Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/envsci

Valuing the benefits of implementing a national strategy on biological diversity—The case of Germany

Jürgen Meyerhoff [a,*], *Daija Angeli* [b], *Volkmar Hartje* [a]

[a] *Institute for Landscape Architecture and Environmental Planning, Technische Universität Berlin, Berlin, Germany*
[b] *Society of Biology, London, United Kingdom*

ARTICLE INFO

Published on line 20 August 2012

Keywords:
Biodiversity protection
Contingent valuation
Ecosystem services
National Biodiversity Strategies and Actions Plans
Willingness to pay

ABSTRACT

The National Biodiversity Strategies and Actions Plans (NBSAP), required by Article 6 of the UN Convention on Biological Diversity, have been developed to make them meaningful as strategic instruments. One objective is to make the benefits of conservation more visible and build support for conservation activities. However, so far determining the benefits within the NBSAP has rarely taken place. This paper presents results from a nationwide contingent valuation study investigating the benefits of implementing a set of measures derived from the National Strategy on Biological Diversity (NBS) in Germany. Results from a survey employing the contingent valuation method interviewing more than 2300 people indicate that implementing the NBS would generate substantial benefits, ranging between €2.3 billion and €9.3 billion per year. Monetizing benefits arising from the strategy provide important information for policy makers, especially as biodiversity conservation will very likely face stronger competition with alternative land uses such as food or biomass production in the future. Comparing the benefits to the opportunity and management costs shows that implementing the NBS in Germany is economically sensible.

1. Introduction

All parties to the UN Convention on Biological Diversity (CBD) are committed to develop National Biodiversity Strategies and Actions Plans (NBSAP), as required in Art 6a CBD. The plans are the principal instruments for implementing the convention at the national level. Since the convention came into force, 173 countries (Secretariat of the Convention on Biological Diversity, 2011) have developed these documents with considerable effort by the convention bodies to make them meaningful as strategic instruments. Among these efforts, the Biodiversity Planning Support Program was established to support approaches to integrate biodiversity planning into national sectoral strategies and the IUCN developed a guideline to integrate economic measures in NBSAP planning (Emerton, 2001). It covers the assessments of costs and benefits of biodiversity conservation planning and of the potential use of economic instruments to implement the NBSAP. The NBSAPs have been reviewed and their shortcomings in integrating them into sectoral policies have been identified (CBD WGRI, 2007; Prip et al., 2010). While most NBSAPs mention the importance of economic instruments in a general way, very few countries identify specific measures and procedures such as economic valuation (Prip et al., 2010). To the best of our knowledge, until recently only one developed country has conducted a nationwide and comprehensive assessment of the costs and benefits in the NBSAP. Christie et al. (2011) provide an estimate of the value of changes in biodiversity and associated ecosystem services through implementing the United Kingdom Biodiversity Action Plan (UK BAP). In a primary valuation study, they

* *Corresponding author.*
E-mail address: juergen.meyerhoff@tu-berlin.de (J. Meyerhoff).
1462-9011/$ – see front matter
http://dx.doi.org/10.1016/j.envsci.2012.07.020

estimated the value of the ecosystem services directly attributed to the conservation activities currently undertaken under the UK BAP across the UK to be £1366 m per year, ranging from £1259 to £1472 m. Currently, not all proposed measures of the UK BAP are implemented; according to their study a full implementation of the UK BAP would result in an additional benefit of £746 m per annum (range: £654–838 m).

Determining the benefits people obtain from the natural environment has been an essential topic in environmental economics for a long time (cf. Hanley and Barbier, 2009). However, in general valuation studies focus on measures to protect certain species (e.g. MacMillan et al., 2004) or specific areas such as national parks (e.g. Martín-López et al., 2007). The Economics of Ecosystems and Biodiversity (TEEB) initiative started to address the benefits of biodiversity on a national and global scale (TEEB, 2010). The TEEB initiative, however, mainly draws on existing studies and has fostered studies at the national level also taking a benefit transfer approach: such studies are currently underway in the Netherlands, Brazil and Norway (e.g. Hendriks, 2011). Another example of a national assessment applying a benefit transfer approach is the United Kingdom National Ecosystem Assessment which recently provided a detailed ecosystem service valuation for past trends and future scenarios (UK National Ecosystem Assessment, 2011).

The German national government has issued a ''National Strategy on Biological Diversity'' (NBS) in 2007 (BMU, 2007) to fulfill its obligations to develop a NBSAP and to implement the CBD at the national level. The German NBS defines about 330 goals and about 430 measures to achieve the sustainable use of natural resources and to stop the loss of biodiversity for a range of sectors and ecosystems. However, a recent government report (BMU, 2010) concerning the achievements of the NBS clearly shows that the objectives set for 2010 have not been met. On the contrary, as a result of intensive agriculture and conversion to settlement and infrastructure, trends for species diversity and landscape quality have shown a significant trend away from the target in the decade leading to 2008 (BMU, 2010). Germany lies far behind the targets set in the NBS in other areas such as endangered species and ecological conditions of water bodies and wetlands as well. The government report points out that efforts will have to be significantly increased to achieve a turnaround.

