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Heini Ahtiainen

Department of Economics and Management, University of Helsinki
P.O. box 27, 00014
University of Helsinki, Finland
heini.ahtiainen@helsinki.fi

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Abstract

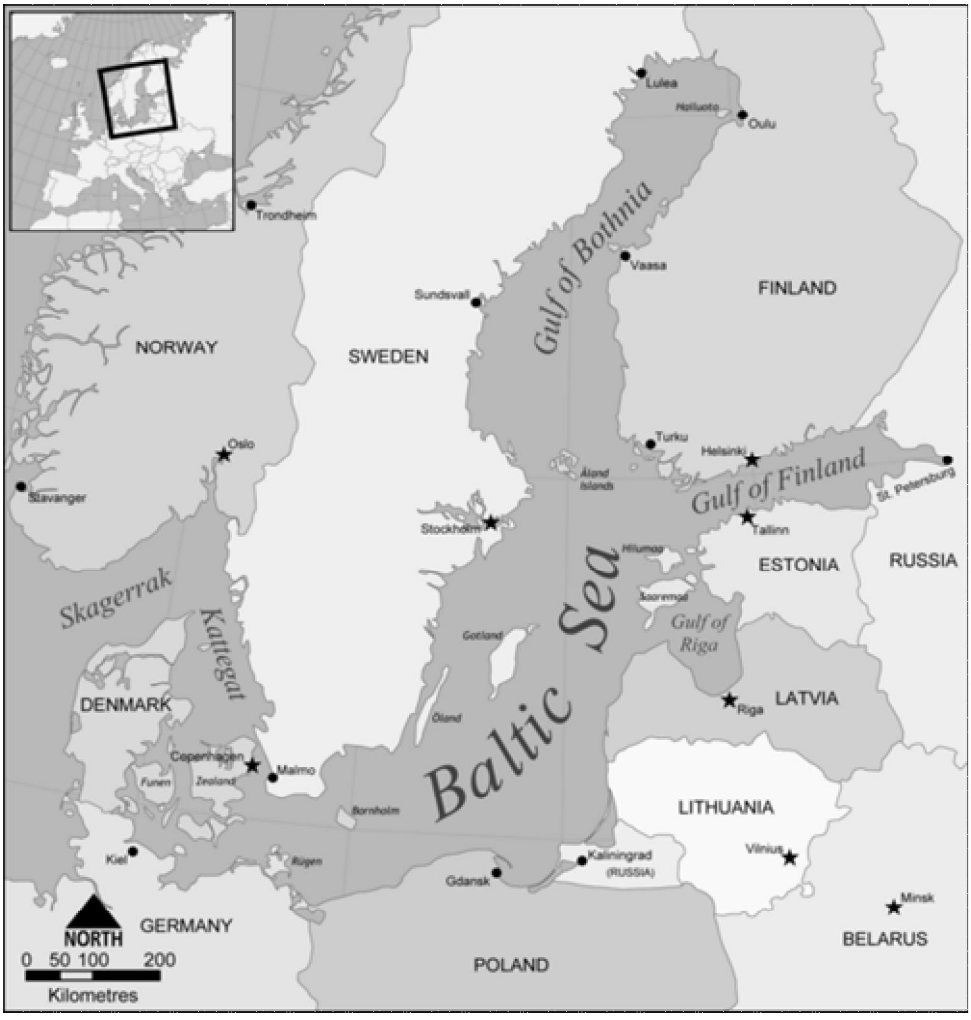
Oil transportation and other maritime traffic in the Gulf of Finland have increased rapidly over the last decade, and this development is estimated to continue in the future. The increasing volume of oil and other transport leads to higher risk of oil spills in the Gulf of Finland. The Gulf of Finland is an important area in the environmental and economic sense. An oil spill would cause harm for example to the nature and to the recreational use of the area. This paper presents the contingent valuation study that is conducted to elicit respondents' willingness to pay for improvements in the oil spill response capacity and for reductions in the harm of future oil spills in the Gulf of Finland. The mean willingness to pay is estimated with two approaches; the Turnbull lower bound estimator and the logit model, and then aggregated to the relevant population. The Finn's aggregate willingness to pay for reducing the harm from future oil spills ranges from 89 million to 330 million, depending on the used approach and on the assumption about non-respondents willingness to pay. The results show that the factors affecting respondents' willingness to pay are the offered bid, income, the perception about the effectiveness of the program, the view on the importance of oil spill combating and the distance of the place of residence to the Gulf of Finland. The results seem to indicate that the respondents value the nature of the area more than the recreational possibilities.

Key words: contingent valuation, oil spills, Gulf of Finland

1 Introduction

Oil transport and other maritime traffic in the Gulf of Finland have increased rapidly over the last decade. In 1995 the amount of transported oil in the Gulf of Finland was 20 million tons and in 2005 it was already 135 million tons (Ministry of the Environment 2006). This development is estimated to continue in the future (Hänninen & Rytkönen 2004, 60; Finnish Environment Institute 2006b). The increasing volume of oil and other transport leads to higher risk of oil spills in the Gulf of Finland. The oil spill response capacity should be increased as the volume of oil transportation grows.

The Gulf of Finland is the easternmost part of the Baltic Sea, surrounded by the coastal states of Finland, Estonia and Russia (see Picture 1). The ecosystem of the Baltic Sea is vulnerable to contamination, because its salinity level is low and natural cleansing happens at slow rate (Hänninen & Rytkönen 2004, 16). The International Maritime Organization (IMO) named the Baltic Sea as a Particularly Sensitive Sea Area (PSSA) in 2004. PSSAs are areas that need special protection because they have significant ecological, socio-economical or scientific attributes (IMO 2002).



Picture 1. Baltic Sea and the Gulf of Finland

The Gulf of Finland is important environmentally and economically. The nature in the Gulf of Finland is considered to be unique. The total number of species is relatively small and if a group of organisms is damaged, there are not necessarily other organisms available to replace them (Finnish Environment Institute 2006a). The Gulf of Finland is an important corridor for shipping and it is used as a transportation route for oil. The largest oil harbours are Primorsk in Russia, Kilpilahti in Finland and Muuga in Estonia (Hänninen & Rytkönen 2004, 17).

