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Willingness to pay among households to prevent coastal resources from polluting by oil spills: A pilot survey

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ABSTRACT

In many coastal regions oil spills can be considered to be one of the most important risks for the coastal environment. Efficient contingency management in responding to oil spills is critically important. Strategic priorities in contingency management highly depend upon the importance attributed to different economic and ecological resources such as beaches or birds. Due to the lack of a market for natural resources in the real world, these resources cannot be directly measured in monetary terms. This increases the risk that natural resources and their services are neglected in contingency decision making. This paper evaluates these natural resources in a hypothetical market by using the methodology of stated choice experiments. Results from a pilot survey show that according to the perspective of individuals, an oil spill combat process should focus on the protection of coastal waters, beaches and eider ducks.

1. Introduction

In the German Bight increased risk of accidental spills together with the lessons gained with oil spills in the recent past have led to a restructuring of existing oil spill contingency management. Contingency management is related to short-term operational issues as well as long-term preparedness. Operational decision making during an imminent spill is always a difficult task, not only due to the complex dynamics of the physical system in the coastal zone but also because it involves assessment and balancing of various ecological and economic values of coastal areas under risk (Liu and Wirtz, 2005). Therefore the specific benefits of different combat strategies need to be assessed. During operational decision making, protecting one specific habitat (or a tourism asset like popular beaches) has to be compared to the consequences of not protecting another habitat.

Evaluating combat strategies and preparedness is directly linked to the valuation of the environmental goods that are subject to (potential) oil spills. However, there is still limited information available about the monetary benefits of coastal habitats to society (Ojeda et al., 2008; Spurgeon, 1999; Stål et al., 2008). Little is known about how much households are willing to pay for such a set of environmental goods which are prevented from suffering oil pollution. Hence, more guidance is required on the relative importance of environmental impacts of oil pollution, and, especially in democratic societies, it is essential for decision makers charging for combat planning to know more about how the different combat options are perceived by the public.

The overall purpose of this paper is therefore to examine on the basis of a pilot survey in the North Sea coast area of the state of Schleswig–Holstein, which is one of the 16 federal states (Laender) in Germany, the attitudes towards oil combat activities among German households. In particular, the paper analyses how the public values specific natural resources protected by oil pollution combat strategies. More specifically, the study aims at providing a monetary assessment of specific benefits that are relevant for operational and strategic planning of oil spill combat.

In Sections 2 and 3 of the paper the methodological basis of the study, which includes choice experiments (CEs), random utility theory and the analytical model, is described in detail. Section 4 develops a survey to elicit the willingness of households to pay for specific combat management scenarios. Different levels of benefits and prices are specified in a number of experiments. These provide the necessary variation with which the marginal value of each benefit can be estimated. Section 5 presents and analyzes the results of the choice experiments (CEs) and is followed by exploration of its potential application and limitation in an oil spill combat management system. Finally, Section 6 summarizes major findings of the study.

2. Methodological framework

The estimation of the preferences for natural non-market resources and for changes in environmental quality constitutes an important element of the environmental economic literature (Mel-

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man et al., 2008). But due to the lack of a market, quantification of natural resources in monetary terms is always prone to large uncertainties, implying a risk of their negligence during decision making. A large class of stated preferences approaches appropriate to support environmental risk management has been tested during the last decade (Schläpfer, 2008). Most often, a contingent valuation method (CVM) has been chosen to estimate the consumer's willingness to pay for natural resources (Baral et al., 2008). However, its elicitation format which asks respondents to state directly their maximum willingness to pay for a particular environmental good has also been questioned (Garrod and Willis, 1998). As an alternative, Choice Experiments (CEs) provide a structured technique where respondents are asked to choose their most preferred alternative from a set of alternatives rather than to state their maximum willingness to pay for a specific natural resource. CEs has recently been applied to management problems in diverse fields such as forestry (Horne et al., 2003; Rolfe et al., 2000; Lehtonen et al., 2003), wetland conservation (Carlsson et al., 2003; Kuriyama, 1998), fishery (Wattage et al., 2005), waste treatment (Guikema, 2005; Garrod and Willis, 1998), water supply (Hanley et al., 2005; Haider and Rasid, 2002), life-stock management under hunting (Bullock et al., 1998; Boxall et al., 1996) and renewable energy (Álvarez-Farizo and Hanley, 2002). Although the number of CEs studies continues to increase, to our knowledge, to date none has addressed oil spill contingency management.

The general flow of the procedure of applying the CEs is to prepare firstly the survey. This includes the identification of the valuation problem and the making of preliminary decisions about the survey format; that is, whether it should be a telephone survey, a postal survey and or a face to face interview. This is followed by survey design which includes the design of the questionnaire and the pilot, which might result in the modification of the questionnaire, all to be followed by its implementation. The final step is the processing and analysis of the data and the communication of results.