The development and implementation of the German NBS so far was not accompanied by a comprehensive survey of its economic benefits. Overall, only one study so far has investigated the economic costs and benefits of a nationwide nature conservation program in Germany (Hampicke, 1994). Public policy thus passes up the chance to demonstrate to what extent implementation of the NBSAP would generate benefits. We think that demonstrating these benefits will become more and more important in both developed and developing countries. Land use conflicts will probably intensify in the future and thus might push back conservation activities. An example of this is the use of land for biofuel production (e.g. Hellmann and Verburg, 2010; Schleupner and Schneider, 2010).

Using Germany as a case study, this paper aims at contributing to mainstreaming economic evaluation as part of NBSAPs. It provides an assessment of the economic benefits of a nationwide program of measures designed to significantly minimize the threat to biological diversity and compares them to the costs of the required management actions. While implementing a national biodiversity protection plan brings a wide range of benefits from improved water quality to enhanced recreational opportunities, this paper focuses on the benefits arising from the ecosystem service maintenance of biodiversity through protecting natural habitats and ecosystems across Germany. To capture these benefits we establish a hypothetical market using a contingent valuation survey (Carson and Hanemann, 2005; Hanley and Barbier, 2009). While the paper focuses on the economic benefits, this does not mean that these are the only or the best information to judge whether biodiversity conservation is favorable from a societal point of view. Rather, we argue that making the economic benefits of biodiversity conservation more visible provides policy makers additional arguments for weighting the pros and cons of conservation measures.

2. Methodology

2.1. *A biodiversity protection program for Germany*

For the purpose of the contingent valuation (CV) study, the goals and measures of the German NBS were refined and quantified with regard to the total extent of the area on which the measures would be implemented within Germany. A comprehensive program detailing the quantity structure of conservation measures in terms of area specific land use changes was developed (Hartje et al., 2010) which complements the specifications of the NBS through more detailed requirements of existing legislation and a literature review. An abbreviated version of the biodiversity protection program consisting of six programs for different ''ecosystem types'' was presented to survey respondents. In this study, the term ecosystem type summarizes agricultural and forest lands within and outside of protected areas as well as habitats under the EU Habitats Directive (Council Directive 92/43/EEC) categorized based on land use and management. The focus lies on land based ecosystems which are influenced either by conservation efforts or agricultural and forestry management.[1] The program covers approximately 25% of the total land area of Germany and excludes urbanized land. Six programs for all land-based ecosystems under human influence were set as follows (avoiding double counting of areas that would fall into more than one category): 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). The ecosystems specific programs were then summarized in a comprehensive program (BIOPROG).

Table 1 summarizes the total land area, intended measures and the area on which these should be implemented. These

[1] Though mentioned in the NBS, sea and coastal as well as freshwater habitats and those habitats that are not influenced by human land use or conservation efforts, like rock formations, were not considered in this study.

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 peatlands 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 peatlands area (50,000 ha), Raising water levels on 20% of peatlands used as pastures and meadows and on 10% of peatlands used for forests purposes (12.7% of the peatlands area, 173,000 ha), Abandonment of agricultural use on peat soils and establishment of adapted land uses on 11.0% of the peatlands 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 (5000 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 (3000 ha).

measures include maintenance, restoration as well as creation. For example, summarized under the ecosystem type pastures and meadows, we find the conservation of species rich pastures and meadows. This is done through a range of measures from grazing with fewer animals to reduced fertilizer use on 900,000 ha, the restoration of 45,000 ha of species rich grassland and the establishment of new traditional orchards on an area of 0.3% of the grassland area.

2.2. *The survey*

In the first part of the questionnaire, participants were asked some general questions regarding the environment and then 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 next part was designed to determine participants' willingness to pay (WTP) for the conservation programs. Afterwards, information regarding respondents' conservation activities or the number of nature related trips during the twelve months prior to the interview as well as socio-demographics were requested.

For the purpose of the WTP elicitation, the six biodiversity protection programs were presented to respondents, using a fixed set up for the information presented per program on one computer screen: the first section characterized the ecosystem type, gave its current total area in hectare and examples of typical plant and animal species. Section 2 outlined causes of biodiversity loss and current threats to biodiversity relevant to this ecosystem type, and pointed out the need for additional measures. Section 3 listed measures for the protection of biodiversity as well as their extent in hectare. A text only description was used. Finally, on the bottom of each screen the WTP question was presented.

Each respondent faced a sequence of four protection programs. The first three programs were randomly chosen from the set of the six ecosystem type specific programs (Table 1). Subsequently and as the fourth program, each respondent was presented a program comprising all six ecosystem specific programs (BIOPROG) or a program that in addition to the six ecosystem specific programs included a climate change precaution measure (BIOPROG+). This program will be implemented in an area that is 20% larger than that described in the BIOPROG program and will thus facilitate adaptation of species to a changing climate. Apart from the size of the area both nationwide programs do not vary. The BIOPROG or the BIOPROG+ program was randomly assigned to respondents. Respondents were informed that so far it has not been decided which of the programs will be implemented to make the survey more consequential. Furthermore, they were told that the programs they will face were randomly determined out of a basket of potential programs and were also asked to value each program independently. The overall number of programs each respondent would face was not disclosed.

