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Abstract
One of the most serious threats to the Baltic Sea and its ecosystem services is human-induced eutrophication. European Union legislation, in the form of the Marine Strategy and Water Framework Directives, requires information on the benefits of improving the condition of the sea to a good environmental status. Our study uses a unique dataset collected from all nine littoral countries of the Baltic Sea, in combination with state-of-the-art marine modelling of the area, to estimate the benefits of reducing eutrophication in the Baltic Sea. We find average willingness to pay (WTP) for decreased eutrophication to differ substantially by country, but also that there is a general acceptance to pay more to improve the status of the whole sea area. We estimate the aggregate WTP for an improvement in the eutrophication level following the HELCOM Baltic Sea Action Plan (BSAP) to be 4000 million Euros annually. Our results provide, however, a strong message to the decision makers about the need for ensuring fulfilment of the policy targets in the BSAP. Failure to fulfil the targets would imply foregoing substantial societal benefits.

Key words: the Baltic Sea, contingent valuation, eutrophication, willingness to pay

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1. Introduction

The Baltic Sea in Northern Europe is one of the world's largest semi-enclosed bodies of brackish water (HELCOM 2010). Nine countries surround the sea: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden, and the adult population in these countries reaches over 230 million people. The sea provides valuable ecosystem services, such as food, recreation and climate regulation. The value of the sea to the inhabitants of the nine Baltic Sea littoral countries is reflected by the fact that during the summer months, the average citizen in these countries spends leisure time by the sea on 10-35 days (SEPA 2010). However, the condition of the Baltic Sea is alarmingly poor. SEPA (2008a) finds that only 10 out of 24 marine ecosystem services are considered to have a good status, and HELCOM (2010) concludes that none of the seven Baltic Sea regions have good ecosystem health conditions, based on the holistic assessment of the ecosystem health (HOLAS). Future provision of ecosystem services is threatened by various pressures, including overfishing, alien invasive species, effluents of hazardous substances, physical disturbances, and effluents of nutrients (phosphorus and nitrogen) which cause eutrophication.

The focus of this study is eutrophication, which is viewed as one of the most prominent threats to the Baltic Sea (HELCOM 2009). The Baltic Sea is particularly sensitive to nutrient loads due to limited water exchange, while the effluent loads are high arising primarily from agriculture, sewage and other anthropogenic sources. Most areas of the Baltic Sea are affected by eutrophication, some areas even heavily (HELCOM 2009, 2010). Visible effects of eutrophication on the marine environment are, for example, decreased water transparency, decrease of bladder wrack stands (*Fucus vesiculosus*) (Kautsky et al. 1986), heavy growth of filamentous macro algae, oxygen deficiency in sea bottoms and blooms of blue-green algae (i.e. cyanobacteria) (Pihl et al. 1996; Sundbäck et al. 1996). These effects accumulate over time and affect the functioning of the entire marine ecosystem.

In order to meet the challenges arising from the anthropogenic pressures such as high nutrient loads, there are several governing frameworks have been put in place. At the European Union level, the Water Framework Directive (WFD; European Parliament 2000) and the Marine Strategy Framework Directive (MSFD; European Parliament 2008) are the most important legislative tools that aim to deliver a 'good environmental status' (GES) in coastal and open-sea waters as an overall target. On the regional level, the HELCOM Baltic Sea Action Plan (BSAP; HELCOM 2007) is the most prominent initiative, in which the littoral Baltic states have agreed on, among other targets, producing a Baltic Sea which is unaffected by eutrophication in 2021. In order to fulfil this objective, nutrient reduction targets for each country have been specified by joint negotiations.

Fulfilment of the nutrient reduction targets is bound to be costly. However, this is not a sufficient argument for inaction. It is equally important to consider the benefits that would arise from taking action (i.e. the potential 'costs of inaction'). The need for assessing benefits of environmental improvement measures is highlighted in the WFD and the MSFD. The latter requires an analysis of the 'cost of degradation' (European Commission 2010), i.e. the cost of not taking sufficient action (European Commission 2011). Further, the MSFD requires cost-benefit analyses of policy measures which aim to achieve a good environmental status.

Knowledge on the benefits of reducing the emission of nutrients to the Baltic is valuable in at least three respects:

- It provides guidance in determining the economically optimal level of nutrient abatement measures.
- It provides information regarding the distributional effects of eutrophication and improved water quality.
- It provides information on the scale of social value at stake if the abatement measures undertaken are insufficient to deliver policy objectives.

SEPA's literature review (2008b) of previous valuation studies estimating the benefits of an improved environmental condition in the Baltic Sea concluded that most existing studies are local case studies, which are difficult to link to current policy targets for various reasons. An often cited earlier large-scale study is the Baltic Drainage Basin Project (BDBP), which is reported in e.g. Söderqvist (1996), Gren et al. (1997), Turner et al. (1999) and Markowska & Zylicz (1999). The study was based on Lithuanian, Polish and Swedish contingent valuation (CV) surveys, which assessed public willingness to pay (WTP) for a 50% reduction in nutrient loads to the Baltic Sea. A WTP figure for the whole population around the Baltic Sea was estimated from BDBP results using benefit transfer (BT). The BDBP study indicated that a healthy Baltic Sea is a valuable asset – aggregate WTP was estimated to be 5 billion Euros per year[1]. While the BDBP provided important information, it also underscored two valuable lessons:

- WTP estimates are difficult to transfer between countries, especially if the countries are highly heterogeneous in income levels. This is also a conclusion from Ready & Navrud (2006), Bateman et al. (2011) and Czajkowski & Ščasný (2010).
- New studies should include a clear quantitative link between the benefit estimates and the Baltic environmental status predicted by an ecological model. The BDBP study did not provide such a link, which makes it hard to use the results in a cost-benefit analysis. SEPA (2008b) states:
  "Methodologically, voices are raised about the importance of connecting the economic measures to specific and scientifically measurable ecological conditions, in order to know more precisely what is valued. Valuation should be used as a tool for making priorities between different political targets, and this connection is crucial for having the results usable."

In this paper, we present the results from a unique large-scale CV study on the benefits of reducing eutrophication in the Baltic Sea, conducted simultaneously in all nine Baltic littoral countries in 2011. Based on approximately 10500 responses to identical questionnaires, we examine respondents' willingness to pay (WTP) for two scenarios related to reaching the BSAP nutrient reduction targets. To the best of our knowledge, this is the first CV study ever to cover all of these nine countries, and is the largest international CV study to consider the marine environment.

This paper contributes to the literature by presenting a valuation study that was performed in all the littoral countries of the Baltic Sea. Thus, there is no requirement to rely on benefit transfer to produce social WTP estimates. Further, we explicitly account for the expected environmental state of the Baltic Sea under various scenarios following proposed nutrient abatement measures to properly inform respondent about the environmental 'good' to be valued. This is achieved by combining dynamic marine models, assumptions about the future development of the key economic sectors in the Baltic Sea catchment, and information on present nutrient loads and the current state of the sea. The overall aim is to produce WTP results that can be compared with the costs of specific scenarios of reducing eutrophication.