The Gulf of Finland and its many coastal areas are sensitive to oil spills. Even small oil spills may have serious consequences. The ecosystems can be damaged permanently and the recreational use of the coast can be unpleasant or even impossible for several months. It has been estimated that the Gulf of Finland could not bear a large scale oil accident either economically or ecologically. (Hänninen & Rytkönen 2004, 96-98.) Therefore it is vital that there is enough oil spill response capacity to combat oil spills. Increasing the oil spill response capacity reduces the damages from oil spills.

So far there have only been rather small oil spills in the Gulf of Finland. During the year 2006 there were already two close call situations of large-scale oil spills. The possibility of oil spills can be considered high in the Gulf of Finland because of its characteristics. Traffic in the gulf is heavy and the transportation routes are shallow and narrow. Difficult ice conditions affect the traffic during the winter. (Hänninen & Rytkönen 2004, 25-26.)

The reduction of the negative impacts from future oil spills is costly, but it is also beneficial to the people of Finland. If the ability to combat oil spills is improved, the nature and the recreational use of the coast and sea area will suffer less if an oil spill occurs. The valuation of the benefits to the nature and the recreational use of the coast is not possible through the markets and market prices. The reduction of the pollution of the coast and sea is a public good, which cannot be sold and bought in the market and thus there is no market price for it. Finding the value of reducing the harm from oil spills requires the use of an economic valuation method. Valuation methods, such as contingent valuation, have been developed to estimate the value of public goods.

The contingent valuation study presented in this paper is the first to estimate the value of reducing the harm from future oil spills in the Gulf of Finland. The results of the study can be used to determine the future development in the oil spill response capacity in Finland and to compare the costs and benefits associated with improving the ability to combat oil spills in the Gulf of Finland.

Contingent valuation is the most commonly used method in environmental valuation (Carson, Flores & Meade 2001, 173). The first contingent valuation study was made by Davis in 1963 who estimated recreational benefits in Maine. Since the 1960s economists have used contingent valuation to value various environmental and also other types of goods (Mitchell & Carson 1989, 9-12). More than 5000 contingent valuation studies in over 100 countries have been made (Carson et al. 2004, 3).

The contingent valuation method aims at eliciting people's preferences about public goods. The preferences are elicited by a carefully designed survey that directly asks respondents willingness to pay (or willingness to accept) for the change in the provision of the public good. The survey contains a description of the good in question and the hypothetical market where it is sold and bought. The willingness to pay responses are contingent on the hypothetical market, thus the name of the method (Mitchell & Carson 1989, 3).

In the case of reducing the oil spill damages the non-use values can be substantial, so it is important to use a valuation method that can capture both use and non-use value. Contingent valuation, as other stated preference methods, can be used to measure both value categories (Carson, Flores & Meade 2001, 173).

The contingent valuation method has been a subject of criticism in environmental valuation. There have been concerns about the ability of contingent valuation studies to produce reliable value estimates. The NOAA Panel, chaired by Nobel Prize winners Kenneth Arrow and Robert Solow, assessed the reliability of the contingent valuation method. The Panel concluded that by following a set of guidelines contingent valuation studies can convey useful and reliable information (Arrow et al. 1993, 4610). The guidelines have been taken into consideration when designing and implementing this study.

This paper presents the Finns' willingness to pay for improving the oil spill response capacity and reducing the damages from future oil spills in the Gulf of Finland. The paper is organized as follows. Section 2 discusses the design and development of the survey questionnaire used in the study. Section 3 presents the structure of the questionnaire and the crucial elements of the survey. Section 4 discusses the execution of the survey including sampling and survey administration. Section 5 presents the results and section 6 concludes.

2 Survey design and development

The aim of the survey was to obtain a reliable estimate of the Finn's willingness to pay for improving the oil spill response capacity in the Gulf of Finland. The questionnaire was designed and pretested during the first half of the year 2006 and the data was collected with a mail survey in the summer 2006. The aim of the survey design was to induce respondents to reveal valid stated values and thus ensure the content validity of the study.

2.1 The objectives of the survey design

The first objective was to make the survey understandable to all respondents. The language, pictures and questions were kept as simple as possible without forgetting the

information that had to be to conveyed and elicited. The comprehensibility of the questionnaire was the focus of the pretesting phase.

The second objective was to make the scenario and the choice mechanism realistic and plausible. The focus of the interest was choosing the payment vehicle and the format of the valuation question. Also the choice to use willingness to pay rather than willingness to accept was considered to enhance the plausibility of the survey (see for example Mitchell & Carson 1989, 37).

The third objective in the survey design was to produce a conservative estimate of the willingness to pay, as recommended for example by the NOAA Panel (Arrow et al. 1993, 4608). The survey design was conservative throughout the survey development, which means that when making choices, an alternative that would yield a smaller willingness to pay estimate was adopted. This included using a one-time payment instead of yearly payments and not showing pictures of oiled birds and other affected animals to respondents. Also using the willingness to pay elicitation format reduces the value estimate compared to willingness to accept (Arrow et al. 1993, 4608).

2.2 Survey development and pretesting

The survey instrument was designed during the first half of the year 2006. In the early stage there were several meetings with natural scientists, in which the description of the scenario and the harm from oil spills were put in their initial form. During the meetings the questionnaire was revised for pretesting.

The first pilot interviews were conducted already in November 2005. These were preliminary in the sense that the questionnaire was not yet formulated. Total of 7 respondents answered in face-to-face interviews to open questions about the state of the Gulf of Finland and the oil transports in the gulf.

More pilot interviews were conducted in April 2006. There were total of 14 respondents to in-person pilot interviews. The interviews were implemented by allowing the respondents think aloud the same time they filled in the questionnaire. The respondents were also asked specific questions about the expressions used in the questionnaire and the content of it. The interviews provided information about how the respondents understood the questions and if they had any difficulties with the wording. They also revealed a need for more specific information in the oil spill damage description and gave some suggestive information about the willingness to pay distribution. After these interviews the questionnaire was revised based on the respondents' comments.

A larger pilot was conducted in May 2006. The questionnaire was adapted to electronic form and made available on the Internet. The respondents were university students and staff who received an e-mail that introduced the questionnaire and requested them to answer it. In total 206 respondents answered the Internet survey.