As WTP elicitation format a single-bounded dichotomous choice question was used. It presents respondents with one randomly chosen bid value and asks whether they are willing to pay the presented amount in order to implement the program.[2] An advantage of this elicitation format is that it is incentive compatible (Carson and Hanemann, 2005). A payment to a fund ''Protection of biological diversity'' managed by the German Federal Agency for Nature Conservation served as a payment vehicle. Participants were informed that payments are earmarked for biodiversity conservation and that the agency would report on program implementation regularly on the internet. Moreover, they were informed that if half of the respondents agree to a WTP question the payment would be compulsory. After the final WTP question respondents were presented a scale concerning their response certainty ranging from 1 to 10 where 1 equals ''not at all sure'' and 10 equals ''very sure''. Evidence from valuation studies suggests that respondents differ with respect to the certainty of their responses in surveys and that this certainty can, at least partially, be captured by an appropriate debriefing question (Champ et al., 1997; Loomis and Ekstrand, 1998). Finally, respondents were asked for how many years they would be willing to pay if they agreed to pay for the implementation of the BIOPROG or BIOPROG+ program. 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. Panel members are recruited by computer aided telephone interviews and the panel is thus not prone to biases due to participants' self-selection. Panelists drawn were invited via mail and were rewarded for finalizing the web-based survey a 4€ voucher for an online bookstore. Overall, 8662 panel members were invited in four waves, a week between each wave, and were reminded twice before the end of the survey in case they have not participated. Two pretests, one with researchers and one with 120 panelists, were conducted before the main survey which took place in November and December 2009.

[2] 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 program Y? It will be implemented if at least half of the participants approve the program. If it is not implemented, nobody needs to pay anything.'' The bids were randomly chosen from the vector {1, 3, 5, 10, 15, 20, 30, 50, 75}, or, for the nationwide programs, from the vector {3, 5, 10, 15, 20, 30, 50, 75, 110}.

2.3. *Econometric analysis*

Willingness to pay estimates derived from dichotomous choice valuation questions can be very sensitive to the econometric model used for the analysis. 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). We present estimates from the Turnbull lower bound as a non-parametric approach and from a Random Effects Probit (REP) model as a parametric approach. The Turnbull lower-bound estimator as a distribution-free strategy offers a conservative lower bound for all non-negative distributions of WTP (Haab and McConnel, 1997). However, covariates such as demographics cannot be included in the estimate. A parametric alternative is therefore the probit model. It allows assessing the influence of covariates like respondents age, gender, or conservation activities. As respondents were asked to evaluate four options in the same survey, it is likely that the errors across all four choices are correlated. Thus, a random effects probit (REP) model is used to address this correlation (Haab and McConnel, 1997). Each program was presented to more than 1000 respondents in order to get confidence intervals of a reasonable size. Finally, ''don't know''-responses to the valuation questions were recoded to ''No''.

3. Results

3.1. *Descriptive statistics*

Overall, 2326 useable interviews were achieved corresponding to a response rate of 26.9% of the invited panel members. Table 2 displays the socio-demographics for both the 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 women or mean age. However, the sample deviates especially with respect to education showing on average higher educated respondents. Accordingly, the mean income is higher as well.

Among all respondents, 60% answered that they have heard the term biodiversity before and that they know the meaning of it. Another 25% answered that they have heard the term but do not know the meaning of it. Only 11% stated that they have never heard this term. 4% answered ''don't know''. With regards to environmental topics the national government should turn to in the future, a majority of respondents finds that climate change is 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 so respondents were not aware that the main focus of the survey was on biodiversity. Responses to a question concerning the main causes for biodiversity loss indicate that people see intensive agricultural, forestry and fishery practices, land use changes and development and environmental pollution as the primary

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

	Sample (2009)				Germany (2008)[a]
	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 €[b]	2398.00	2250	250	6250	2122.00
Nature oriented trips	6.24	2	0	210	7.20[c]
Member of environmental organization (1 = yes)	0.05	0	0	1	[d]
Urban[e] (1 = YES)	0.32	0	0	1	0.29
Number of households	2326				40,076,000

[a] If not stated otherwise the figures for Germany originate from the Statistical Yearbook 2009 for the Federal Republic of Germany.
[b] Due to missing values this figure is based on 1941 observations.
[c] This figure is based on the study by Maschke (2007) and applies to 2006.
[d] No data are available for membership in environmental organizations on the national level.
[e] Urban is defined as living in a city with 100,000 inhabitants or more.

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. Respondents could select up to two policy areas.

causes for biodiversity loss in Germany. Regarding nature related trips, 68% reported that they have taken one or more nature oriented trips during the last twelve months prior to the interview, with an average of slightly above 6 trips per year.

Regarding the peoples' general willingness to pay, 70% of all participants responded positively to at least one of the four WTP questions. More than half of these respondents have taken one or more nature related trips. A chi-square test significantly rejects the null-hypothesis of no association between being willing to pay and nature related trips. Also the majority of non-users stated a positive WTP. However, as we asked for nature related trips during the last twelve months prior to the interview the definition of being a user is quite narrow and many people might have conducted nature related trips in earlier years, the relation might be actually stronger than documented through the present data.