The major strength of Choice Experiments, given the purpose of this study, is that it provides more information about respondent preferences compared to a CVM. With the latter approach the value of each attribute of multi-attribute goods cannot be distinguished. For instance, the damage to natural resources caused by an oil spill includes a variety of effects on coastal waters, beaches, birds and so on. While a CVM can estimate the total value of protection from oil spills, it does not enable the value of avoiding each harmful effect to be identified. In contrast, CEs permit the analyst to differentiate between all attributes included in the scenario. Therefore, the CEs facilitates not only the analysis of the perceptions about the different attributes linked to oil combat activities, but preferences for the total value of indirect service of oil combat as a whole can be elicited. Additionally, the marginal rates of substitution for each included attribute relative to a monetary attribute are useful outputs from CEs since they indicate the relative importance of each of the attributes (Kristina, 2002).

3. Choice experiments method

The random utility theory underlying the CEs technique provides the theoretical underpinning for integrating choice behavior with economic valuation (Turner et al., 1998). Within the choice selection approach, the random utility theory postulates that an individual's utility $U(y, q,)$ corresponding to a change of an environmental item depends on the individual's characteristics, here for simplicity reduced to income y, and the non-market item itself which is to be valued and denoted by q (Hanemann and Kanninen, 1996). The other key component is a stochastic part , which is unobserved by analysts. It can stand for both variation in preferences among the members of a population as well as measurement error. A random utility of a choice alternative can be generally broken down into two: a measurable (explainable) part as well as a random part. Consider if a choice with index j, the discrete utility of a consumer i with respect to choice j can be described as follows

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

V_{ij} represents the measurable part of the utility and ε_{ij} captures the unexplainable proportion. Suppose that an individual is confronted with the possibility of obtaining a change in a resource q from q_0 to q_1 with $q_1 > q_0$. If the individual views this as an improvement, $U(q_1, y,) > U(q_0, y,)$ holds. The individual is told that this change will cost \$A. The answer is "yes" only if $U(y\text{-}A, q_1,) > U(y, q_0,)$, and "no", otherwise.

Selection of one choice (e.g. j) over another (e.g. k) implies that the utility held by that choice j is greater than the utility of the choice k. The probability of choosing alternative j is

$$\Pr\{j \text{ is selected}\} = \Pr\{U_{ij} > U_{ik} \quad \forall j \neq k\} \tag{2}$$

In a general Logit model the random part ε_{ij} is assumed to be independently and identically distributed (IID) with a Weibull distribution. Thus, the probability of a choice j from a choice set consisting of p choices has a closed form depending on the matrix of formalized utilities of individual i (Malhotra, 1984)

$$\Pr\{j \text{ is selected}\} = \frac{\exp(V_{ij})}{\sum_{k=1}^{p} \exp(V_{ik})} \tag{3}$$

where the probability of any particular alternative j being chosen can be estimated with a conditional Logit model (CLM) (Karousakis and Birol, 2008). Generally, the observed utility V_{ij}, as in the following application, is formally a function of all attributes of the choice j and of the respondent i. A common specification of this function is linear in parameters,

$$V = \beta X = \beta_a X_a + \beta_b X_b + \ldots \beta_m X_m \tag{4}$$

where β is a vector of parameters to be estimated through the maximum likelihood method. The vector X contains discrete levels of observable attributes related to environmental resources, costs and the individual's socio-economic characteristics. The method of maximum likelihood can be used to estimate the values of unknown parameters (i.e. β) of the economic models in the Choice Experiments (Hanemann, 1984). The maximal WTP for option j denoted as C_j^*, is defined as the payment that just makes an individual indifferent between the choice j and status quo k. Algebraically, it can be expressed as:

$$V(X_j, C_j^*, S_i) = V(X_k, C_k = 0, S_i) \tag{5}$$

C_k denotes the cost of choice k and S_i is a vector of demographic factors represented by respondent i. Hence, a marginal WTP ($mWTP$) value of a change within a single attribute m can be represented as a ratio of coefficients as follows

$$mWTP_m = -\frac{\beta_m}{\beta_c} \tag{6}$$

where β_m is the coefficient of attribute m and β_c is the coefficient of the monetary attribute. This formula provides effectively the marginal rate of substitution between cost change and the attribute in question (Bennett and Blamey, 2001). In addition, a relative difference of willingness to pay (ΔWTP) associated with all changes in environmental resources between two choice profiles reads,

$$\Delta WTP_{j,k} = -\left(\frac{\sum \beta_m (X_j - X_k)}{\beta_c}\right) \tag{7}$$

ΔWTP quantifies the variation in environmental items in money terms as represented by two different choices indexed by j and k, respectively. It is here used to elicit preferences for different environmental scenarios related to a management option.