The Internet pilot gave information about how the respondents accepted the scenario and that they understood the questions correctly. There was an open question at the end of the questionnaire about the questionnaire itself and the respondents provided useful comments in it. Only few opposed the payment vehicle or the choice mechanism. None of the respondents questioned the content of the scenario, although some emphasized the importance of the prevention of oil spills. The questionnaire was again revised based on the answers and the comments given. A mention of the prevention of oil spills was included in the scenario to avoid protest answers that its absence could have caused, although the questionnaire focused on the reduction of harm after an oil spill has occurred.

2.3 Key design issues

The key design issues for this study included the choice of the payment vehicle and the timing of the payment, as well as the choice of the elicitation format. The objective to keep the payment vehicle and the elicitation format realistic and plausible was the basis of the design.

The state of Finland provides the oil spill response capacity at present from the state budget. Thus it was a natural choice that the financing for the increase in the oil spill response capacity would be collected through taxes and the state would supply the service. The Finns have usually a high regard for the state and consider it reliable in its promises. In pretesting, when asked specifically about taxes as a payment vehicle, respondents considered taxes to be a good payment vehicle and on the contrary opposed voluntary collections and donations to funds. Most respondents thought it was fair that everyone should pay for the reduction of the damages from oil spills. However, some respondents brought out that they opposed the increase in taxes as such or that the user of oil products should pay. The increase in oil prices could also have been the payment vehicle, but we rejected this approach because in the early 2006 oil prices were high in Finland. High oil prices had already raised opposition and using them as a payment vehicle could have caused more protest answers than using higher taxes. The payment was chosen to be made one-time, which is a conservative choice compared to yearly payments.

In general, the choice question can take different formats. The referendum format, which poses the valuation question as a referendum, is recommended for example by the NOAA Panel (Arrow et al. 1993, 4612). The format is preferred because it imitates the situation of a real referendum and the respondents are therefore familiar with the setting. However, there are seldom referendums in Finland on environmental issues, and it is the parliament who makes the decisions and enacts laws. The referendum format was not regarded suitable for Finland because choosing it would have reduced the survey's plausibility. The valuation question was phrased as a single bounded dichotomous choice. It is similar to the referendum format, but the respondent is not asked to vote in a referendum but to answer *yes* or *no* to a specific cost to fund the project. According to Carson, Flores & Meade (2001, 190), the single bounded dichotomous choice question is

incentive compatible (i.e. the respondent has the incentive to answer truthfully) if the government has the power to supply the good and collect the payment for it. As already mentioned, this is the case in Finland for the oil spill response capacity. Incentive compatibility is important as it implies that the respondents do not have the incentive to behave strategically.

3 The final questionnaire

The central part of the final questionnaire was the description of the oil spill damages, the program to improve the oil spill response capacity in the Gulf of Finland and the valuation question. Other sections of the survey preceding and following the valuation question included questions about the recreational use of the coast of the Gulf of Finland and attitudinal and demographic questions. Table 1 depicts the structure of the questionnaire.

Table 1. Structure of the questionnaire

Part	Content
1	Respondent's relationship to the Gulf of Finland
2	Attitudinal questions about the use of tax revenues
3	Description of the damages oil spills cause and attitudinal questions, including - harm to the nature - harm to the recreational use
4	Description of the program to improve the oil spill response capacity, including - the program to prevent oil spill damages - the improvements achieved with the program
5	Valuation question, including - how the program would be paid for - the cost of the program to the respondent - the valuation question - the motivation question
6	Demographic and other background questions

3.1 Respondents relationship to the Gulf of Finland

The first part of the questionnaire asked about the respondents' relationship to the Gulf of Finland. There were two questions about the respondents' relations to the gulf and the recreational use of the area. These first two questions were chosen as they apply to everyone, are easy to answer and relate directly to the topic (see Dillman 2000, 92-94).

The first question, "*In which of the following ways does the Gulf of Finland relate to you?"* was designed so that almost every respondent could answer *yes* to at least one of its subquestions.

3.2 Attitudinal questions

The second part of the questionnaire asked the respondents' attitudes toward the use of tax revenues for different programs. The purpose was to remind that tax revenues are used already for several objects and that it might be more important to use the revenues for something else than for reducing the damages from oil spills. The general programs that tax revenues are allocated for were taken from the Ministry of Finance's list of programs the government spends the most money to. The measures for the environmental protection were all local as the reduction of the oil spill damages.

3.3 Description of the damages

The third part of the questionnaire described the harm that oil spills can cause in the Gulf of Finland and duration of this harm. The aim of this section was to inform the respondent of the damages that oil spills can cause and to find out how the respondent felt about the different kinds of damages and their relative importance. It was also useful to know which of the damages the respondents thought were most serious because this can be taken into consideration when deciding how the oil spill response capacity is used when an oil spill occurs.

The damage description assumed that the spill would be a severe one, spilling a substantial amount of oil to the Gulf of Finland. The description included damages to the wildlife and to the recreational use of the Gulf of Finland.

The oil spill in the Gulf of Finland was told to harm birds, young seals, small animals that live in the sea bottom, aquatic vegetation, insects and fish. The number of affected organisms varies considerably with the location of the spill and therefore it would not have been possible to give reliable estimates of the dead and injured organisms for all organism groups. Only the magnitude of the affected birds was presented with the total number of birds living in the Gulf of Finland. Concerning other organism groups there was a general expression that many of them would die, e.g. "Many small animals that live in the sea bottom will die". These descriptions were accepted in the pilot interviews as being detailed enough.

We also had a concern that respondents would think that some species were going to become extinct in the Gulf of Finland as a consequence of an oil spill. This in fact might happen, but the probability is very small. It would require that the species lived only in the Gulf of Finland and oil would completely spoil its habitat. With the conservativeness of the design in mind, we decided not to mention the small possibility that some organisms could become extinct. There was a sentence, however, which said that "The number of the species that live in the Gulf of Finland can decrease for several years".

This is more likely to happen as an oil spill can cause some species to disappear from the gulf but recover in a few years after the spill.

The recovery time of nature and organisms was also mentioned as it gives the respondents information of the duration of the damages. The total recovery time of the nature was said to be 10 years at the most if another oil spill would not occur.

The harm to the recreational use of the Gulf of Finland was also included in the description of the damages. The harm to the recreation included the decrease in the catch in fishing and hunting, the restrictions of boating and swimming in the oil and the unpleasantness of the recreational use of oiled coast. The respondent could also specify an additional harm. The duration of the damages to the recreation were said to last from a few months to two years if there would not be another oil spill in the Gulf of Finland.