3.2. *Estimation results*

3.2.1. *Determinants of willingness to pay*

Table 4 reports the results from two REP models. The log-logistic functional form was fitted to the WTP responses because it provided a better fit and more plausible results than other functional forms. In Model 1 all yes-responses are left as they were stated by respondents, in Model 2 yes-responses were recoded to "no" when the score on the certainty scale was below 7. In both models all bids have the expected negative sign, indicating that the probability that respondents agree to pay the stated amount decreases for higher amounts. The coefficients are highly statistically significant as well. The same applies to the program specific constants. Among the explanatory variables in both regressions the number of years a respondent stayed in school (EDUYEARS), the number of nature related trips during the last twelve months (NATURETRIPS), membership in and/or donating to an environmental or nature conservation organization (CONSERVATION ACTIVITY) positively influence people's WTP. In contrast, respondents AGE does not show any influence while each GENDER (Model 1) and URBAN (Model 2) affects WTP responses significantly but only at a 10% level. Finally, the correlation coefficient ρ is significantly different from zero in both models with a value of 0.62 respectively 0.84, indicating that the REP model is appropriate. Responses to the 10-point response certainty scale for both the BIOPROG and the BIOPROG+ reveal that, on average, those who are willing to pay for one of these programs are more certain about their decision. The mean value is 7.11 for those who are willing to pay and 6.32 for those who are not.

3.2.2. *Willingness to pay*

Table 5 reports the mean WTP estimates based on the REP model and the Turnbull lower bound estimator. As the sample deviates from the German population regarding some

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

Variable	Model 1 Yes-responses not recoded			Model 2 Yes-responses recoded to no if certainty below 7		
	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 habitats	−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	***
Nature trips (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	***
Log likelihood$_0$	−5489			−4760		
Log likelihood$_{Model}$	−4821			−3508		
McFadden-R^2	0.12			0.26		
Correctly predicted	63.75%			73.91%		

Note. N = 2326.
* Significant at 10% level.
*** Significant at 1% level.

socio-demographic variables, additional WTP estimates based on population statistics are calculated. Only for the variable CONSERVATION ACTIVITY no population values are available (Table 2). According to the REP Model 1 (not considering response uncertainty), the forest program attracts the highest mean WTP of all programs, 35€ per household per month. The lowest WTP estimate is 7€ per month for dry habitats. The estimates for the other ecosystem type programs range from 13€ (peatlands) to 24€ (floodplains) per month. The WTP estimates for both the programs BIOPROG as well as BIOPROG+ are of the same magnitude with 33€ and 34€ respectively. Taking response uncertainty into account has a huge impact on WTP estimates; estimates drop to about 10 percent of the value calculated without response certainty.

The Turnbull lower bound estimator results in different values. The mean WTP for forests is still the highest (25€) among the ecosystem type programs but lower than the estimates for the programs BIOPROG and BIOPROG+ with both 29€. The floodplains program has the second highest and dry habitats the lowest WTP among the ecosystem type programs. Taking response uncertainty into account, the values are significantly lower but do not change as strongly as in the REP model. The Turnbull lower bound estimates for BIOPROG and BIOPROG+ are around 20€ per month and range from 8€ to 17€ for the ecosystem type specific programs.

Comparing WTP estimates among each other using a *t*-test reveals, firstly, that the mean WTP for BIOPROG and BIOPROG+ does not differ significantly. Thus, respondents do not seem to additionally value the risk premium of implementing the measures on a 20% larger area to facilitate adaptation to climate change. Moreover, the WTP estimate for the forest program does not differ significantly from those estimates for programs BIOPROG and BIOPROG+. On average protecting biodiversity in forests seems to be more important for respondents than protecting it on floodplains or peatlands, for example. Finally, 40% of those who positively respond to the WTP questions indicated that they are willing to pay infinitely while the remaining 60% stated they would be willing to pay for an average of about 7 years.

3.3. *Benefits versus costs*

To calculate the total WTP of the German population, the estimates for the six ecosystem type programs and the BIOPROG program are multiplied by the number of households in Germany. Taking a conservative approach we assume that each person interviewed represents a household, i.e. not more than one person per household is willing to pay for the conservation programs. Thus, we aggregate across the number of households. Instead of using the WTP estimates

Table 5 – Mean WTP estimates in € per month for all programs (95% intervals below the mean).

Program	Respondents per program	Random effects probit		Turnbull lower bound	
		Response uncertainty not considered Population values	Response uncertainty considered Population values	Response uncertainty not considered	Response uncertainty considered
Forest	1181	35.09	3.12	24.76	17.18
		26.74/43.44	1.27/4.98	19.54/29.98	13.99/20.37
Arable land	1145	14.34	1.56	16.45	10.34
		10.93/17.75	0.69/2.43	13.70/19.59	7.89/12.79
Grassland	1163	16.01	1.30	16.41	10.40
		11.69/20.33	0.36/2.24	13.62/19.21	6.55/14.25
Peatlands	1163	12.52	1.22	16.38	12.48
		9.10/15.94	0.31/2.12	13.55/19.20	9.58/15.38
Floodplains	1148	23.91	1.70	18.18	9.12
		16.91/30.93	0.26/3.15	15.02/21.32	6.58/11.66
Dry habitats	1192	7.05	0.75	12.51	8.45
		4.88/9.23	0.27/1.23	8.72/16.29	5.18/11.72
BIOPROG	1154	33.47	4.72	28.94	19.24
		25.74/41.21	1.58/7.87	24.61/33.27	15.29/23.19
BIOPROG+	1172	33.80	3.98	29.10	20.17
		25.64/41.97	0.84/7.13	22.86/35.34	14.46/25.88

Note. Total number or respondents is = 2326; each faced four WTP questions; total number of observations = 9304; the confidence intervals for the random effects probit model are calculated by the Krinsky and Robb (1986) method as implemented in NLOGIT 4.0, the mean Turnbull lower bound estimates and their variance were calculated using the Turnbull ado-file for STATA provided by Azevedo (2010).