4. An application of choice experiment to oil spill combat options

4.1. The investigation area

The North Sea is a relatively shallow sea area located on the European continental shelf, between Norway, Sweden, Denmark, Germany, the Netherlands, Belgium, France and Great Britain. It experiences more than 15,000 ship movements per year and is one of the most frequently traversed sea areas of the world. Two of the world's largest ports are situated on the North Sea coast. The southern North Sea, along the German and parts of the Dutch and Danish coasts, consists of the Wadden Sea, a particularly important natural ecosystem which supports breeding populations of seabirds, seals, dolphins and other marine species. Large parts of the Wadden Sea are protected areas. The German Wadden Sea is – with exception of public waterways and some islands – designated as a National Park and Biosphere Reserve. Tourism and recreation are among the main economic activities found in the area. Therefore the islands and coastal areas of the German Wadden Sea, where the interviews underlying the choice experiments for this study were conducted (see Fig. 1), are highly vulnerable to hazardous oil spills from an ecological as well economic point of view.

Shipping in the southern North Sea and the Wadden Sea is governed by a comprehensive regime of protection measures set up by the International Maritime Organization (IMO), the European Community, or at a trilateral or national level. This regime includes, but is not limited to, a Vessel Traffic Management System (VTMS), a Traffic Separation Scheme (TSS), pilotage, mutual emergency management and the prohibition of single hull oil tankers from entering adjacent ports (Wadden Sea Forum, 2004). Following the accident of the wooden freighter "Pallas" in 1998 the IMO has designated the whole Wadden Sea as a "Particularly Sensitive Sea Area" (PSSA). Even though during the "Pallas" accident only 244 tonnes of heavy oil were released into the sea, about 16,000 sea birds were killed and the costs for emergency management and cleaning reached 15 million EUR.

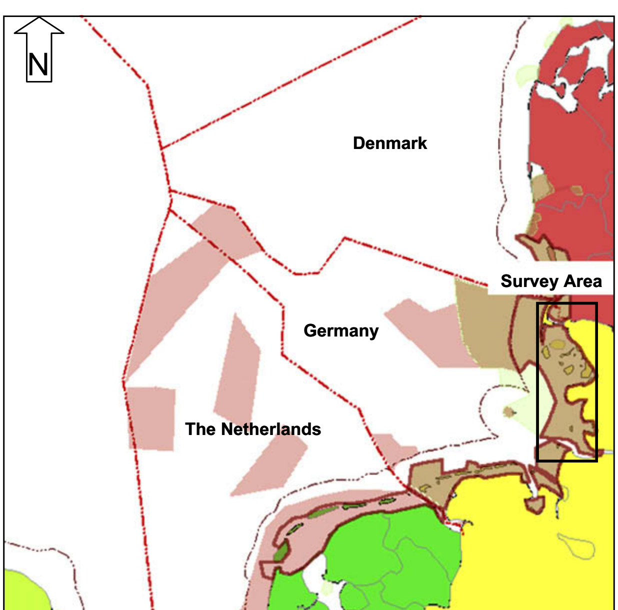


Fig. 1. The North Sea EEZ of Germany, the Netherlands and Denmark including protected areas and investigation area (Source: Coastal Futures Map Server).

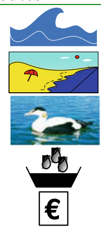
4.2. Design of the questionnaire

To assess the values that German people might hold for coastal resources, a questionnaire was designed and tested via a pilot survey in several locations along the northern part of the German Wadden Sea coast. The questionnaire was divided into four main parts with questions addressing (1) background information, (2) attitudes and behaviors (3) the evaluation itself and (4) demographic characteristics (more details can be found in the Appendix). Through reading background information provided in the first part of the questionnaire, respondents were introduced to issues of oil spill pollution, potential benefits and costs of combat strategies in the German North Sea area. A set of questions in the second part were designed to 'warm up' respondents and finally, the fourth part records respondents' current socio-economic status. Only the evaluation part contains choice experiments questions in a context of a hypothetical oil accident at the German Bight, 2010, and consists of a number of choice sets. Generally, employing combat strategies may alleviate negative ecological impacts of oil spills and increase response costs on the other hand. To address these benefits and costs, five key attributes were employed as indicators of combat management. These attributes include three different types of natural resources, the oil collection ratio during the combat and finally, the yearly payments required for the maintenance of the combat strategy. For simplicity, only coastal waters, beaches and Eider ducks are included as the main natural resources to suffer from oil spills. Generally the first cleanup response is always given to restoring coastal waters and beaches in the aftermath of oil spill. Eider ducks were included because they are common to the German coast and, thus, are a species well known to the public. In particular, Eider ducks are known to have especially suffered under the Pallas oil spill in the investigation area (Reineking, 1999).