3.4 Explanation of the program

There were two possible ways to formulate the scenario: preventing future oil spills or reducing the harm from future oil spills. The scenario focused on reducing the harm from future oil spills. The reduction of the harm was chosen over the prevention of oil spills for several reasons. Although it is usually considered to be cheaper and more effective to prevent oil spills than to clean up after them, the prevention of oil spills in the Gulf of Finland presented many difficulties for the scenario design.

It would not have been credible to suggest that all future oil spills could be prevented in the Gulf of Finland as in other oil spill contingent valuation studies (for example Carson et al. 2004). These studies presented the respondent with an escort ship program that meant using an escort to each and every oil transport ship. The program would prevent all oil spill damages in the area it was introduced to. The ship traffic in the Gulf of Finland is heavy and it might not even be possible to employ a similar escort ship program. The prevention of oil spills would in addition need international co-operation with Estonia and Russia, because a lot of the oil transports in the gulf go to their harbours. These transports are considered to be most risky, which came up also in the pilot interviews. The Finns are usually very sceptical towards Russia and would probably have questioned its capability to introduce an escort ship program and the program's ability to prevent all oil spills.

Because it would not have been possible to use a scenario that suggested that all future oil spills would be prevented, we would have had to use an estimate of how much the probability of oil spills would have decreased. It is difficult to obtain a reasonable estimate of the probability of an oil spill in the Gulf of Finland and to describe it understandably to the respondents. The assessment of how much the oil spill prevention measures would reduce the probability of an oil spill is even more difficult.

For the sake of simplicity we decided to concentrate on the damages that oil spills cause and their prevention. It was presumable that some respondents would protest against

focusing on reductions in oil spill damages and demand the prevention of oil spills instead. Protests came up also in the pretesting phase, although in the pilot interviews most were satisfied with the prevention of the damages from oil spills. The protesting was taken into account in the scenario where we mention that the Finnish government uses money to both purposes (i.e. to the prevention of oil spills and to the reduction of the harm from oil spills), and that this questionnaire focuses on the reduction of the harm from oil spills.

The scenario described the improvements in the oil spill response capacity that would lead to the reduction of the harm from future oil spills. There was a question about how effective the respondent saw the program which was expected to be an indicator of the willingness to pay.

3.5 Valuation question

Respondents were informed about the payment vehicle and the context for the payment. The payment vehicle was an additional tax for the year 2007, i.e. a one-time payment. It was explained to the respondent that also oil companies would participate in funding the program. The purpose of mentioning the oil companies' participation was to reduce the protest answers that oil companies should pay for the program. The valuation question was a single bounded dichotomous choice, i.e. the respondent answered *yes* or *no* to a specific cost. There were 6 different costs; 5 €, 25 €, 50 €, 100 €, 200 € and 400 € which were randomly distributed among the respondents. The valuation question was followed by a control question about the reasons for answering *yes/no/not sure* in the valuation question, in which there were several options and also an open space for a different reason than those presented.

3.6 Demographic questions

The sixth and final part of the questionnaire consisted of the demographic questions and background information about the respondent. There was also an open question where the respondent could freely write down his/her comments about the questionnaire and the oil spill response system.

4 Survey execution

The sample frame was provided by the Finnish Population Register Centre, which holds the register of all Finns. Stratified random sampling was used. The population was divided into two strata: those, who live in the coastal municipalities of Gulf of Finland and those, who do not. The purpose was to ensure we could get a representative sample of those who live in the coastal area. The sample units (individuals) were chosen randomly from both strata. The sample size for those who live on the coast was 245 and for those who live elsewhere 755. Thus total sample size was 1000 individuals. The

individuals were from 18 to 80 years old Finns who live in the mainland (the part of the population living in the Åland Islands was not included).

The survey was administered through mail in June 2006. The first follow-up was sent a week after and another follow-up four weeks after the questionnaire. Mail surveys are commonly used in contingent valuation (Carson, Flores & Meade 2001, 180). Total of 373 questionnaires were returned, which makes the overall response rate 37.3 %. Out of the 373 questionnaire 13 were returned empty or filled incompletely, so the number of usable questionnaires was 360.

5 Results

The valuation question was analysed with two approaches; the Turnbull estimator (Turnbull 1976) and the logit model. The Turnbull approach is well suited for estimating the willingness to pay as it avoids the complexity of statistical analysis of parametric models, but the logit model is more suitable for analysing the effects of the variables and testing the model (Haab & McConnell 1997, 269).

5.1 Protest answers

This section discusses the treatment of protest answers. Protesting refers to the situation where respondents do not report their true value for the good in question. Individuals either provide a zero value or an unrealistically high value for the good instead of their true willingness to pay (Bateman at al. 2002, 177-178).

Bateman et al. (2002, 178) take the view that the only option is to exclude protest responses as it is impossible to know the respondent's true value for the good. However, according to Meyerhoff & Liebe (2003, 592), the exclusion of protest answers is unjustified and protest answers should be included in the analysis as there are no established rules for treating protest responses. Despite the absence of established rules, there are usual procedures for the treatment of protest answers. Here we follow the common practice in contingent valuation and identify protesters based on the respondents' answers to the questionnaire and exclude them from the data set before the analysis.

A variety of techniques have been used to identify protest answers. A common technique for identifying protest zeros is through a follow-up question that probes respondents' motivations for answering the choice question. These answers can be used to distinguish between those who truly place a value of zero on the good, and those who respond zero for some other reason. (Bateman et al. 2002, 178.)

Our survey included a follow-up question to find out why respondents were willing or unwilling to pay the amount of money in the choice question. The respondents were given a set of pre-determined reasons and they could also specify their own reason. We

identified the protesters on the basis of the follow-up question. Those who said that the only reason for refusing to pay was that oil companies should pay all costs from oil combating were identified as protesters. There were total of 26 respondents who chose only that reason and they were excluded from the data set. In addition, five respondents did not answer the willingness to pay question, so they were also excluded before data analysis. The number of usable responses in the willingness to pay analysis was reduced from 360 to 329.

In addition to removing protest zeros we identified high protest answers by identifying those respondents, whose willingness to pay was greater than a certain percentage of their income. In other contingent valuation studies percentages like 5 % and 10 % have been used (Boyle 2003, 145, Mitchell & Carson 1989, 226). We looked for respondents who had been willing to pay 400 € and had the yearly pre-tax income of less than 10 000 €, which was the lowest income category. There were none of these respondents. This suggests that respondents considered their budget constraints when answering the choice question.