Table 6 – Benefits versus costs – yearly basis.

	Cost		Benefits				
	Mio ha	Σ costs in billion €	€ per household per year	Σ WTP in billion €	Benefit-Cost ratio	Σ WTP in billion €	Benefit-Cost ratio
		Implementation and maintenance costs per year in €	Turnbull lower-bound with response certainty	Only share of responding households is WTP (26.9% of households in Germany)	Benefits per invested €	All non-responding households are WTP the same as responding households	Benefits per invested €
Forest	11.00	0.36	206.16	2.22	6.26	8.26	23.27
Arable land	12.00	0.90	124.08	1.34	1.49	4.97	5.53
Grassland	4.80	1.76	124.80	1.35	0.76	5.00	2.84
Peatlands	1.40	0.09	149.76	1.61	18.35	6.01	68.20
Floodplains	0.16	0.09	109.44	1.18	13.11	4.39	48.73
Dry habitats	0.50	0.07	101.40	1.09	16.82	4.06	62.52
BIOPROG	29.86	3.26	230.88	2.49	0.76	9.25	2.84

Note: The number of households in 2009 was around 40.1 million.

based on the REP model that are very sensitive with regard to the response certainty, aggregation is based solely on the estimates from the non-parametric Turnbull lower-bound; this estimator is seen as adequate when the goal is to estimate total WTP (Haab and McConnel, 1997). In the aggregation process we also take into account that only 26.9% of the invited panel members finished the questionnaire. To demonstrate the influence of the response rate on the aggregated measures (see Whitehead and Blomquist, 2006), we firstly treat all non-responding households as if they are not willing to pay, and, secondly, all non-responding households as having on average the same WTP as those who participated. Finally, only households indicating a response certainty of 7 or higher on the response certainty scale are taken into account. Due to empirical findings adjusting the WTP estimates this way brings them closer to what would be real payment (Morrison and Brown, 2009). Depending on these assumptions, the aggregated WTP values range from €1.1 billion for dry habitats to €8.3 billion for the forest program. For the BIOPROG program the lower bound is of €2.3 billion and the upper bound is of €9.3 billion per year (Table 6).

The costs of implementing the conservation programs are estimated at about €3.3 billion per year (Wüstemann et al., 2012). This figure covers both opportunity costs arising from necessary land use changes, establishing for example new structural elements on arable land, and maintenance costs, for example, due to annually moving. Table 6 shows a comparison of the costs and benefits and the cost–benefit ratio for each program. Comparing both on an annual basis shows that, apart from the grassland program, the benefits, determined for each ecosystem type program separately, would cover the costs even if only the share of responding households is willing to pay. However, Table 6 also indicates that adding these figures would significantly overestimate the willingness to pay for the aggregated program. Whether the BIOPROG program passes a benefit cost test depends on how many people are actually willing to pay. If only the share of responding households would pay, full implementation of the BIOPROG program would not be justified solely based on the results of the contingent valuation. The break even point is at around 36%. If a share of households equal or larger to this number would be willing to pay the program would pass a benefit cost test. However, a full benefit cost analysis would also need to consider other benefits likely to arise as a result of the measures, such as improved water quality and higher recreational value.

4. Discussion and conclusion

Overall, the presented results show that implementing the NBS in Germany would create substantial benefits. Among the specific ecosystem type conservation programs the forest program, the second largest program, attracts the highest mean WTP and accordingly the highest aggregated WTP. Lower but still significant WTP values are calculated for the other ecosystem type programs, aggregating to more than €1 billon per year for each program. The aggregated WTP values for the comprehensive program BIOPROG, ranging from €2.3 billion to €9.3 billion, are substantially lower than the aggregated WTP for all ecosystem type programs. This is expected as respondents were asked to value all programs independently. The finding that the WTP for the BIOPROG program is lower than the sum of the ecosystem type programs is therefore in line with economic theory and can be explained by substitution and income effects (Carson and Hanemann, 2005, p. 910ff). However, the aggregated WTP for the comprehensive programs is always significantly larger than the aggregated WTP for the ecosystem specific programs. An exception, discussed below, is the forest program.

The WTP estimates for both the BIOPROG and the BIOPROG+ program do not differ statistically significantly. People do not seem to additionally value the risk premium opposing higher adaptation pressure from climate change for species at the moment. A recent survey about Germans' environmental awareness found out that so far, climate change is not seen as a major cause for biodiversity loss by the general public (BMU, 2008). Findings from the present survey reveal that the majority of respondents do not link the risk of losing plant and animal species to climate change but to other factors such as intensive agricultural and forestry practices or land use changes. This might explain why, on average, people do not state a higher WTP when conservation measures responding to climate change are added to the comprehensive program.