The paper is organized as follows: In Section 2, we present the background, including the development of scenarios, the ecological model, the design of the questionnaire, and the choice of methods for WTP estimation. In Section 3 we present our results in terms of descriptive statistics and WTP estimates. Finally, in Section 4, we discuss our findings. Detailed background information, such as the full questionnaire and the pretesting procedure is found in appendices.

[1] The estimates vary between the studies mainly because of the aggregation methodologies chosen. The figure presented is in 2005 prices and is based on an update of the results to present-day conditions, performed in SEPA (2008b).

2. Survey and methods

The data originates from an international CV study conducted in all nine Baltic Sea countries in 2011. Identical questionnaires, translated into national languages, were employed to collect the data. The survey was designed via international cooperation during 2010-2011. Significant effort was made to ensure that the questionnaire was equally relevant and accurate in all nine countries, in terms of describing the effects of eutrophication and providing information of the elements of the valuation scenario. We followed the tailored design method (Dillman et al. 2009) closely in the design and implementation procedures of the survey.[2] In Appendix A, we describe the thorough pre-testing procedure that was undertaken.

To collect the data, we used internet panels in Denmark, Estonia, Finland, Germany and Sweden, and face-to-face interviews in Latvia, Lithuania and Russia. In Poland, we employed both face-to-face interviews and an internet panel. Table 1 summarizes the survey modes, age-intervals of the sampled individuals and the survey company used in each country.

Table 1. Survey mode, age of sampled individuals and contractor for each country.

Country	Survey mode	Age of sampled individuals	Contractor
Denmark	Internet panel	18-74	Analyse Danmark
Estonia	Internet panel	15-74	Turu-uuringute AS
Finland	Internet panel	18-74	Taloustutkimus Oy
Germany	Internet panel	18-70	LINK Institut für Markt- und Sozialforschung GmbH
Latvia	Face-to-face interviews	18-74	DATA SERVISS Ltd.
Lithuania	Face-to-face interviews	15-74	Europos tyrimai
Poland	Face-to-face interviews, internet panel	20-60	MillwardBrown SMG/KRC
Russia	Face-to-face interviews	18-85	The Fund for Regional Problems Investigation
Sweden	Internet panel	18+	Norstat Sverige AB

The questionnaire consisted of six sections. The first provided a description of the Baltic Sea, the second contained questions about leisure time spent at the sea, and the third provided a description of, and questions regarding, eutrophication. The fourth section presented the valuation scenario and the willingness to pay questions, while the fifth posed debriefing questions regarding response certainty and motivation for willingness to pay. The final section included questions regarding respondents' socio-economic background. The full questionnaire is shown Appendix C. In Section 2.1, we describe the ecological basis for the eutrophication scenarios used in the survey; in section 2.2, we present the elements of the valuation scenarios; and in section 2.3, we describe the econometric methods for WTP estimation.

2.1 Ecological modelling and the portrayal of eutrophication

The core question in the questionnaire concerned respondents' WTP for reduced eutrophication, and, as a consequence, improved water quality of the Baltic Sea. The reduction in eutrophication was demonstrated to respondents using eutrophication-level maps which described the predicted condition of the Baltic Sea in the year 2050. Two maps were presented for comparison: (1) a map describing the baseline scenario for eutrophication based on the present nutrient load reduction efforts, and (2) another map illustrating a scenario in which additional measures for reducing nutrient loads in the Baltic Sea had been implemented (see Figures 1 and 2). These additional abatement measures included improving the capacity of waste water treatment and adjustments in the agricultural sector, for example, reducing the use of fertilizers. Marine model simulations (Ahlvik et al. 2012) suggested that the full benefits of investment in nutrient abatement are realized only after 40 years, and thus the year 2050 was selected as the base year for the

[2] I.e. we used careful pre-testing to evaluate the questionnaire, made an effort to ensure a logical question ordering and grouped related questions together, and sent multiple contacts to the potential web survey respondents and varied the content of the contacts to increase their effectiveness.

comparative scenarios. Our rationale for developing the maps were to a) achieve a description which was appropriate for the entire Baltic Sea region, b) depict clear and easily understandable differences between the different levels of eutrophication, and c) use vocabulary which would be easily understood by population groups throughout the region.

To create the eutrophication scenarios and the maps, we used exogenously given projections on nutrient loads and marine model simulations. As the first step, a dynamic marine model by Ahlvik et al. (2012) was used for projecting the state of the Baltic Sea over the 40 years time horizon 2010 - 2050. This model describes the exchange of water and nutrients across the seven basins of the Baltic Sea, and projects the development of nutrient concentrations as a consequence of the current state and exogenously given load projections. The second step was to use more detailed biogeochemical models to translate the predicted nutrient concentrations from the basin-level marine model into phytoplankton biomass and other attributes of water quality at a spatially detailed level. Two biogeochemical models were used: the EIA-SYKE 3D model (Virtanen et al. 1986, Koponen et al. 1992, Kiirikki et al. 2001, 2006) and the DMI-BSHcmod - Ecological Regional Ocean Model (ERGOM) (Maar et al. 2011; Neumann 2000; Neumann et al. 2002; Neumann and Schernewski 2008).

The third step in preparing the eutrophication maps was to aggregate the multidimensional outputs describing the state of the Baltic Sea into a single indicator value, the average Ecological Quality Ratio (EQR). This indicator describes the present status in relation to the agreed reference condition for a particular eutrophication indicator (Andersen et al. 2010). In this study, the Ecological Quality Ratio was derived from three core eutrophication indicators, chlorophyll *a*, phosphate-phosphorus and nitrate-nitrogen concentrations and it was categorized according to the HELCOM classification into High, Good, Moderate, Poor or Bad water quality (Andersen et al. 2010). Each of the five eutrophication levels was assigned a color for mapping and was further described in terms of five separate ecosystem characteristics: water clarity, blue-green algal blooms, underwater meadows, fish species and oxygen conditions in deep sea bottoms (see Appendix B). The description of the changes in eutrophication used in the valuation study was generalized and approximated from the detailed description (see questionnaire in Appendix C). The details concerning the 3D-models and indicators can be found in Dahlbo et al. (2012).

The fourth and the final step in preparing the eutrophication maps was to repeat steps 1-3 for a baseline load scenario and two alternative policy scenarios. The baseline load projection was based on existing information about the present water protection infrastructure in different Baltic Sea countries, population and urbanization forecasts, and model projections for the agricultural sector and existing policies (see Ahlvik et al. 2012 for details). The two alternative policy scenarios were constructed based on the projected decrease of the nutrient load as a result of measures carried out within the on-going Baltic Sea Action Plan (BSAP; HELCOM 2007). One scenario was based on the full implementation of the BSAP load reduction targets (the "BSAP" scenario) and the other was based on a less ambitious load reduction target in which 50% of the BSAP targets are achieved (the "½BSAP" scenario). Estimating the benefits of the full implementation of the nutrient load reduction targets in the BSAP scenario allows us to link the results directly to the plan. Including the ½BSAP scenario provides information on marginal WTP and allows the opportunity to interpolate the benefits associated with intermediate levels of eutrophication.