All but one attribute (e.g. the payment) have been assigned with 2 levels. The payment attribute was split into 4 levels. The combinations of these levels were used to build choice profiles to be presented to the respondents. Selected attributes and levels (cf. Table 1) form an array of 64 ($2^{4*}4$) possible profiles. Clearly some means is required to reduce this set to some more manageable number for the respondent. An orthogonal design process, as the most common approach in economic application (Street and Burgess, 2008), was used to select 8 out of 64 profiles. This technique preserves the major discrimination features despite the reduced number of combinations. These eight profiles together with a *status quo* represent 8 choice sets, as each choice set consists of two profiles, the status quo (i.e. Option B) together with an alternative profile (i.e. Option A) as shown in Fig. 2. An example choice set is given

Table 1
Attributes and levels used in the choice experiments.

Attribute	Level	
Coastal waters	200 km^2 130 km^2	Avoided from oil pollution
Beachs	80 km 30 km	Avoided from oil pollution
Eider ducks	15,000 5000	Birds avoided from oil pollution
Collect ratio	50% 25%	Of spilled oil to be collected by combat vessels
Yearly payment	€150 €50 €20 €0	



Attributes	Combat options: Alternative A	Combat options: Alternative B
	200km^2	130km^2
	80km	30km
	15000 birds	5000 birds
	50%	25%
	€50	€0
I would prefer ❑ A; ❑ B; ❑ Neither A nor B		

Fig. 2. Example for a choice experiment. Pictograms represent the attributes sea water, beaches, birds (Eider ducks), oil removal and yearly payment, respectively. Different attribute levels in the alternative A compared with those in the alternative B are highlighted in bold.

in the Appendix. According to a pretest of the questionnaire within a 5-people group, we found, in order not to frustrate volunteers addressed by our study, firstly the length of questionnaire should be kept as short as possible. The optimal is that people should be able to finish the questionnaire in 5–10 min. Secondly, both the number of profiles to be compared in each choice set and the total number of choice sets should be as small as possible. Thirdly, a graphical design should be used as it helps respondents understand questions at first glance.

4.3. Survey

For the experiment reported here, a Choice Experiments (CEs) survey was undertaken on different days during the period 24th October to 11th November 2007. Due to time and budget constraints, a combined interview and questionnaire was carried out. Individuals were surveyed at primarily four tourism hot spots including St. Peter Ording, the city of Westerland on the island of Sylt, Buesum and the city of Husum, all located along the North Sea coast of Schleswig–Holstein, Germany, as shown in Fig. 1. These spots were chosen to represent a variety of recreation experiences offered and a favored resort with a large number of visits by both local residents and national travelers.

In the survey, tourists were interviewed face-to-face on the beaches, in the parks, and the marine exhibitions by 5 trained students. The survey was administrated so as to be approximately representative of the population in terms of gender and age, and only individuals aged 18 or over were interviewed. The response rate of tourists was high, with very few rejections. In total 122 tourists were willing to be personally involved in the survey. Each respondent was given a letter and a questionnaire. They were politely requested to complete the questionnaire, and were occasionally given explanatory help by the interviewer.

5. Results and discussions

Among the 122 tourists who were interviewed face to face, 120 (98%) completed all questions in the survey. The other two refused to answer the question on net income and therefore their data were not pooled into the analysis. Although a small sample of 120 tourists were surveyed, each individual responded to 16 options in 8 choice sets, giving a total of 1920 observations which is sufficient for a statistically robust analysis of the econometric model. Among the observations, a costly combat option was chosen 563 times. This high proportion reflects a strong interest in environmental issues among German respondents. The findings about behavioral attitudes indicate a high awareness of oil spill problems in general. Up to 95% of respondents had already seen an oil spill in the media. Nearly 72% of interviewees knew about the Pallas accident in 1998 which happened off the island of Amrum, in Germany. In addition to the information on the awareness of the oil spill reported here, several attitudinal questions were also asked. Statements were coded according to the semantic scale: 1. Strongly agree; 2. Agree; 3. No idea; 4. Disagree. When asked to express comments on the following statements: (1) An oil spill is one of the major threats to sea waters; (2) it is a major problem that birds or other species may be killed by oil spills and (3) coastal beaches or other habitats can be severely polluted and damaged by oil spills, the percentage of respondents strongly agreeing increased from 69% to 83% to 87%, corresponding to those specific statements, respectively. Regarding the protection priority for coastal environmental resources or public goods, up to 42% of respondents insisted that tidal flats should be protected first from oil pollution. As seen in Fig. 3, other environmental features like plants, beaches, birds and seals are given a priority for protection by only 18%, 14%, 13% and 13% of interviewees.