The fact that the mean WTP value for the forest program is statistically not significantly different from the mean WTP values for the comprehensive programs could, at a first glance, be seen as a violation of the so called scope test, i.e. people should be willing to pay less for an embedded program like the forest program. Heberlein et al. (2005) point out that this conventional scope test could lead to false conclusions. Their WTP estimates for a biodiversity protection program also failed to pass the scope test. Deeper analysis of their data lead them to conclude that when respondents know more about the part (the embedded program), when they like the part more, or when they have more experience with the part, then they are likely to assign higher economic values to the part than to the whole. Our data about the destinations of the nature related trips show that forested areas are very popular destinations. Moreover, additional questions concerning the land cover of the trip destinations reveal that the majority perceived it as being predominately forested. Respondents might therefore perceive a larger share of the landscape as forested than is defined as a forest in the conservation program. For example, floodplains can also be covered by trees and arable landscapes often contain forested areas. Based on the findings by Heberlein et al. (2005) respondents might therefore assign higher economic values to the forest program because they perceive large parts of the landscape as belonging to forests, and, above all, have more experience with forests than with other landscape elements.

The Turnbull lower bound estimator results of around 20€ per month for the comprehensive programs. The estimates presented by Hampicke (1994) for a comparable nationwide conservation program equal, when adjusted for inflation (on average 2% per year over the 20 years), in today's prices approximately €16 per household per month. Comparing this number with the results from the present study, the value of biodiversity protection has slightly increased by around €4 per household per month. However, there are methodological differences between the studies and thus any comparison requires to be cautious. Hampicke (1994) presented a comparable but differing program, used a mail survey with an open ended elicitation format and did not adjust the estimates for response uncertainty. Nonetheless, the comparison does indicate that the value of protecting biodiversity to society has remained stable over the course of the last 20 years.

The suite of WTP estimates reveals the influence of the econometric approach on welfare measures. In the parametric approach, the results are highly sensitive to respondents' response uncertainty. Thus, using the non-parametric Turnbull lower bound provides more reasonable estimates in the present case. Applying the REP model reveals, on the other hand, that willingness to pay positively correlates as expected with education, number of nature related trips and conservation activities, establishing validity of the WTP responses. Especially the influence of the number of trips shows that stated willingness to pay is positively related to recreational activities. A close relation between recreation and biodiversity protection is also found by Mayer et al. (2010) who investigated tourism in six out of the 14 German national parks. They used expenditure, i.e. actual spent money, as a measure in their study. The identified economic impact ranges from €525 million of a national park at the North Sea coast to €1.9 million for a rather small park in central Germany comprising predominantly beech forests. We interpret the convergent findings as an indication of validity of the results of the present study.

Comparing the benefits and costs for each ecosystem type shows that for all but one specific program the benefits outweigh the costs. However, as the willingness to pay for the comprehensive program is significantly lower, the conservative measure for the BIOPROG program would not cover all costs. The break even point is reached when 36% of all households are willing to pay. Thus, for policy makers the results indicate that implementing the BIOPROG program is to a large extent justified even when conservative assumptions are applied and without considering benefits of other ecosystem services. While 40% of the respondents stated that they are willing to pay infinite, the remaining participants stated that on average they would pay for 7 years. A reason why the majority is only willing to pay for a limited period might be that people want to see that conservation measures are indeed implemented. Building trust towards institutions could therefore be crucial for policy makers. Halkos and Jones (2012) show that institutional trust is an important determinant of willingness to pay. However, to what extent trust determines the period people are willing to pay is a question for further research.

The relatively low response rate of 27% is a weakness of the present study. However, compared to other internet surveys the rate is well within the range of reported rates. For example, Batemann et al. (2011) report 12% for one of their web surveys and Bliem et al. (2012) report 25.6% and 23.3% response rates for their web surveys. The low response rate can partly be attributed to the selected survey mode. Due to the budget constraints and the aim to achieve a high number of interviews, motivated by the aspiration to present each program to a sufficient number of respondents, it was decided to recruit respondents from an internet panel. Results from studies comparing the effects of survey modes suggest that, regarding contingent valuation, currently internet surveys tend to have lower response rates (see Lindhjem and Navrud, 2011a, for a review and for empirical studies Lindhjem and Navrud, 2011b as well as Nielsen, 2011). Also the shift towards higher educated and higher-paid households might be a result of the survey mode. Although access and use of the internet has increased constantly in previous years, higher educated people are still better represented online (Initiative 21, 2010). However, as panel members were not informed in the invitation that the interview is concerned with eliciting WTP measures for biodiversity conservation, it is unlikely that rejecting economic valuation is a main reason for not participating. Also dropouts per page do not suggest that people opposed the valuation method.

A shortcoming of the study due to its design is that no estimates for protecting marine and alpine biodiversity were determined. Providing appropriate estimates for these ecosystems will be a topic for future surveys. Moreover, the study focuses on investigating the economic benefit of maintaining species and habitats. Implementing the NBS will very likely result in an increase of provision on a range of other ecosystem services, for example increased water quality or carbon sequestering by peatlands. However, adding values of other services to the presented estimates might be prone to double counting benefits and thus countermeasures should be applied (Fu et al., 2011).