2.2 Valuation scenario

The valuation scenario was carefully formulated based on feedback from the pre-testing phase. We presented the change in eutrophication visually on maps to the respondents, using the water quality colour scale, where each colour was characterised by the previously described ecosystem characteristics). The description also included information on possible measures to reduce eutrophication, specification of the payment vehicle, and a statement clarifying who will have to pay to secure the environmental improvement. Prior to the valuation question, respondents were asked to identify the two social issues which they perceived to be most important in their home country; the purpose being to remind them that environmental problems in the Baltic Sea constitute only one among many potentially important social issues. Finally, respondents were also asked to note that – if they agreed to pay – they would have to pay every year for the rest of their lives and this would therefore leave less money to spend on other things, and were also reminded that the eutrophication reduction program would not ameliorate other environmental problems in the Baltic Sea, and that they had the possibility of using alternative water bodies for water recreation (see e.g. Bateman et al. 2002).

The payment vehicle used was a special Baltic Sea tax, stated to be collected from each individual and firm in all Baltic Sea countries, and ear-marked specifically for reducing Baltic eutrophication. Previous study results indicated that ear-marked payments were, in general, preferred by the citizens of the nine Baltic Sea countries in funding actions concerning the sea (Söderqvist et al. 2010), and the tax was deemed both credible and acceptable based on pre-testing.

The WTP question comprised two separate stages: first - and prior to the actual presentation of the scenarios and maps - the respondent was asked whether s/he would in principle be willing to pay for reducing eutrophication in the Baltic Sea (this type of question is referred to as a *spike question*). If the answer was *yes* or *don't know*, then the respondent was presented with the maps comparing the two policy scenarios with the baseline scenario, together with their associated WTP questions. If the answer to the spike question was *no,* the respondent was directed straight to debriefing questions regarding motives for unwillingness to pay.

Each questionnaire included two alternative nutrient reduction programs based on the ½BSAP and BSAP scenarios, which differed in the extent of improvements in Baltic condition as a consequence of different efforts being undertaken to reduce eutrophication (see Figures 1 and 2). In both cases, the respondent was requested to compare the eutrophication status under the baseline scenario in 2050 with eutrophication status under the ½BSAP and BSAP policy scenarios. The order of presentation of the two policy scenarios was randomized to examine possible order effects[3].

The elicitation format was a payment card, constructed using the approach outlined in Rowe et al. (1996). The payment card was a 4 x 5 matrix, with 18 positive bids, a zero bid and the option to choose *don't know*[4]. Monetary amounts presented on the card were country-specific, chosen based on the results of the pilot studies. The WTP question was formulated as follows: "What is the most you would be willing to pay every year to reduce eutrophication in the Baltic Sea as shown in the maps? Please consider your disposable income carefully before answering the question."

[3] The scenario order was not changed in the Danish survey where the order of presentation of the scenarios was: ½BSAP first, BSAP second. Other studies (e.g.Bateman et al. 2011, Hasler et al. 2011) have shown order effects and we assume that these effects might be present in this study as well. Our results do not portray this bias to exist in most cases, e.g. Finland and Sweden that are culturally comparable to Denmark have no order effect bias. See section *3.4 Determinants of willingness to pay* for the results.

[4] In the Russian survey, a 4 x 4 bid matrix was employed due to technical problems. The second column, including low-to-mid range of bids was lost, and thus the WTP figures for Russia have a larger interval between the low values and higher values in the bid vector than originally intended.

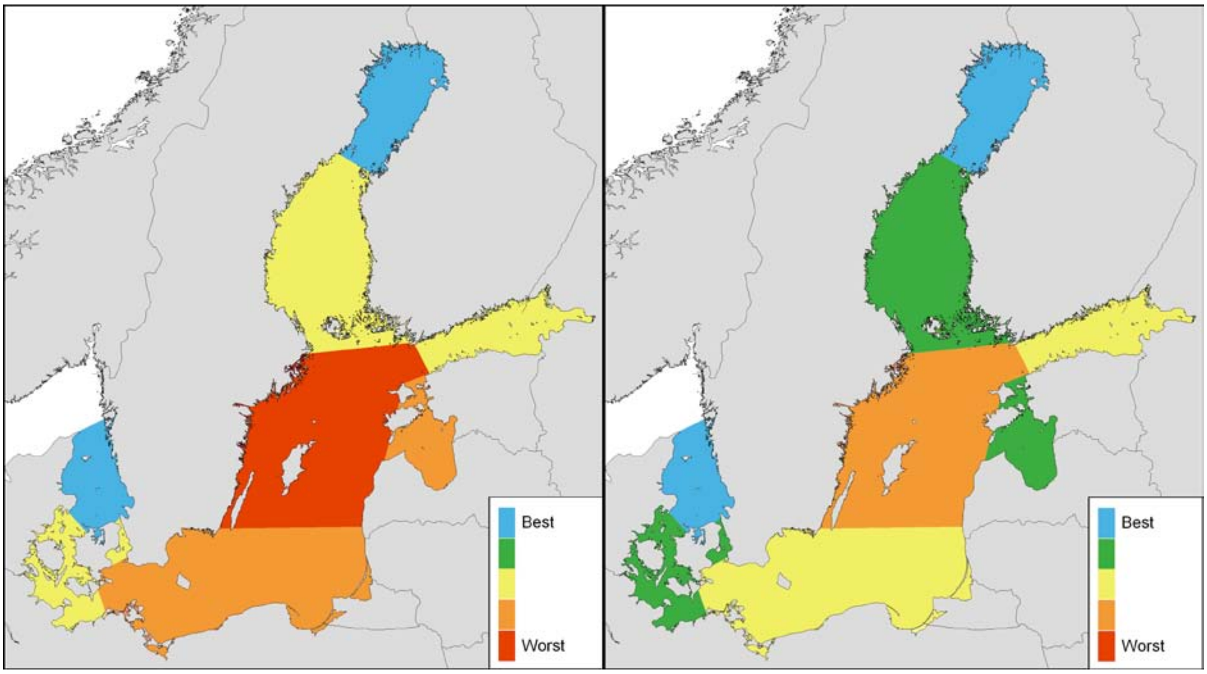

Figure 1. Maps of Baseline scenario (left map) versus ½BSAP scenario (right map) in 2050 as presented in the survey