5.2 Willingness to pay question

The respondent's response in the dichotomous choice valuation question gives either a lower or an upper bound to his/her willingness to pay. If the respondent answers *yes* to the bid, which is the offered sum, it represents the lower bound to his/her willingness to pay and if the respondent answers *no*, the bid is the upper bound to his/her willingness to pay. The responses are in a form of single-bounded interval data. The bid amounts that were randomly assigned to the respondents were 5 €, 25 €, 50 €, 100 €, 200 € and 400 €. Table 2 presents the responses to the choice question by the bid amount.

Table 2. Responses by bid amount (N=329)

Bid amount	Number of respondents	Yes	No	Not sure
5 €	58	70.69 %	12.07 %	17.24 %
25 €	60	53.33 %	26.67 %	20.00 %
50 €	52	42.31 %	30.77 %	26.92 %
100 €	59	40.68 %	38.98 %	20.34 %
200 €	52	19.23 %	48.08 %	32.69 %
400 €	48	10.42 %	64.58 %	25.00 %

In the following analysis *no* and *not sure* responses are combined into a single *not-yes* category. The interpreting of *not sure* responses as *no* responses keeps the willingness to pay estimate conservative. The same approach has been used for example in Carson et al. (2004). The results of the combining can be seen in Table 3. As predicted by economic theory the percentage of the sample voting *yes* decreases as the bid amount increases.

Table 3. Choice measure by bid amount

Bid amount	Yes	Not-yes
5 €	70.69 %	29.31 %
25 €	53.33 %	46.67 %
50 €	42.31 %	57.69 %
100 €	40.68 %	59.32 %
200 €	19.23 %	80.77 %
400 €	10.42 %	89.58 %

5.3 Turnbull lower bound estimate on mean willingness to pay

To estimate the mean willingness to pay for reducing the harm from future oil spills we use the Turnbull lower bound estimator for interval-censored data. The estimator constructs an interval estimate for the willingness to pay based on respondents' choices in the valuation question. By combining those choices we obtain estimates for the relative frequency of responses at different willingness to pay intervals. (Carson et al. 2004, 84.) The seven intervals defined by the bid amounts are (1) 0 € - 5 €, (2) 5 € - 25 €, (3) 25 € - 50 €, (4) 50 € - 100 €, (5) 100 € - 200 €, (6) 200 € - 400 € and (7) 400 € - ∞.

The Turnbull estimator provides an estimate of the fraction of the population who would answer *yes* at each of the bid amount used. The estimate of the lower bound on the sample mean is one of summary statistics that can be defined on the basis of the Turnbull estimates. The fraction of the sample estimated to be in each interval is treated as having the willingness to pay value that equals the lower bound of the interval, and then the ordinary sample mean is calculated. (Carson et al. 2004, 84, 172.) Table 4 reports the Turnbull estimate of the lower bound on the sample mean.

Table 4. Turnbull estimate of the lower bound on the sample mean

Lower bound of interval	Upper bound of interval	Probability of answering *yes* at upper bound	Change in density
0 €	5 €	0.7069	0.2931
5 €	25 €	0.5333	0.1736
25 €	50 €	0.4231	0.1102
50 €	100 €	0.4068	0.0163
100 €	200 €	0.1923	0.2145
200 €	400 €	0.1042	0.0881
400 €	∞	0	0.1042
Estimate of lower bound on sample mean 85.19 €			

The first two columns in Table 4 present the lower bound and the upper bound of the intervals. The probability of answering *yes* in the third column is the estimated fraction of those in Table 3 who would answer *yes* at each bid amount, with the exception that no respondent is expected to have an infinite willingness to pay in the last row. The estimates on change in density in the fourth column are a translation of the probability estimates in the third column.[1] The Turnbull estimator indicates that 29.31 % are willing to pay between 0 € and 5 € and 17.36 % are willing to pay between 5 € and 25 €. The remaining entries can be interpreted similarly.

The Turnbull willingness to pay estimate can be calculated by multiplying the lower bound of each interval by the fraction of the sample estimated to be in each interval (change in density) and summing the resulting columns of numbers. The mean willingness to pay per person calculated with the Turnbull lower bound estimator is 85.19 €. The median (50^{th} percentile) respondent falls in the 25 € - 50 € interval.

5.4 Logit model

Logit regression is commonly used for analysing binary choices. Table 5 lists the variables that are included in the estimated logit regression model and their sample averages. The logit model is estimated with the statistical program LIMDEP. Different specifications of the logit model are possible. The model presented here includes several theoretically important variables, such as income, opinions about the program and the use of tax revenues to combat oil spills, and the distance to the site in the form of if the respondent lives on the coast of the Gulf of Finland. Some variables that were not statistically significant and that did not influence the dependent variable were excluded from the model.

Table 5. Variables included in the logit regression model on willingness to pay and their sample averages

Variable	Definition	Sample average
bid	The money amount that the respondent is asked to pay in the choice question (€)	117.3
inc	The individual income before taxes in the year 2005 (€)	23 096
eff	How effective the respondent sees the program: 1 not effective at all 2 not too effective 3 somewhat effective 4 effective 5 very effective	3.7370
coast	1 if the respondent lives in a coastal municipality, 0 otherwise	0.2699
oiltax	1 if the respondent thinks it is very important to use tax money to combat oil spills, 0 otherwise	0.6367

[1] For example in the first row the estimate of 0.2931 is 1.00 (100 % are assumed to be willing to pay 0 €) minus the estimate of 0.7069. The other estimates of the change in density are calculated in a similar way.

Table 6 presents the estimated logit model on willingness to pay and the unrestricted and restricted log likelihood, proportion of correct predictions, the pseudo R^2 statistic, the likelihood ratio and the mean willingness to pay calculated from the model. The mean willingness to pay from the logit model is 73.57 € and due to the assumption about the linearity of the utility function it is also the same as the median willingness to pay.