All respondents were tourists, and could be divided into 5 groups according to the number of their yearly visits to the German North-Sea and the Baltic Sea areas. As shown in Fig. 4, nearly half of the respondents visit the area several times (>3) per year and only a small number of respondents, namely 6%, were first time visitors. In the section on behavior questions, respondents were also asked to select activities participated in during their visit, using multiple-choice questions. Results shown in Fig. 5 indicate that walking is the most popular activity undertaken by 95% of respondents,

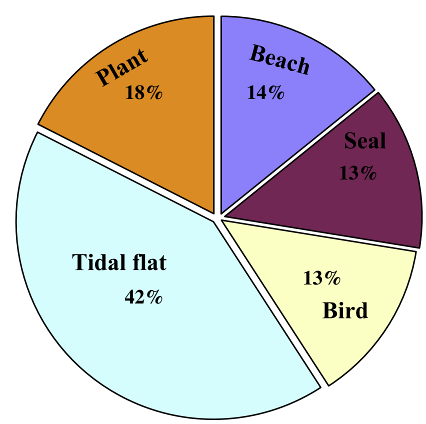


Fig. 3. Statistical distribution of protection priorities to different coastal environmental resources or goods.

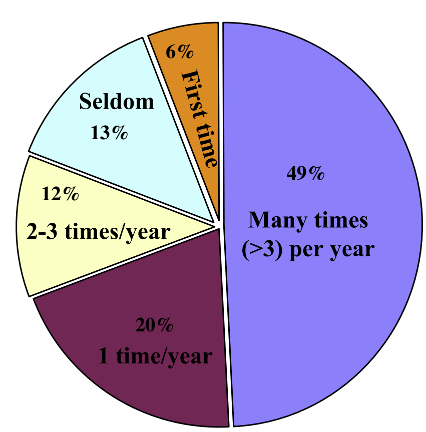


Fig. 4. Annual frequency of visits to the German North-Sea and Baltic Sea.

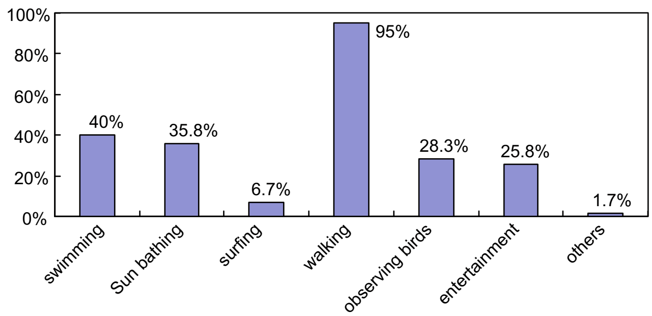


Fig. 5. Respondents' share of popular activities during their visits. Among others, entertainment includes playing on the beach and rowing the boat.

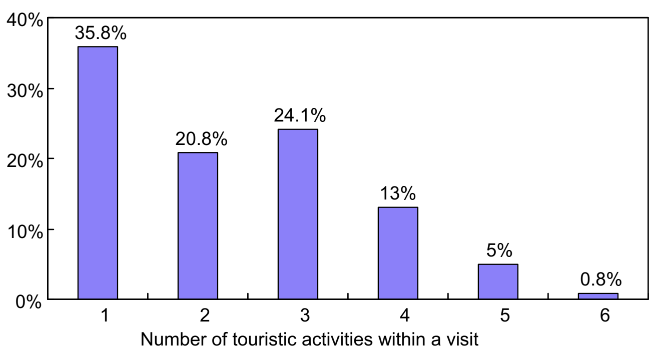


Fig. 6. Total number of different kinds of activities done during respondents' all visits. 35.8% of respondents stated that they only did one kind of activity during their all visits.

followed by swimming, lying on the beach, observing birds, entertainments and others. By examining the total number of the different types of activities (see Fig. 6), it can be seen that more than 80% of respondents stated that their total number of different activities did not exceed 3.

5.1. Social and economic characteristics

In addition to behavior and attitudinal questions, data were also collected on the social and economic characteristics of the respondents and the households. Descriptive statistics are reported in Table 2.

Based on data from the 2006 Federal Statistic Office of Germany, males represent 51% of the population; the average age of the population is 43 years; the average household size is 2.1 persons; household mean monthly net income is €2808. In comparison with the social and economic characteristics of the sample (see Table 2), our sample consists of a slightly larger proportion of men (54%); is of an older age (46.63); a larger household size (2.56 = Adult + Children = 2.08 + 0.48); and an approximately similar household monthly net income. Overall, however, the values are comparable and the sample could be said to be representative.

5.2. Logistic model interpretation

A conditional Logistic model calculation can be performed by using SPSS® software. In the regression the dependent variable is the individual's response to option A in each choice set and the independent variables are the collection of attributes including environmental and demographic factors. All attributes are statistically significant in the model at conventional levels, as significance levels ranging from 1% to 10% are exhibited, as shown in Table 3. With the inclusion of interaction terms, the model reveals that individuals with more adults in their households, higher monthly income and a membership of environmental organization are more likely to prefer the alternative (i.e. option A), offering the more costly combat option. As shown in Fig. 7, 85.9% of households with 4 adults are willing to pay for the combat option, while this choice is made by only 44.7% of households with one adult. Also the percentage of households saying "yes" to the alternative option increases as monthly income increases or if the respondent is a member of any environmental organization. In addition, the survey results show that respondents with a higher level of education are less willing to pay for combat supports. This could be explained by the fact that these respondents are influenced by the principle of 'polluter pays', as their answer in being asked the follow-up question of why not support financially the costly alternative combat if a spill occurred, showed. They refused to offer higher donations as they thought it was duty of polluters to pay for the combat options.