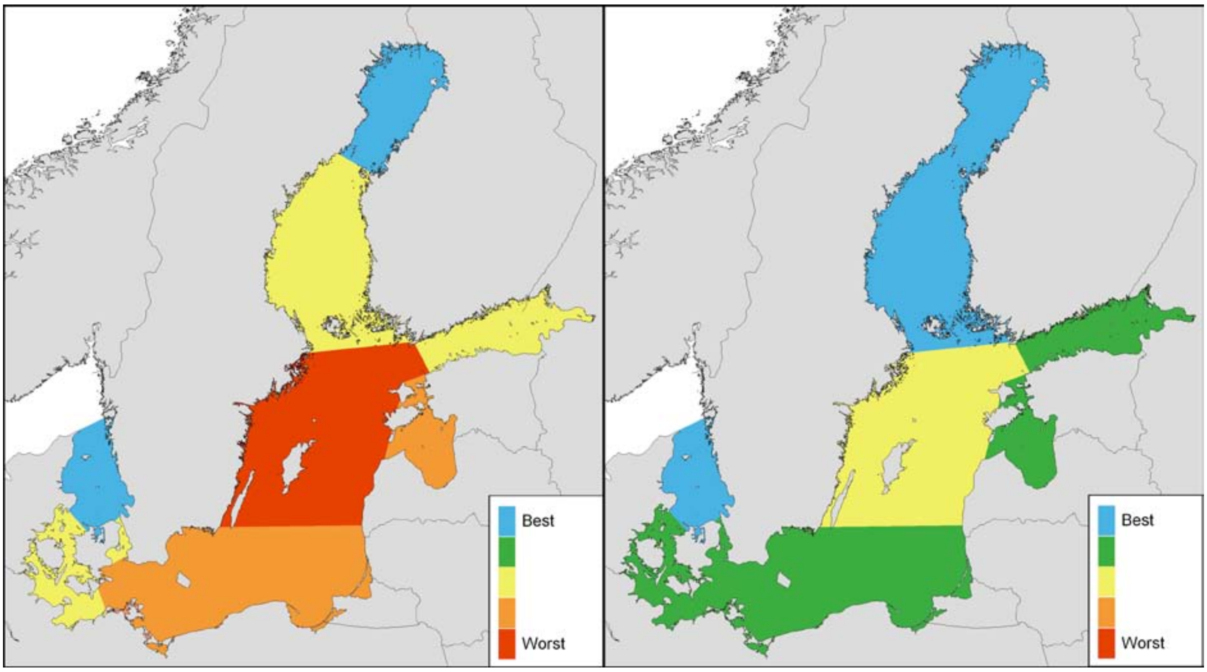

Figure 2. Maps of Baseline scenario (left map) versus BSAP scenario (right map) in 2050 as presented in the survey

2.3 Econometric approach

As the first step, we estimated a binary logit model with individual-specific demographic, attitudinal and behavioural variables, which predicts the probability of a respondent being willing to pay in principle (Greene 2007, Greene & Hensher 2010). This allowed us to identify factors associated with the tendency of being willing to pay. The dependent variable was binary, indicating whether the respondent was willing to pay (value=1) or not (value=0). Respondents were considered to be willing to pay if they *i) stated a positive willingness to pay in the payment card, regardless of whether they said "yes" or "don't know" to the spike question (i.e. in the market for improvements)*, and *ii) said "yes" to the spike question but chose zero in the payment card*. The respondents in ii) were assumed to be willing to pay something between zero and the lowest positive bid mentioned in the payment card. We assumed zero willingness to pay for those who *i) stated not willing to pay in the spike question*, *ii) were unsure in the spike question and chose a zero bid in the payment card*, and *iii) were completely unsure about their willingness to pay, i.e. stated "don't know" both to the spike question and the payment card.* While our assumptions are straightforward, they are conservative as respondents in the third category may include people who would be willing to pay something.

Next we employed two approaches to estimate the mean and median willingness to pay for each country: the interval regression model (Cameron and Huppert 1989) and the spike model (Kriström 1997). The purpose of using these two approaches was to compare the results and to see whether the WTP results are robust to the chosen approach.

The interval regression model is a generalization of the Tobit-model. In the model, the true willingness-to-pay is assumed to lie in the interval between the reported bid, i.e. the lower bound L, and the next highest bid in the payment card, i.e. the upper bound U (see Cameron & Huppert 1989). The intervals at the extremes of the payment card are subject to assumptions. The lower bound can, for example, be set to minus infinity if negative willingness to pay is deemed possible. In our application, the respondents were screened for being in the market prior to the valuation question, and the value for the good was assumed to be non-negative, and thus the lower bound of the lowest interval for the WTP was strictly zero. The upper bound is also a subject to assumptions, as the highest category is unbounded in the payment card. We took a conservative view on the highest category, combining it with the second highest category, and specifying the upper bound for the highest WTP interval as the highest bid added with one unit of national currency. Following the approach of Cameron & Huppert (1989) and Lindhjem & Navrud (2011), the WTP estimates were log-transformed to account for the naturally skewed distribution of WTP figures toward lower values.

Formally, the model is specified as follows:

$$\begin{aligned} &y^* = x\beta + \varepsilon, \varepsilon \sim N[0, \sigma^2 I] \\ &y = j \; if \;\; A(j-1) \leq y^* \leq A(j) \\ &j = 1, \dots, J, A(0) = 0, A(J) = highest \; bid + one \; unit \; of \; currency. \end{aligned} \tag{1}$$

Here, L_i and U_i denote the lower and upper bounds of the interval. If y_i equals 1, $L_i = 0$ and U_i is A(1), which is the first (positive) bid in the payment card.

The log-likelihood function for the model can be written as:

$$\ln L = \sum_{(\, i=1,N)} \{\ln \left[\Phi\left(\frac{U_i - x\beta}{\sigma}\right) - \Phi\left(\frac{L_i - x\beta}{\sigma}\right)\right]\}, \tag{2}$$

where Φ is the standard normal cumulative density function.

Once the optimized β and σ have been attained, the conditional mean of y* for any given vector of variables will be βx. Since we use a lognormal conditional distribution for valuations, the mean WTP is $\exp(\beta x + \sigma^2/2)$ and the median is exp(βx) (Cameron & Huppert 1989).

The interval regression model was estimated only for those respondents whose WTP was positive. To estimate the mean and median WTP, the interval regressions were run without covariates and bootstrapped using 500 repetitions to obtain the 95% confidence intervals for the WTP.

In the spike model, each respondent's mean WTP is modelled directly, i.e. there is no censoring for only those who have positive WTP. Instead, the distribution of WTP is assumed to have a jump-discontinuity (spike) in the probability density function at WTP=0.