Table 6. Logit model on willingness to pay

Dependent variable: Choice in the valuation question (no = 0, yes = 1); 289 observations

Variable	Coefficient	P-value
Bid	-0.0099***	0.0000
	(0.0016)	
Inc	0.00003***	0.0021
	(0.00001)	
Eff	0.2911*	0.0899
	(0.1716)	
Coast	0.6628**	0.0387
	(0.3206)	
Oiltax	0.8013***	0.0065
	(0.2942)	
Constant	-1.7658**	0.0110
	(0.6947)	
Log likelihood (U)	-157.72	
Log likelihood (R)	-198.19	
Proportion of correct predictions	72.3 %	
Pseudo R^2	0.2042	
Likelihood ratio statistic	80.95	
Mean WTP	73.57 €	

Standard errors are given in parenthesis under coefficients. Individual coefficients are statistically significant at the ***1%, **5% or *10% level.

5.4.1 Effect of the explanatory variables

The logit model allows us to examine whether the explanatory variables are significant in determining the willingness to pay responses and whether they affect the responses as the economic theory, intuition and empirical expectations predict. It is important for the

validity of the results that the effects of the variables conform to theoretical and empirical expectations (Bateman et al. 2002, 195).

The logit coefficients do not have simple interpretations. However, the signs of the coefficients provide information about the effects of the variables to the probability that the dependent variable is one, in our case to the probability that the answer in the choice question is *yes*. If the coefficient is positive, an increase in the variable increases the probability of a *yes* answer in the choice question and if it is negative, an increase in the variable decreases the probability of a *yes*. (Stock & Watson 2003, 303.)

Perhaps the most fundamental of the expectations of economic theory is that as the price of a good increases then the consumption of the good should fall (Bateman et al. 2002, 320). The coefficient on BID is negative as the economic theory predicts, which means that the proportion of respondents who answer *yes* in the choice question decreases as the bid amount increases.

Economic theory predicts a positive association between willingness to pay and respondent's income (Bateman et al. 2002, 320). The coefficient on INCOME is positive as can be expected. It indicates that the higher the income of the respondent, the more likely s/he is to answer *yes* to the offered sum in the choice question.

The positive sign of the coefficient on EFF is consistent with the expectation. The more effective the respondent sees the program, the more willing s/he is to accept the bid in the choice question.

Empirical studies have shown that some categories of value decline with increasing distance and therefore it is expected that willingness to pay decreases as the respondent's distance to the good increases (Bateman et al. 333). The coefficient on the variable COAST is positive as can be expected. If the respondent lives in one of the coastal municipalities of the Gulf of Finland, it is more likely that s/he answers *yes* in the choice question.

The coefficient OILTAX describes the attitudes of the respondent towards the use of tax revenues to combat oil spills. The positive coefficient on OILTAX is expected. It indicates that if the respondent thinks that it is very important to use tax revenues to combat oil spills, s/he is more likely to be willing to pay the bid amount.

All variables that are included in the logit regression model are statistically significant in determining the willingness to pay responses, and they also conform to the prior expectations that are derived from economic theory or are empirically driven.

5.4.2 Measures of fit

The proportion of correct predictions and the pseudo R^2 statistic measure the fit of the model. The proportion of correct predictions is the proportion of the total number of the

observations that are correctly predicted. The proportion of correct predictions in our model is 72.3 %.

Pseudo R^2 statistic (sometimes called McFadden's R^2) provides a measure of the explanatory power of the entire model (Bateman et al. 2002, 196). The statistic is restricted to the interval (0, 1). If the value of the pseudo R^2 is zero, the logit model does not explain the distribution of willingness to pay in the sample at all. The larger the pseudo R^2 is, the greater is the explanatory power of the model. There is no specific value of pseudo R^2 that would make the model satisfactory. However, Bateman et al. (2002, 196) notes that values under 0.1 raise concerns about the explanatory power of the model. The pseudo R^2 calculated from our model is 0.2042, which exceeds 0.1 but is still relatively low.

The likelihood ratio test is similar to the F test. It tests the null hypothesis that all coefficients in the logit model are zero. The likelihood ratio statistic from our model, 80.95, exceeds the critical value of the χ^2 distribution with the significance level of 1 % with five degrees of freedom, 15.09. Thus the null hypothesis is rejected and the coefficients of the model are different from zero.

5.5 The differences in the willingness to pay estimates

The willingness to pay estimate from the logit model (73.57 €) is somewhat smaller than the Turnbull estimate (85.19 €). One explanation could be that the logit model assumes that some respondents have negative willingness to pay and, on the contrary, the Turnbull estimator restricts the willingness to pay to be positive. According to Haab and McConnell (2002, 74) the Turnbull estimate of the lower bound offers a lower bound of willingness to pay for all non-negative distributions of willingness to pay. Because the willingness to pay distribution in the logit model is not non-negative, the estimate from the logit model can be smaller than the Turnbull estimate.

It is rather difficult to find the reasons behind the disparity of the willingness to pay estimates as typically in contingent valuation studies that the willingness to pay estimate is calculated either parametrically or non-parametrically. However, van Biervliet, Le Roy & Nunes (2006) have estimated the willingness to pay using both logit model and the Turnbull estimator of the lower bound. Van Biervliet, Le Roy & Nunes (2006) found that the differences between the logit model and Turnbull lower bound estimates on the mean willingness to pay were small.

5.6 Aggregate willingness to pay

The objective of aggregation is to move from the mean willingness to pay of the sample to the total willingness to pay of the population. Aggregation might seem straightforward, but in reality it presents some problems. First, the sample that has produced the mean willingness to pay estimate has to be representative compared to the population. The relative share of respondents who live on the coast of the Gulf of Finland

is larger in our data set than in the Finnish population due to the stratified sampling. The issue will be discussed in the following section, where the willingness to pay estimates are adjusted to take the stratification into account. Other adjustments are not made since the differences between the data set and the Finnish population are small. Second, an assumption has to be made about the willingness to pay of those, who were chosen for the sample but did not answer the questionnaire. This issue will also be examined before calculating the aggregate willingness to pay for the Finnish population.

The population of interest, for which the willingness to pay is aggregated, consists of 18 to 80 years old Finns who live in the Finnish mainland. Those who live in Åland Islands were excluded from the sampling and thus from the aggregation population. The total size of the relevant population according to the Statistics Finland was 3 949 551 people at the end of the year 2005.