Marginal rates can be generated for the continuous variables: waters; beaches; birds; and oil collection, as shown in Table 4. For example, the mean marginal rate for beach reflects that each unit (1 km) increase in the length of beaches prevented from oil spill has a marginal value of €0.13 per household. Confidence inter-

Table 2
Descriptive statistics of respondents ($N = 120$) and summary of environmental attributes.

Social and economic characteristics	Min	Max	Mean (SD)
Age of respondent	20	75	46.43(13.841)
The total number of adults in household	1	4	2.08(0.726)
The total number of dependent children in household	0	4	0.48(0.856)
	Percent (%)		
Gender (male = 1, female = 0)	54.2/45.8		
Education attainment (university degree and above = 1, 0 otherwise)	20.8/79.2%		
Resident location (living in the North of German = 1, 0 otherwise)	62.5/37.5		
Household monthly net income (more specifically the six-point scale employed was, less than €1000 = 1, between €1001 and €2000 = 2, between €2001 and €3000 = 3, between €3001 and €4000 = 4, between €4001 and €5000 = 5, more than €5000 = 6	12.5/30/33.3/10/5/9.2		
Membership of environmental organization (yes = 1, no = 0)	9.2/90.8		
Have you observed birds during your visits? (yes = 1, no = 0)	28.3/71.1		
Have you ever seen an oil spill from TV or newspaper? (yes = 1, no = 0)	95/5		
Is oil spill one of major threats to sea water? (strongly agree = 1; agree = 2; no idea = 3; disagree = 4)	69.1/24.2/5.0/1.7		
Environmental attributes	Min	Max	Mean (SD)
Water (km^2)	130	200	151.87(32.45)
Beach (km)	30	80	45.63(23.182)
Duck (bird)	5000	15000	8125(4636)
Oil collection (%)	25	50	32.81(11.59)
Payment (€)	0	150	36.88(56.77)

Table 3
Conditional logistic model with interactions for oil spill combat service attributes.

Variable Symbol	Definition	Coefficient	SE
WAT	Saved coastal waters (km^2) during the combat. Numerical variable	0.003***	0.001
BEA	Saved beaches in km during the combat. Numerical variable	0.004**	0.002
DUC	Saved Eider ducks during the combat. Numerical variable	2.43E-5***	8.76E-6
OIL	Collected oil in tons during the combat. Numerical variable	0.009**	0.004
PAY	Yearly payments made by each household for using strategy to respond to the spill. Numerical variable	−0.030***	0.007
ORG*PAY	Membership of any environmental organization. Dummy variable: yes = 1; no = 0	0.005**	0.002
EDU*PAY	Education attainment (university degree and above = 1, 0 otherwise)	−0.005***	0.002
ADU*PAY	Continuous variable indicating the total number of adults in the household	0.004***	0.001
INC*PAY	Ordinal variable represents monthly net income of household. 1 = less than €1000; 2 = between €1001 and €2000; 3 = between €2001 and €3000; 4 = between €3001 and €4000; 5 = between €4001 and €5000; 6 = more than €5000	0.002***	0.001
BEO*PAY	Have you observed birds during your visits? Dummy variable: yes=1; no=0	0.004***	0.001
KNO*PAY	Have you ever seen an oil spill from TV or newspaper? Dummy variable: yes = 1; no = 0	0.012**	0.006
MEE*PAY	Is an oil spill one of major threats to sea water? Ordinal variable: Strongly agree = 1; Agree = 2; No idea = 3; Disagree = 4	−0.002*	0.001
$\chi^2(12)$ = 164.8 (significant at 0.000 level)			
Sample size = 1920 (120*8*2)			

SE, standard error.
* Statistically significant at 10% level.
** Statistically significant at the 5% level.
*** Statistically significant at the 1% level.