The spike model incorporates a binary variable reflecting market participation ($S = 1$, $S = 0$ otherwise) and a variable expressing the interval of respondent's willingness to pay. The payment card allows us to infer the lower and upper bound of each respondent's WTP, provided that the respondent is 'in-the-market'. Denoting these respondents' cumulative distribution function of WTP as G, the probability of selecting a bid t_k on a payment card (provided a respondent is in-the-market) can be expressed as:

$$\Pr\left(t_i^k\right) = G\left(t_i^{k+1}\right) - G\left(t_i^k\right), \tag{3}$$

and the overall cumulative distribution function of WTP of all respondents (denoted F), becomes:

$$F(t) = \begin{cases} 0\, for\ t < 0 \\ p\, for\ t = 0 \\ G(t) for\ t > 0 \end{cases}. \tag{4}$$

Combining these together, the log-likelihood function of observing the particular set of choices of N individuals in the sample is given by Eq. (5). Maximizing this function results in the estimation of the parameters of the WTP distribution.

$$\log L = \sum_{i=1}^{N} S_i \sum_{t_k=0}^{t_k=K} Y_i^{t_k} \ln\left(F(t_{k+1}) - F(t_k)\right) + \sum_{i=1}^{N} (1 - S_i) \ln\left(F(0)\right). \tag{5}$$

As a result, the spike model becomes a form of the interval regression model, in which respondents who are not willing to pay anything (not being in-the-market) are modelled together with respondents whose WTP is greater than zero. The WTP distribution assumed by the modeller (e.g. normal, log-normal, Weibull) is thus allowed to have a jump-discontinuity (spike) in the probability density function at WTP=0, and it is then fitted to the entire population.

The final stage of our analysis was to identify the factors determining the WTP in each country, where we employed the interval regression model.

Two other important methodological challenges remain: the treatment of protest responses and response uncertainty. In general, protest responses are defined as the responses of persons who do not state their true WTP value due to objecting some component of the survey. These objections may be directed towards the payment vehicle, distrust regarding the money being used to the purpose stated in the survey (Meyerhoff and Liebe 2010, Morrison et al. 2003, Jorgensen and Syme 2000) or more general opposition to the survey set-up. In this study, respondents who expressed zero WTP were presented with debriefing questions (see Appendix C for the statements used) about their motives for not being willing to pay. In our present analysis protest responses were not excluded. The decision not to exclude these protest answers presumably produces a conservative estimate of the WTP, as it is expected that the protesters also include people who might value the changes positively, although they have stated a zero willingness to pay.

Following each valuation scenario respondents were asked to specify on a ten-point scale[5] how certain/uncertain they were about their stated WTP. This information was used as an explanatory variable in the modelling of WTP. Concerning respondents' uncertainty about their stated WTP, several studies have found that this varies significantly between respondents (Martínez-Espiñeira and Lyssenko 2012). Findings from earlier experiments indicate that monitoring the response uncertainty can help to calibrate WTP estimates and bring them closer to the true willingness to pay (Morrison and Brown 2009). In our study we collected this information to understand, in general, how certain people are concerning their stated WTP in the Baltic littoral countries, and to see whether the degree of certainty affects WTP.

[5] A seven-point scale was used in Denmark instead, which was transferred to a ten-point scale to make the results comparable to other countries.

3. Results

This section summarizes the main results of the survey. Section 3.1 presents descriptive statistics for the sample, Section 3.2 presents the results related to the attitudes and recreational use of the Baltic Sea, and Section 3.3 presents the WTP results.

3.1 Descriptive statistics for the sample

In total, 10564 interviews were conducted through face-to-face or internet panel. The smallest country-specific sample was 505 (Estonia) and the largest 2029 (Poland). As shown in Table 2, in countries where an internet survey was used, the response rate was generally lower (e.g. 32.5% in Germany and 34.0% in Sweden) than in countries where the survey was carried out using face-to-face interviews (e.g. 60.5% in Lithuania and 69.3% in Russia). In all countries except Russia, the sample was drawn from the entire population. In Russia, two samples were constructed separately: one for the Baltic coastal regions and another for the rest of the country.[6]

Table 2 also shows selected socio-demographic data for the sample: mean age, percentage of women among the respondents, mean household size, and percentage of respondents who have a high level of education and a high [low] income (defined in most cases as the highest [lowest] quintile of the relevant population).

The samples collected in each country exhibited similar properties in terms of representativeness. Generally, respondents were characterized by larger households, higher income and higher education levels compared to the relevant national population. As our analysis uses unweighted data, aggregation of the results is not straightforward. Based on the relatively large sample sizes from each country, and taking the socio-demographic factors into account in the modelling, it is, however, possible to assess if biases in sample representativeness are likely to have severe effects on results. We return to this issue in Section 3.5.

Table 2. Socio-demographic data for the survey samples by country. Corresponding figure for relevant population in parenthesis, where applicable.

Country	Sample size	Response rate (%)	Mean age	Female (%)	Household size	Higher Education (%)	High income (%)	Low income (%)
Denmark	1061	38.2	49.87 (45.9)	43.26 (50.3)	2.24 (2.14)	47.97 (25.0)	15.08 (13.9)	15.74 (27.5)
Estonia	505	42.1	38.36 (43.5)	49.90 (53.1)	2.89 (2.2)	54.46 (30.7)	21.19 (20)	13.66 (20)
Finland	1645	39.4	50.65 (45.4)	48.51 (50.9)	2.26 (2.1)	32.40 (28.7)	14.04 (10)	23.04 (30)
Germany	1495	32.5	41.96 (42.6)	49.9 (51.0)	2.51 (2.1)	39.46 (25.0)	23.79 (28.6)	26.42 (12.0)
Latvia	701	45.0	43.73 (44.5)	54.64 (53.0)	2.84 (2.5)	24.54 (23.0)	15.12 (20)	22.53 (20)
Lithuania	617	60.5	42.53 (42.3)	49.27 (53.5)	2.77 (2.5)	22.37 (24.3)	15.56 (20)	16.53 (20)
Poland	2029	n/a (36)*	39.45 (38.5)	49.73 (51.0)	3.32 (2.6)	32.13 (18.3)	9.27 (40)	40.71 (20)
Russia	1508	69.3	44.43 (39.0)	54.83 (54.0)	2.97 (2.6)	44.03 (22.8)	13.02 (22.7)	14.60 (18.9)
Sweden	1003	34.0	53.63 (41.1)	53.84 (50.2)	2.20 (2.0)	50.34 (33)	29.21 (20)	11.07 (20)

*n/a for face-to-face interviews, 36 for internet panel

[6] The coastal part included Leningrad Region, Saint Petersburg and Kaliningrad Region, and the other parts were represented by Khabarovsk Region, Novosibirsk Region, Samara Region, Stavropol Region, Sverdlovsk Region, Rostov Region and Voronezh Region.

3.2 Attitudes and recreation in the Baltic Sea area

In addition to the valuation scenario and the WTP elicitation, the questionnaire also included questions on people's attitudes towards the Baltic Sea and recreation in the area. The respondents were asked to indicate whether or not they agree with statements concerning the Baltic Sea environment and its protection, with 5 meaning they agreed totally and 1 meaning they disagreed totally with the statement. Table 3 reports the mean values for these attitudinal responses. Concern about the Baltic Sea environment is strongest in Sweden, Lithuania, Estonia and Finland, where people also acknowledge their individual responsibility of the issue. In Germany people seem to worry less compared to other countries. Swedish respondents agree most strongly that Baltic Sea environmental problems are amongst the most important environmental problems that the country faces, and also feel individually more responsible compared to other countries. In Germany, Russia and Denmark people are more indifferent.