5.6.1 The mean willingness to pay estimates for the population

Due to the stratified sampling, our sample and data set included more people who live on the coast of the Gulf of Finland in relation to the real share of Finnish population that lives on the coast. The logit model also showed that those who live on the coast are more likely to be willing to pay the money amount in the choice question. Therefore the willingness to pay estimates are biased upwards. To correct the bias, we estimate the mean willingness to pay separately for the two strata. The mean willingness to pay estimate for the population is the weighted sum of the estimates from the two strata.

Table 7 presents the mean willingness to pay estimates for the Finnish population. These adjusted estimates will be used in calculations that follow.

Table 7. The mean willingness to pay estimates for the population

Turnbull estimator of the lower bound	83.65 €
Logit model	68.61 €

Non-response bias refers to the situation where the number of those who provide a valid answer to the willingness to pay question is smaller than the number of the chosen respondents in the sample. Some level of non-response bias is inevitable in contingent valuation surveys (Mitchell & Carson 1989, 267). Non-response bias includes two distinct types of biases: item non-response and unit non-response bias.

In item non-response bias the respondent fails to answer some key question, typically the willingness to pay question. Also *not sure* answers in the willingness to pay question are item non-responses. (Bateman et al. 2002, 346.) Of 360 respondents there were five who

did not answer the willingness to pay question and 77 who answered *not sure*. Thus the total item non-response in the willingness to pay question is 22.8 %.

According to Mitchell & Carson (1989, 267), non-response rates of 20 to 30 percent for the willingness to pay question are not uncommon when the sample is random, scenario is complex and the object of valuation is an environmental good which people are not accustomed to valuing. To this extent, Mitchell and Carson (1989, 267) consider the rather high levels of non-response to willingness to pay questions acceptable or even desirable. To address the item non-response, we chose to treat *not sure* answers as *no* answers. Bateman et al. (2002, 309) recommend this approach and it has been used for example in Carson et al. (2004).

Unit non-response bias occurs when some of the chosen respondents have not answered the survey. The bias is unlikely to be random as those who are not interested in the good or have no value for it are less likely to participate in the survey. In consequence, the remaining respondents have higher values for the good than the overall population. (Bateman et al. 2002, 346.) Unit non-response bias is sometimes called sample selection bias (see for example Mitchell & Carson 1989, 276).

Of the 1000 individuals in our sample there were 329 respondents (32.9 %) who provided a valid answer to the survey. To aggregate the willingness to pay across the population an assumption has to be made about the willingness to pay of those, who did not return the survey. Mitchell and Carson (1989, 278) have suggested a rather simple approach to address the unit non-response bias. In the following we assume that there are r respondents who have answered the survey and m non-respondents who have not. We calculate the aggregate willingness to pay as follows:

$$(1) \qquad \overline{WTP}_{(a)} = \frac{1}{r+m}\left[\sum_{r} WTP_i + \sum_{m} (a) WTP_i\right]$$

where a is the multiplier that expresses the non-respondents willingness to pay in relation to the willingness to pay of the respondents. Using different multipliers in place of a we can calculate the appropriate willingness to pay estimates for different assumptions of non-respondents' willingness to pay. If $a = 1$, non-respondents are assumed to have the same mean willingness to pay as respondents and if $a = 0$, non-respondents are assumed to have zero willingness to pay. Also multipliers between 0 and 1 can be used.

The chosen multiplier has a significant effect on the aggregate willingness to pay estimate. To examine this effect we calculate the aggregate willingness to pay using the multipliers 0, 0.5 and 1. When we use 0 as a multiplier we assume that non-respondents are not willing to pay anything. The assumption of a zero willingness to pay for non-respondents can be justified on the objective of keeping the willingness to pay estimate conservative. This extreme solution has been used for example in Bishop and Boyle (1985). If we use the multiplier 0.5 we assume that each non-respondent's willingness to

pay is half of the willingness to pay of a similar respondent and use the multiplier of 0.5. The third assumption is that non-respondents have the same mean willingness to pay as respondents and the multiplier is 1. However, it is possible that using 1 as a multiplier leads to an overestimation of the aggregate willingness to pay (Bateman et al. 2002, 351).

The mean willingness to pay estimates using three different assumptions about non-respondents willingness to pay are calculated using equation (33). The estimates are calculated for the Turnbull estimate and the logit model estimate. The results are collected into Table 8. The mean willingness to pay estimates in Table 8 are the final estimates that are used in calculating the aggregate willingness to pay.

Table 8. The mean willingness to pay estimates based on the different assumptions about non-respondents willingness to pay

Non-respondents willingness to pay	Zero willingness to pay (multiplier = 0)	Half of the willingness to pay of the respondents (multiplier = 0.5)	Same willingness to pay as respondents (multiplier = 1)
Turnbull estimator	27.52 €	55.59 €	83.65 €
Logit model	22.58 €	45.60 €	68.62 €

5.6.2 The aggregate willingness to pay

Now we have obtained the mean willingness to pay estimates that are used in aggregating the willingness to pay for the Finnish population. As there are six different mean willingness to pay estimates, there will be six different estimates of the aggregate willingness to pay. The aggregate willingness to pay can be calculated:

(2) $$Aggregate\ WTP = N * \overline{WTP}_{STR}$$

where N is the number of individuals in the population, $N = 3949551$ and $\overline{WTP}_{STR}$ refers to the mean willingness to pay estimates in Table 8.

We calculate the aggregate willingness to pay both based on the Turnbull estimate and the logit model estimate using the equation (2). Table 9 lists all aggregate willingness to pay estimates. The first column presents the aggregate willingness to pay estimates when non-respondents are assumed to have zero willingness to pay, the second column presents the estimates when non-respondents are assumed to have half of the willingness to pay of the respondents and the third column presents the estimates when non-respondents are assumed to have the same willingness to pay as respondents.

Table 9. Aggregate willingness to pay estimates

Non-respondents	zero WTP	half of the WTP of the respondents	same WTP as respondents
Turnbull estimator	109 million €	220 million €	330 million €
Logit model	89 million €	180 million €	271 million €

Next we calculate the 95 % confidence intervals for the aggregate willingness to pay estimates. The 95 % confidence interval has the 95 % probability of containing the true value of the population aggregate willingness to pay. To calculate the confidence intervals for the aggregate willingness to pay estimates we need the variances of the mean willingness to pay for the two strata. Table 10 presents the 95 % confidence intervals for the Turnbull lower bound estimates.