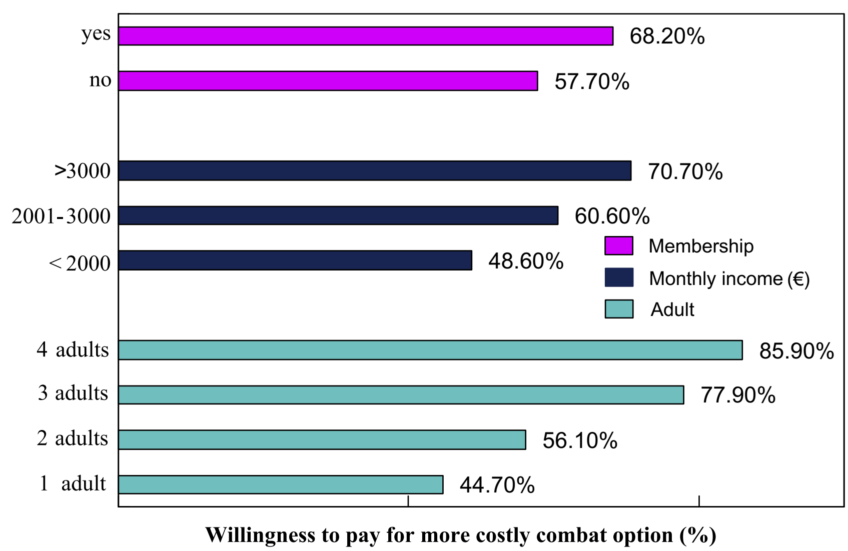


Fig. 7. Positive effects of demographic characteristics of household on choosing a more costly oil spill response strategy.

vals around the estimates of mean willingness to pay are calculated by the simulation approach developed by Park et al. (1991). The conservative estimations (i.e. 95% lower bound) can further be used to estimate value differences between any two profiles used in this study. For the two profiles presented in Fig. 2 the differential WTP equals,

$$\Delta WTP = \frac{-[\beta_{\text{water}}\Delta\text{water} + \beta_{\text{beach}}\Delta\text{beach} + \beta_{\text{bird}}\Delta\text{bird} + \beta_{\text{oil}}\Delta\text{oil}]}{\beta_{\text{payments}}}$$
$$= €29.1/(\text{household year})$$

Such a difference only corresponds to 0.09% of annual household income, based on national accounting which shows that households in Germany had a yearly net income of EUR 33,700 on average in 2005 (Federal Statistical Office Germany, 2006). Multiplying €29.1 by the total number of households in Germany (i.e. 39 Millions in the census of 2006), it leads to a willingness to pay €1135 Million for the protection of specific coastal resources from oil pollution.

Often decision makers are forced to make responses immediately when facing an oil spill. In such instances, the use of CEs requires too much time for it to be an option for strategic decision making. In addition, CEs require specific knowledge about how to design the questionnaire and specific statistical skills to deal with

Table 4
Marginal value and confidence intervals for environmentally related attributes.

Attributes	Marginal estimates of WTP	95% Lower bound	95% Upper bound
Water	$-\beta_{\text{water}}/\beta_{\text{payment}}$ = 0.105 €/km^2	0.102	0.108
Beach	$-\beta_{\text{beaches}}/\beta_{\text{payment}}$ = 0.139 €/km	0.134	0.144
Birds	$-\beta_{\text{duck}}/\beta_{\text{payment}}$ = 0.8E-3 €/bird	0.78E-3	0.82E-3
Oil collection	$-\beta_{\text{oil}}/\beta_{\text{payment}}$ = 0.334 €/ton	0.322	0.346

Note: there were 1000 draws made from a bivariate normal distribution generated using the means and variance covariance matrix of the coefficients. The 1000 WTP estimates were used to calculate the confidence interval.

discrete choices, both together implying time consuming data analysis. Therefore, such a method is best suggested to be conducted *ex ante* and to collect possible information for application within emergency situations.

It is impossible to directly ask people's WTP for one specific combat option, since they are unfamiliar with oil spill contingency management. Hence, attributes such as indicators of combat management should be determined carefully to help people identify the differences between combat alternatives. Generally, they should be well known to people and their quantity changes need to be plausible and well understood (Boxall et al., 1996). One of the recommendations of the National Oceanic and Atmosphere Administration (NOAA) report by Arrow et al. (1993) was that discrete choice formats should be used over open ended formats to elicit values for non-market environmental goods. CEs taking economic values of environmental resources into account break the environmental impacts in multiple dimensions down to a single dimension, a monetary value (Braeuer, 2003). The Cost Benefit Analysis (CBA) and the Multi-criteria analysis (MCA) are two widely used decision making tools in the approval of environmental management. Preferences elicited from CEs can be used in these analyses to help decision makers find optimal combat options. For example, in a CBA they support the calculation of the Net Present Value (NPV) associated with combat management and may help to identify cost effective combat management strategies. In addition, findings of a choice experiment survey constrain the weights of the importance between environmental resources used in the multi-criteria analysis.