Economic valuation is of course by no means a panacea to overcome all obstacles of implementing NBSAP. A greater use of valuation studies demonstrating the often invisible benefits of biodiversity could however help to implement conservation measures, as it will support to mainstream biodiversity policy onto the level of macro-policymaking where it is competing with the currently dominating views of sectoral planning. In the future, the ability to mainstream the protection of biodiversity as a political objective and its related planning as an instrument will be more important when biodiversity conservation will very likely face increasing competition from alternative land uses such as the production of food or renewable energy. This competition will not only take place in developed but also in developing countries. So far, public policy does not seem to be prepared well to ensure that essential non-market benefits of biodiversity conservation will be taken into account. Monitoring the benefits that arise from protecting biodiversity, as required by the National Biodiversity Strategies and Actions Plans, would be one important step to ensure that decisions on future land uses will not only be guided by conventional market values. Even the conservative estimates provided in this paper invite policy makers to do more in favor of biodiversity conservation than is done today.

Acknowledgments

The authors gratefully acknowledge the helpful comments by two anonymous reviewers. Funding for the project ''Biodiversity and climate change: adaptation strategies – cost–benefit scenarios and climate-benefits'' (Fkz. 3508 81 2100) was provided by the German Federal Agency for Nature Conservation, Bonn. The views expressed in this article are those of the authors and do not reflect the official policy of the German Federal Agency for Nature Conservation.

REFERENCES

Azevedo, J.P., 2010. TURNBULL: Stata Module to Estimate the Turnbull Empirical Distribution Estimator of Willingness to Pay. (accessed 12.08.10)http://ideas.repec.org/c/boc/bocode/s457125.html.

Batemann, I.J., Brouwer, R., Ferrini, S., Schaafsma, M., Barton, D.N., Dubgaard, A., Hasler, B., Hime, S., Liekens, I., Navrud, S., De Nocker, L., Ščeponavičiūte˙, R., Seme˙niene˙, D., 2011. Making benefit transfers work: deriving and testing principles for value transfers for similar and dissimilar sites using a case study of the non-market benefits of water quality improvements across Europe. Environmental and Resource Economics 50, 365–387.

Bengochea-Morancho, A., Fuertes-Eugenio, A.M., del Saz-Salazar, S., 2005. A comparison of empirical models used to infer the willingness to pay in contingent valuation. Empirical Economics 30, 235–244.

Bliem, M., Getzner, M., Rodiga-Laßnig, P., 2012. Temporal stability of individual preferences for river restoration in Austria using a choice experiment. Journal of Environment Management 103, 65–73.

BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety), 2007. National Strategy on Biological Diversity. BMU, Berlin.

BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety), 2008. Umweltbewusstsein in Deutschland 2008. Ergebnisse einer repräsentativen Bevölkerungsumfrage (Environmental awareness in Germany. Results of a representative population survey) BMU, Berlin.
BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety), 2010. Indicator Report 2010 to the National Strategy on Biological Diversity. BMU, Berlin.
Carson, R.T., Hanemann, W.M., 2005. Contingent valuation. In: Mäler, K.-G., Vincent, J.R. (Eds.), Handbook of Enviromental Economics. North-Holland, Amsterdam, pp. 821–936.
CBD, UNEP/CBD/COP/9/4 26, July 2007. WGRI convention on biological diversity. Working Group on Review of Implementation 2007 Report of the Ad-hoc Open-ended Working Group on Review of Implementation of the Convention on the work of its second meeting. <http://www.unep.org/bpsp/Economics/Synthesis%20%28Economic%29.pdf>
Champ, P.A., Bishop, R.C., Brown, T.C., McCollum, D.W., 1997. Using donation mechanisms to value nonuse benefits from public goods. Journal of Environmental Economics and Management 33, 151–162.
Christie, M., Hyde, T., Cooper, R., Fazey, I., Dennis, P., Warren, J., Colombo, S., Hanley, N., 2011. Economic valuation of the benefits of ecosystem services delivered by the UK Biodiversity Action Plan. Report to Defra, London.
Emerton, L., 2001. The use of economic measures in national biodiversity strategies and action plans: a review of experiences, lessons learned and ways forward IUCN. In: Regional Environmental Economics Program for Asia, Karachi.
Fu, B.J., Su, C.-H., Wie, Y.-P., Willett, I.R., Lu, Y.-H., Liu, G.-H., 2011. Double counting in ecosystem services valuation: causes and countermeasures. Ecological Research 26, 1–14.
German Federal Agency for Nature Conservation, 2010. Mehr Schwung bei der Umsetzung der Nationalen Biodiversitätsstrategie notwendig (more momentum in implementing the national biodiversity strategy needed). Press release, 12 February 2010, Bonn.
Haab, T.C., McConnel, K.E., 1997. Referendum models and negative willingness to pay: alternative solutions. Journal of Environmental Economics and Management 32, 251–270.
Halkos, G.E., Jones, N., 2012. Modeling the effect of social factors on improving biodiversity protection. Ecological Economics 78, 90–99.
Hanley, N., Barbier, E.B., 2009. Pricing Nature: Cost–Benefit Analysis and Environmental Policy. Edward Elgar, Cheltenham.
Hampicke, U., 1994. Ethics and economics of conservation. Biological Conservation 67, 219–231.
Hartje, V., Angeli, D., Heiland, S., Meyerhoff, J., Rühs, M., Schäfer, A., Schliep, R., Spielmanns, S., Wüstemann, H., 2010. Biodiversity and climate change: adaptation strategies, cost–benefit scenarios and climate-benefits. Report to the German Federal Agency for Nature Protection, Berlin.
Heberlein, T.A., Wilson, M.A., Bishop, R.C., Schaeffer, N.C., 2005. Rethinking the scope test as a criterion for validity in contingent valuation. Journal of Environmental Economics and Management 50, 1–22.
Hellmann, F., Verburg, P.H., 2010. Impact assessment of the European biofuel directive on land use and biodiversity. Journal of Environmental Management 91, 1389–1396.
Hendriks, K. 2011. TEEB NL. Presentation at the BfN workshop on exchange on TEEB processes in European countries. <http://www.bfn.de/fileadmin/MDB/documents/ina/vortraege/2011/2011_TEEB-EU_14_Hendriks_Netherlands.pdf> (accessed 21.01.12).
Initiative D21, 2010. (N)Onliner Atlas 2009. Eine Topographie des digitalen Grabens durch Deutschland, 72 S.
Krinsky, I., Robb, A.L., 1986. On approximating the statistical properties of elasticities. Review of Economics and Statistics 68, 715–719.
Lindhjem, H., Navrud, S., 2011a. Using internet in stated preference surveys: a review and comparison of survey modes. International Review of Environmental and Resource Economics 5, 309–351.
Lindhjem, H., Navrud, S., 2011b. Are internet surveys an alternative to face-to-face interviews in contingent valuation? Ecological Economics 70, 1628–1637.
Loomis, J.B., Ekstrand, E., 1998. Alternative approaches for incorporating respondent uncertainty when estimating willingness to pay: the case of the Mexican spotted owl. Ecological Economics 27, 29–41.
MacMillan, D., Hanley, N., Daw, M., 2004. Costs and benefits of wild goose conservation in Scotland. Biological Conservation 119, 475–485.
Martín-López, B., Montes, C., Benayas, J., 2007. The non-economic motives behind the willingness to pay for biodiversity conservation. Biological Conservation 139, 67–82.
Maschke, J., 2007. Tagesreisen der Deutschen Teil III. Deutsches Wirtschaftswissenschaftliches Institut an der Universität München, München.
Mayer, M., Müller, M., Woltering, M., Arnegger, J., Job, H., 2010. The economic impact of tourism in six German national parks. Landscape and Urban Planning 97, 73–82.
Morrison, M., Brown, T.C., 2009. Testing the effectiveness of certainty scales, cheap talk, and dissonance-minimization in reducing hypothetical bias in contingent valuation studies. Environmental and Resource Economics 44, 307–326.
Nielsen, J.S., 2011. Use of the Internet for willingness-to-pay surveys. A comparison of face-to-face and web-based interviews. Resource and Energy Economics 33, 119–129.
Prip, C., Gross, T., Johnston, S., Vierros, M., 2010. Biodiversity Planning. An Assessment of National Biodiversity Strategies and Action Plans. United Nations University Institute of Advanced Studies, In: http://www.ias.unu.edu/resource_centre/UNU-IAS_Biodiversity_Planning_NBSAPs_Assessment_final_web_Oct_2010.pdf.
Schleupner, C., Schneider, U.A., 2010. Effects of bioenergy policies and targets on European wetland restoration options. Environmental Science and Policy 13, 721–732.
Secretariat of the Convention on Biological Diversity, 2011. Status of development of national biodiversity strategies and action plans of equivalent instruments (NBSAPS) at 8 July 2011. <http://www.cbd.int/doc/nbsap/nbsap-status.doc> (accessed 14.10.11).
TEEB, 2010. The economics of ecosystems and biodiversity: mainstreaming the economics of nature: a synthesis of the approach, conclusions and recommendations of TEEB.
UK National Ecosystem Assessment, 2011. The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge.
Whitehead, J.C., Blomquist, G.C., 2006. The use of contingent valuation in benefit–cost analysis. In: Alberini, A., Kahn, J.R. (Eds.), Handbook on Contingent Valuation. pp. 92–115.
Wüstemann, H., Hartje, V., Meyerhoff, J., Rühs, M., Schäfer, A., 2012. Costs and benefits of implementing a national strategy on biological diversity in Germany. In: Paper Presented at TEEB Conference 2012, Mainstreaming the economics of nature: challenges for science and implementation. Leipzig, Germany.

Jürgen Meyerhoff works at the Chair in Environmental and Land Economics at the Institute of Landscape Architecture and Environmental Planning, Technische Universität Berlin. His work has focused on the elicitation of non-market values for environmental goods using both contingent valuation and choice experiments. Current research interests comprise respondents information processing strategies and using Geographic Information Systems to investigate the relationship between stated non-market values and spatial characteristics.

Daija Angeli is the Project Officer for the Natural Capital Initiative at the Society of Biology. Previously, she worked in two research projects investigating costs and benefits of nature conservation in the light of climate change at the Chair in Environmental and Land Economics at the Institute of Landscape Architecture and Environmental Planning, Technische Universität Berlin.

Volkmar Hartje is professor in Environmental and Land Economics at the Institute of Landscape Architecture and Environmental Planning, Technische Universität Berlin. His research interest lies in the application of economic methods to policy making in biodiversity and water management issues. Currently, he focuses on the integration of economic valuation in biodiversity policies on a national and regional scale.