Table 4 shows the activities in which the respondents usually engage when visiting the Baltic Sea. Respondents had the opportunity to tick more than one leisure activity when answering this question. The table thus accounts for multiple responses. The last row of the table reports how often an activity was chosen, and the last column gives the total number of respondents who had participated in at least one activity by country. Each respondent ticked around two activities on average, where being at the beach was the most popular recreation activity (84.9% participation on average), followed by swimming (60.1% participation on average). The popularity of different types of recreation activities is quite uniform across countries, but few exceptions can be observed. People in Germany, Latvia, Lithuania and Poland participated in fishing less than the residents of other countries on average. Beach recreation was most popular Lithuania and Poland, with around 95% participation rate. Swimming in the Baltic Sea was, surprisingly, least participated in Denmark and Finland in comparison to other countries. More Swedes, Finns, Estonians and Danes appear to also boat on the Baltic Sea than others. Baltic Sea cruises were especially popular in Finland – over two thirds of Finnish respondents had cruised on the Baltic Sea. More Swedes (38.5%) have also participated to such cruises much more often than other countries on average (25.0%).

It should be noted that, in total, 14% of the respondents have never been to the Baltic Sea or its coast to spend leisure time here and 15% have not been there in the last 5 years. The largest shares of such respondents are from Russia (53%) and Germany (47%), the lowest from Sweden (6%) and Estonia (9%).

Table 3. Attitudes towards the Baltic Sea environment (mean values) (N=10518)

Country	I am worried about the Baltic Sea environment	Baltic Sea environmental problems belong to the three most important environmental problems	I can myself play a role in improving the Baltic Sea environment	The protection of the Baltic Sea requires an international agreement	The environmental degradation of the Baltic Sea has been exaggerated	It is my duty to get involved in protecting the Baltic Sea
Denmark	3.81	3.50	3.08	4.22	2.52	3.31
Estonia	4.29	3.97	3.29	4.51	2.45	3.54
Finland	4.14	4.02	3.21	4.56	2.16	3.76
Germany	3.49	2.99	2.91	4.26	2.42	3.24
Latvia	3.78	3.74	2.91	4.44	2.62	3.16
Lithuania	4.35	3.96	2.94	4.59	2.56	3.84
Poland	3.67	3.63	3.41	4.41	2.56	3.33
Russia	3.74	3.46	2.79	4.33	2.49	2.83
Sweden	4.41	4.29	3.69	4.74	2.09	3.73
Overall	3.89	3.67	3.15	4.43	2.42	3.62

Response scale: 1: I totally disagree, 2: I disagree rather than agree, 3: I neither agree or disagree, 4: I agree rather than disagree, 5: I totally agree

Table 4. Participation rates to leisure activities at the Baltic Sea (frequency of answers followed by the row percentage) (N=9027)

	Swimming	Fishing	Boating	Being at the beach	Water sports	On a cruise	Other	Cases
Denmark	396 38.6%	167 16.3%	198 19.3%	851 83.0%	25 2.4%	31 3.0%	102 10.0%	1025
Estonia	390 81.6%	89 18.6%	108 22.6%	432 90.4%	25 5.2%	124 25.9%	10 2.1%	478
Finland	563 40.3%	241 17.3%	369 26.4%	912 65.3%	28 2.0%	863 61.8%	65 4.7%	1397
Germany	728 58.6%	33 2.7%	171 13.8%	1115 89.8%	46 3.7%	305 24.6%	133 10.7%	1242
Latvia	451 68.2%	47 7.1%	46 7.0%	591 89.1%	21 3.2%	34 5.1%	32 4.8%	661
Lithuania	511 90.9%	43 7.7%	56 10.0%	535 95.2%	37 6.6%	13 2.3%	6 1.1%	562
Poland	1279 71.4%	84 4.7%	114 6.4%	1700 94.9%	113 6.3%	443 24.7%	49 2.7%	1791
Russia	438 49.0%	154 17.2%	84 9.4%	779 87.2%	14 1.6%	60 6.7%	36 4.0%	893
Sweden	668 67.6%	215 21.8%	270 27.3%	748 75.7%	29 2.9%	380 38.5%	78 7.9%	988
Total	5424 60.1%	1073 11.9%	1416 15.7%	7663 84.9%	338 3.7%	2253 25.0%	511 5.7%	9027

The respondents' perception of to what extent other water bodies were seen as substitutes to the Baltic Sea differs widely from country to country. In Finland, Latvia and Lithuania, approximately 30% of the respondents stated that the recreational experience they have at the Baltic Sea cannot be found elsewhere. In contrast, in Denmark, Germany, Poland and Russia, around 90% of the respondents felt they could have a similar recreational experience at some other water area, and in Estonia all respondents could think of a substitute for the Baltic Sea. For Denmark and Germany this could be explained by the fact that they have coastlines on the North Sea as well.

We also posed a series of questions to determine whether the respondents had heard of the consequences of eutrophication in the Baltic Sea. Table 5 shows a large variation between countries with respect to this familiarity. Generally, most respondents in Finland and Sweden had heard of the effects of eutrophication, while participants from Germany and Russia seemed to be less familiar with these effects than respondents in other countries. The results also show that not all eutrophication effects were equally well-known: respondents were most familiar with blue-green algal blooms and water turbidity.

Table 5. Respondents' familiarity with effects from eutrophication (in %) (N=10540)

Country	DK	EE	FI	DE	LV	LT	PL	RU	SE
Water turbidity	45.6	55.1	94.5	41.5	49.1	49.4	41.2	45.8	82.6
Blue-green algal blooms	60.9	74.7	97.6	57.9	59.2	57.1	50.1	45.6	94.5
Loss of underwater meadows	44.4	53.3	56.4	57.9	36.1	47.8	24.9	35.4	65.9
Changes in fish species composition	41.6	48.1	88.6	22.4	45.5	51.2	31.08	33.7	73.4
Lack of oxygen	66.6	51.1	91.7	33.0	45.1	49.8	37.7	31.0	90.9

Percentages in the table reflect the share of *yes* responses.

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

In general, approximately half of the respondents had at some point experienced the effects of eutrophication, except in Denmark and Germany, where only around 20% of respondents had such experience. In all countries, the most prominent effect experienced by participants was blue-green algal blooms, followed by water turbidity (see Table 6). These effects are probably the most visible to the eye, compared to changes in fish species composition which follows in the third place, and the loss of underwater meadows, fourth[7].

Table 6. Breakdown of eutrophication effects that have been experienced by respondents (in % of those who had experienced the effects) (N=5469)

Country	N	Water turbidity	Blue-green algal blooms	Loss of underwater meadows	Changes in fish species composition	Other
Denmark	247	75.3	81.4	17.8	27.1	6.5
Estonia	245	84.5	87.8	10.2	24.1	2.0
Finland	854	77.9	82.4	4.3	22.1	5.0
Germany	350	73.7	81.7	3.7	10.3	5.7
Latvia	309	79.9	62.1	1.6	14.2	4.9
Lithuania	318	85.5	77.0	7.6	12.6	3.8
Poland	669	79.7	78.2	5.2	8.4	2.8
Russia	660	98.2	98.2	43.6	61.4	34.7
Sweden	1003	40.9	47.4	6.6	13.4	3.4
Total	5469	62.6	63.9	6.5	15.2	4.3

Table 7 shows to what extent respondents personally felt that the specific effects of eutrophication were a problem in the Baltic Sea. All the mentioned effects were seen as problems in all countries. No large differences with regards to the different effects could be observed, which might indicate that eutrophication in general, rather than any of its specific attributes, seemed to be the respondents' main concern.

