates for both comprehensive programmes do not differ much and the confidence intervals overlap largely. People do not seem to value the climate change risk premium additionally. The WTP estimates for the six ecosystem specific programmes are, apart from the forest programme, substantially lower. The reason for a higher WTP estimate for forests might be that forests are, with respect to the surface area, the biggest land use type in Germany. Thus, the public is more familiar with forest and may connect forests to a greater degree to nature than farmland, for example. A lower WTP for measures on dry habitats for biodiversity protection could either be explained by a lack of familiarity with the subject (it is not as obvious for many people what these habitats are and why they need protection) or respondents sensitivity to scale: measures will be implemented on a much smaller area of dry habitats than on woodlands, a lower WTP would be a logical response to the extent of the programmes.

The suite of WTP estimates reveals the strong influence the functional form and the choice of the values for the explanatory variables have. Especially when the response uncertainty is taken into account, the values based on the REP model are of a magnitude smaller. Thus, for the intended cost-benefit-analysis the WTP estimate of around € 20.0 per month from the lower bound Turnbull estimator is preferred.

Comparing this figure with the estimates presented by Hampicke et al. (1991) for a more or less comparable nationwide conservation programme shows that when adjusted for inflation (on average 2% per year over the 20 years) their WTP estimate of € 10 (an average estimate over the programmes they presented to respondents) equal in today's prices approximately € 16 per month per household. Thus, the value of biodiversity protection has increased and a net increase of around 4.6 Euro compared to 1989 occurs. Taking into account that Hampicke et al. (1991) used a different elicitation format and did not adjust their estimates for response uncertainty, the more appropriate WTP estimate from the present study might be the unadjusted Turnbull estimate. In this case the net difference is even bigger.

The cost-benefit analysis will show whether the benefits outweigh the costs associated with the conservation programmes and whether biodiversity protection is still as beneficial to society as Hampicke et al. (1991) demonstrated 20 years ago.

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