6. Conclusions

This paper describes and presents an empirical example of stated choice experiments for oil spill combat options with different levels of management attributes. It is designed to support ongoing discussions about the level of preparedness of coastal spill combat facilities, but also aims at analyzing management preferences held by the public. Future studies have to involve a broader spectrum of stakeholders and infers even more robust statistics. Although our study is only a pilot survey involving a small number of respondents, which could lead to a biased result, it reveals how environmental and monetary attributes and individual's characteristics influence the support for different options. First, environmental attributes including coastal waters, beach, birds and oil collection ratios are proved to generate a significant impact on utility for the respondent. Second, the significant impact of the monetary attribute (e.g. the yearly extra payment) on the utility of respondent implies that an environmentally friendly combat option has to represent a minor cost for the household. Third, it is pointed out that an individual with more adults in his/her household, higher monthly income and a membership of an environmental organization is more likely to prefer a more costly but environmental friendly scenario. The existence of such demographic trends, however, put severe constraints on the applicability of the choice experiments as one has to survey a larger group of respondents than in our study in order to avoid a bias. Overall, however, the study does suggest that coastal resources suffering from oil pollution can be measured appropria tely by using the method of choice experiments. Results of the study have revealed that CEs provide essential information for evaluating coastal resources and indicate the priorities for protection. Combat for oil spill management also has wide application potential in other fields of coastal planning and management (Wattage et al., 2005; Haekan and Bjoern, 2000; Brown et al., 2001).

However, our studies also pointed to methodological difficulties based on the primary problem of deriving a monetary value for non-market goods from asking consumers. Political attitudes and values of the respondents clearly affect their willingness to pay. If higher educated people refuse to pay costs which they believe to be, instead, should be paid by those parties responsible for the oil pollution (e.g. the cargo or wind farm industry), the derived WTP value systematically underestimates the value that should be applied outside the public/taxation sector.

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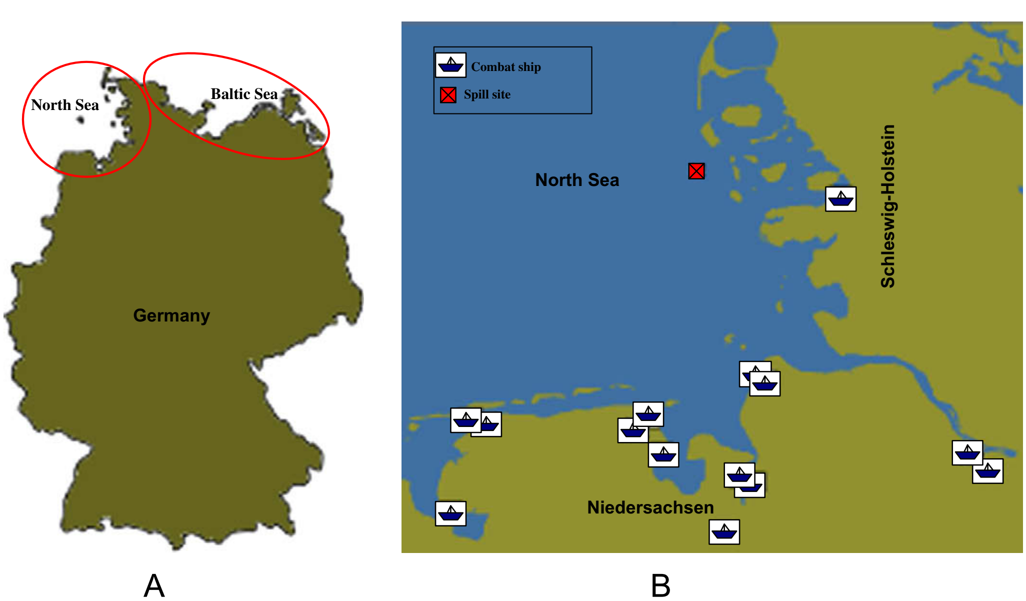

Fig. A1. German coastal areas and oil spills. (A) Coastal regions in Germany; (B) A hypothetical oil spill (amount: 100 tonnes; site: $54^{o}32.5'N; 8^{o}17.24'E$).

Table A1
Characteristics of using combat strategy and descriptions.

	Characteristics of using combat strategy
	Saved Coastal waters (km^2) during the combat
	Saved beaches in km during the combat
	Saved Eider ducks during the combat
	Collected oil relative to spilled oil during the combat
€	Yearly payments made by each household for using an effective response strategy

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Appendix. Background information in the questionnaire

Coastal regions in Germany are in the North where it borders the North and Baltic Seas (Fig. A1). Although many efforts and obvious improvements in prevention measures have been underway since the 1970's, oil spill accidents have still occurred at irregular intervals. For example, around 244 tonnes of fuel oil were released through the damaged tanker "Pallas" into the coastal waters in the German North-Sea area, 1998. On January 1993 Heweliusz, a Polish ferry which sank in the Baltic off Germany leaked 80 tonnes of oil.

In this study, we suggest a scenario that an oil spill could happen at the site where the Pallas oil spill occurred in 2010. In total 100 tonnes of fuel oil were released, as shown in Fig. A1. Compared with doing nothing, a response strategy of using available combat vessels distributed along the German North Sea often succeed in preventing more coastal waters, beaches and birds from being polluted by the spilled oil as seen in Table A1. In general, benefits and costs of employing a combat strategy could vary from case to case. In the following Section, 8 cards are presented. In each card, you will be asked to choose one of two alternatives.

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