Table 7. Extent to which respondents felt effects of eutrophication are a problem (mean values) (N=10509)

Country	DK	EE	FI	DE	LV	LT	PL	RU	SE	Overall
Water turbidity	3.48	3.55	3.44	3.48	3.31	3.53	3.71	3.61	3.73	3.56
Blue-green algal blooms	3.90	3.99	3.94	4.00	3.6	3.51	3.99	3.70	4.36	3.91
Underwater meadows loss	3.87	3.90	3.50	4.01	3.52	3.81	3.85	3.70	4.2	3.81
Fish species composition change	3.87	4.06	3.73	4.09	3.87	3.92	3.98	3.92	4.42	3.97
Lack of oxygen in deep sea bottom areas	4.13	4.04	3.83	4.31	3.83	4.00	4.01	3.84	4.53	4.05

Response scale: 1: Not at all a problem, 2: Rather small problem, 3: Neither small nor big problem, 4: Rather big problem, 5: A very big problem

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

The respondents were also asked how they assess the current water quality of the Baltic Sea by using the proposed water quality scale from *red* to *blue* (see Appendix C). This question was posed to the respondents before providing the scientific assessment developed as part of the study. The actual water quality as assessed in the study shows worse than *green* for all basins excepting the Bothnian Bay and Kattegat. Nevertheless, the responses of the survey showed that respondents perceived the water quality to be better than the scientific assessment, as almost 30% of respondents assess the current quality as *green* or even *blue*, 37% as *yellow* and only 17% assess it as *orange* or *red*.

As could be expected, a larger proportion of the blue and green quality assessments come from Danish respondents since they are likely to be influenced by the Kattegat with its good water quality. However, a

[7] Lack of oxygen at the seabed was not included in this question, since it is not something that can be concretely 'experienced'.

relatively large proportion of better quality assessments is also observed from Swedish respondents, and - more surprisingly – among the Latvian respondents, who are close to the basins with poorest quality (the Northern Baltic Proper and the Gulf of Riga). In general, there is a tendency for respondents to perceive water quality to be better for those basins where the scientific assessment shows low quality.

Altogether, responses to the questions on leisure time and attitudes towards the marine environment indicate that the Baltic Sea is an important site for recreation in the surrounding countries, and that its state, including eutrophication, concerns the people who live in the Baltic littoral countries.

3.3 Willingness to pay results

For each of the two eutrophication reduction programs, this section presents the share of respondents who were willing to pay, the WTP estimates, and the determinants of WTP.

The shares of respondents who are willing to pay, separately for the two eutrophication reduction programs, are shown in Table 8. The shares were highest in Sweden and Finland, and lowest in Russia. Altogether, over half of the respondents were willing to pay something for reducing eutrophication in the Baltic Sea.

Table 8. Shares of respondents willing to pay per country

Country	Share WTP for ½BSAP (%)	Share WTP for BSAP (%)	Share WTP for either or both programs (%)	N
Denmark	54.0	53.7	54.9	1061
Estonia	53.9	56.4	58.0	505
Finland	62.1	63.0	63.4	1645
Germany	54.7	56.2	56.5	1495
Latvia	49.1	49.8	50.1	701
Lithuania	54.1	55.1	55.1	617
Poland	54.3	55.0	55.6	2029
Russia	31.1	32.2	32.4	1508
Sweden	74.1	74.6	75.4	1003
Overall average	53.7	54.6	55.2	10564

The variables included in the logit model, predicting the probability of a respondent being willing to pay in principle, are listed in Table 9.[8] The dependent variable, dWTP, takes the value 1 if the respondent was willing to pay for either (or both) of the programs. The explanatory variables are divided into four categories. Recreation-related variables describe the current and future use of the Baltic Sea. The variable *frequser* is a dummy variable signifying 25 or more annual visits to the Baltic Sea, *vissure*, signifies that the respondent will certainly visit the Baltic Sea in the next five years, and *nosub* is a dummy variable which indicates that the respondent feels that there are no substitutes for the Baltic Sea for a similar recreation experience.

Location-related variables describe the approximate distance between the place of residence[9] and the Baltic Sea (*BSdist, RusCoast*). Attitudinal and knowledge variables include a binary variable for prior knowledge of the effects that eutrophication has on the Baltic Sea (*know*), personal experience of eutrophication in the Baltic Sea (*exper*), and the feeling that the environmental issues of the Baltic Sea are among the three most important environmental problems in the respondent's country (*impor*). Socio-demographic factors include: income, represented by *HINC* (*LINC*) for those with higher (lower) than

[8] All the dependent and independent variables used in the models are described in Appendix D.

[9] Distance in hundreds of kilometers from the geometrical center-point of the municipality or postal code area of residence to the sea (Denmark, Finland, Germany, Latvia, Lithuania, Poland and Sweden), or the nearest point to the sea of the home municipality (Estonia). For Russia we only had information regarding whether the respondent lived in the coastal area (Kaliningrad area or the area surrounding St. Petersburg), and therefore used a binary variable *RusCoast*.

average reported income[10]; age; gender, represented by the binary variable, *female*; size of the household, *hhsize*; and having university level or other higher education, *highedu*.

Finally, the Polish data was collected using two survey modes, face-to-face interviews and an internet panel, and the survey mode effect is taken into account by a dummy variable for the internet panel mode (CAWI).

Table 10 presents the logit regression results. Due to missing values for some variables, some respondents were dropped out of the analysis.

Table 9. Descriptive statistics for the variables included in the logit model explaining the probability of being willing to pay (standard deviations in parenthesis)