Table 10. The 95 % confidence intervals for the Turnbull lower bound aggregate willingness to pay estimates

non-respondents WTP	zero WTP	half of the WTP of the respondents	same WTP as respondents
aggregate WTP	109 million €	220 million €	330 million €
95 % confidence interval	19 - 199 million €	130 - 310 million €	240 - 420 million €

Table 11 presents the 95 % confidence intervals for the logit model estimates.

Table 11. The 95 % confidence intervals for the logit model aggregate willingness to pay estimates

non-respondents WTP	zero WTP	half of the WTP of the respondents	same WTP as respondents
aggregate WTP	89 million €	180 million €	271 million €
95 % confidence interval	0 - 199 million €	70 – 290 million €	161 – 381 million €

The most conservative estimate of the aggregate willingness to pay, 89 million euros, is produced by the logit model when non-respondents are assumed to have zero willingness to pay. The Turnbull estimator produces in all higher estimates than the logit model. The

advantage of the Turnbull estimator is that it restricts the willingness to pay to values that are positive or zero. Negative willingness to pay is not correct when public goods, such as ours, are considered. To have negative willingness to pay the provision of the good should reduce the utility of the respondent. The good can, however, be ignored if it does not provide utility (Haab & McConnell 1997, 253). Turnbull estimates are more valid in that sense.

The estimates where non-respondents are assumed to have the same willingness to pay as respondents may be upward biased as those who have more interest in the issue and also a higher value for the good are usually more likely to participate in the survey (Bateman et al. 346). One objective in our survey was to keep the value estimate conservative, and if we assume that non-respondents are willing to pay the same as respondents, the estimate is unlikely to be conservative. The choice of a conservative value estimate is preferred in the contingent valuation literature (see for example Arrow et al. 1993, 4608) and therefore it is better to assume that non-respondents have zero willingness to pay.

Taking these considerations into account, the estimate for the aggregate willingness to pay is obtained with the Turnbull estimator when non-respondents are assumed to have zero willingness to pay might be appropriate. In that case, the aggregate willingness to pay is 109 million euros. However, because the different estimates and the assumptions behind them are available, it is ultimately up to the policymaker to make the decision about the appropriate aggregate willingness to pay.

The 95 % confidence intervals provide the lower and upper bounds for the aggregate willingness to pay estimates. The lower bound for the aggregate willingness to pay is 0 € and the upper bound is 420 million €, depending on the used approach and the assumption about non-respondents willingness to pay.

6 Conclusions

The rapidly increasing amount of oil transport in the Gulf of Finland has lead to a higher risk of oil spills in the area. The improvements in the oil spill response capacity would reduce the harm from future oil spills by making oil combating faster and more effective. The purpose of this study has been to estimate the willingness to pay for improving the oil spill response capacity in the Gulf of Finland. The sample size in the study was 1000 individuals and the number of valid responses 329 (32.9 %).

In the present study the willingness to pay for improving the oil spill response capacity is estimated with the contingent valuation method using both the Turnbull lower bound estimator and the logit model. The mean willingness to pay estimates range from 22.58 € to 83.65 €, depending on the approach and the assumption about non-respondents willingness to pay. The aggregate willingness to pay is calculated for the population that lives in the Finnish mainland. The aggregate willingness to pay varies from 89 million to 330 million euros.

As the difference between the estimates is quite large, it is useful to choose an estimate to represent the value of improving the oil spill response capacity. The chosen estimate is the Turnbull estimate when non-respondents are assumed to have zero willingness to pay. The Turnbull estimate restricts the willingness to pay to positive values, which is appropriate as the good in question is a public good. Adopting the view that non-respondents' willingness to pay is zero keeps the value estimate conservative. With these assumptions, the aggregate willingness to pay is 109 million euros. Due to the very conservative assumption about non-respondents willingness to pay and the conservative design of the study, the estimate represents a low approximation of the value of improving the oil spill response capacity. However, because the different estimates are available and the assumptions behind them are explicitly stated, it is ultimately up to the policymaker to make the decision about the appropriate aggregate willingness to pay.

The logit model shows the factors that have an effect on respondents' willingness to pay responses. The probability of accepting the bid amount increases with income and with the effectiveness of the proposed program to improve the oil spill response capacity. The probability of accepting the bid is also higher if the respondent thinks it is very important to use tax money to combat oil spills and if the respondent lives in the coast of Gulf of Finland. As the offered bid increases, the probability of answering *yes* decreases. The effects of the variables are statistically significant in determining the willingness to pay answers and they conform to the theoretical and empirical expectations, which is important for the validity of the results.

The results can be utilized in determining the future development in the oil spill response capacity in Finland. Based on the results it seems that protecting the nature and ecosystems is more important to the Finns than the recreational use of the coast and the sea area. This may give useful information to the authorities in deciding how and where the available oil spill response equipment should be used if an oil spill happens. If there is not enough equipment to protect all areas, as is the situation now in Finland, it might be reasonable to allocate the oil spill response equipment to protect the environmentally vulnerable areas instead of recreationally important ones. The higher importance of nature should be taken into account when acquiring new oil spill response equipment, as the protection of nature might need different equipment than the protection of recreational areas.

This study has been made by following most of the generally accepted guidelines and practices in conducting a contingent valuation study. An exception to the guidelines is the use of a mail survey instead of the recommended in-person interviews (Arrow et al. 1993, 4608). Although in-person interviews are recommended, in practise it is common to implement contingent valuation studies using mail surveys. In addition, if the number of valid responses to the survey would have been higher, it would have increased the reliability of the willingness to pay estimates.

The total values based on the aggregate willingness to pay estimates are likely to be underestimations of the true value of the good. There are two reasons for this. As it was

noted in chapter 2, the willingness to pay format is used in place of the theoretically more appropriate willingness to accept because of the problems associated with willingness to accept. The use of willingness to pay results in much smaller value estimates and the value of the good is likely to be underestimated. Another reason for the underestimation is that only the Finnish population is included in the sample frame. When the oil spill response capacity is increased in Finland it affects the oil combating in the entire Gulf of Finland and also the people in Estonia and Russia benefit from it. To estimate the total benefits of increasing the oil spill response capacity it would be useful to conduct similar studies in those countries as well.

An interesting topic for further studies would be the value of improving the oil spill response capacity with another valuation method, such as choice experiment. The choice experiment could be used to estimate the value of different attributes of the good and thus it would provide additional information of the values associated with improving the oil spill response capacity.

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