Variable	DK	EE	FI	DE	LV	LT	PL	RU	SE
Dependent									
dWTP	0.547	0.580	0.635	0.578	0.511	0.551	0.529	0.319	0.754
	(0.49)	(0.49)	(0.48)	(0.49)	(0.50)	(0.49)	(0.49)	(0.46)	(0.43)
Independent									
Recreation									
frequser	0.329	0.232	0.121	0.029	0.133	0.057	0.027	0.112	0.327
	(0.47)	(0.42)	(0.33)	(0.17)	(0.34)	(0.23)	(0.16)	(0.32)	(0.47)
vissure	0.697	0.693	0.418	0.369	0.526	0.583	0.486	0.279	0.737
	(0.46)	(0.46)	(0.49)	(0.48)	(0.50)	(0.49)	(0.50)	(0.45)	(0.44)
nosub	0.111		0.318	0.076	0.329	0.276	0.102	0.094	0.238
	(0.31)		(0.47)	(0.27)	(0.47)	(0.45)	(0.30)	(0.29)	(0.43)
Location									
BSdist	0.129	0.287	0.600	3.557	0.536	1.862	2.991		0.386
	(0.15)	(0.43)	(0.71)	(1.71)	(0.63)	(0.91)	(1.63)		(0.49)
RusCoast								0.647	
								(0.48)	
Attitudinal and knowledge									
know	0.416	0.444	0.855	0.262	0.350	0.391	0.199	0.287	0.756
	(0.49)	(0.49)	(0.35)	(0.44)	(0.48)	(0.49)	(0.40)	(0.48)	(0.43)
exper	0.233	0.485	0.517	0.240	0.448	0.515	0.330	0.463	0.553
	(0.42)	(0.50)	(0.50)	(0.43)	(0.49)	(0.50)	(0.47)	(0.49)	(0.49)
impor	3.490	3.974	4.020	2.990	3.756	3.961	3.612	3.455	4.292
	(0.92)	(0.99)	(0.87)	(1.00)	(1.09)	(1.10)	(1.00)	(1.07)	(0.81)
Socio-demographic factors									
HINC	0.149	0.212	0.139	0.242	0.151	0.156	0.091	0.133	0.291
	(0.36)	(0.41)	(0.35)	(0.43)	(0.36)	(0.36)	(0.29)	(0.34)	(0.45)
LINC	0.157	0.137	0.231	0.263	0.225	0.165	0.413	0.147	0.111
	(0.36)	(0.34)	(0.42)	(0.44)	(0.42)	(0.37)	(0.49)	(0.35)	(0.31)
age	49.984	38.360	50.677	42.539	44.136	42.532	39.160	44.482	53.675
	(13.84)	(12.59)	(14.09)	(14.89)	(16.25)	(16.44)	(11.48)	(16.76)	(16.39)
female	0.433	0.499	0.488	0.481	0.548	0.493	0.489	0.552	0.539
	(0.49)	(0.50)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.49)	(0.49)
hhsize	2.236	2.893	2.263	2.478	2.810	2.773	3.326	2.976	2.191
	(1.04)	(1.20)	(1.20)	(1.24)	(1.27)	(1.27)	(1.32)	(1.19)	(1.09)
highedu	0.475	0.545	0.323	0.415	0.241	0.224	0.311	0.438	0.504
	(0.50)	(0.49)	(0.47)	(0.49)	(0.43)	(0.42)	(0.46)	(0.49)	(0.50)
Survey mode									
CAWI							0.445		
							(0.49)		

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

[10] For those reporting either "don't know" or those who refused to answer the income question, a value of zero was assumed for both LINC and HINC. This accounts for 763 observations in the sample of 10564 observations.

Table 10. Results of the logit models (standard errors in parenthesis)

Dependent variable: dWTP = 1 if respondent is willing to pay for any scenario, = 0 if not									
Variable	DK	EE	FI	DE	LV	LT	PL	RU	SE
frequser	-0.531***	-0.167	0.242	0.028	-0.086	-0.048	-0.548*	-0.068	0.029
	(0.158)	(0.239)	(0.218)	(0.425)	(0.281)	(0.402)	(0.323)	(0.209)	(0.191)
vissure	0.417**	0.433**	0.492***	0.241	0.751***	0.337	0.529***	0.570***	0.601***
	(0.162)	(0.216)	(0.137)	(0.153)	(0.196)	(0.207)	(0.112)	(0.157)	(0.187)
nosub	0.361		0.169	0.496*	-0.284	0.673***	0.627***	0.009	0.039
	(0.226)		(0.131)	(0.263)	(0.196)	(0.209)	(0.175)	(0.215)	(0.186)
BSdist	-0.192	0.078	-0.011	0.120***	-0.179	0.161	0.041		-0.010
	(0.460)	(0.226)	(0.082)	(0.043)	(0.150)	(0.106)	(0.033)		(0.163)
RusCoast								0.022	
								(0.175)	
know	0.136	0.003	0.029	0.238	0.091	0.357*	0.328**	0.283**	-0.056
	(0.156)	(0.202)	(0.159)	(0.150)	(0.190)	(0.192)	(0.138)	(0.138)	(0.188)
exper	0.877***	0.440**	0.196	0.611***	0.834***	0.357*	0.499***	0.366**	0.098
	(0.189)	(0.209)	(0.127)	(0.169)	(0.187)	(0.192)	(0.121)	(0.169)	(0.176)
impor	0.454***	0.285***	0.673***	0.337***	0.309***	0.360***	0.339***	0.212***	0.537***
	(0.082)	(0.100)	(0.069)	(0.067)	(0.085)	(0.086)	(0.056)	(0.058)	(0.098)
HINC	0.065	0.065	0.045	0.122	0.056	0.585**	0.521**	0.143	-0.028
	(0.197)	(0.244)	(0.175)	(0.166)	(0.271)	(0.280)	(0.205)	(0.179)	(0.187)
LINC	-0.142	0.337	-0.190	-0.025	-0.820***	-0.023	-0.189*	-0.064	-0.005
	(0.191)	(0.293)	(0.139)	(0.155)	(0.229)	(0.245)	(0.110)	(0.180)	(0.259)
age	-0.013**	-0.018**	0.002	-0.014***	-0.006	-0.015**	-0.001	-0.009**	-0.002
	(0.005)	(0.008)	(0.004)	(0.005)	(0.006)	(0.006)	(0.005)	(0.004)	(0.005)
female	0.407***	0.022	0.328***	0.226*	-0.062	0.373**	0.219**	0.114	0.287*
	(0.142)	(0.194)	(0.116)	(0.130)	(0.175)	(0.182)	(0.106)	(0.122)	(0.160)
hhsize	0.020	0.054	-0.106**	-0.031	0.029	0.032	-0.006	-0.048	0.097
	(0.068)	(0.080)	(0.048)	(0.052)	(0.072)	(0.078)	(0.040)	(0.051)	(0.078)
highedu	0.088	0.115	0.444***	0.585***	-0.115	0.364	0.231*	0.161	0.198
	(0.140)	(0.197)	(0.128)	(0.135)	(0.218)	(0.233)	(0.125)	(0.123)	(0.162)
CAWI							0.996***		
							(0.117)		
Constant	-1.348***	-0.903	-2.593***	-1.105***	-1.311**	-2.003***	-2.208***	-1.543***	-1.908***
	(0.442)	(0.550)	(0.393)	(0.348)	(0.535)	(0.594)	(0.343)	(0.332)	(0.556)
Number of observations	1035	505	1626	1177	648	617	1902	1431	982
Log likelihood	-654.268	-328.002	-946.169	-749.719	-396.388	-377.080	-1113.066	-847.948	-513.777
Likelihood ratio (LR)	117.2***	31.3***	241.2***	103.7***	105.2***	94.7***	387.4***	98.3***	69.1***
Pseudo R^2	0.0822	0.0452	0.1131	0.0647	0.1172	0.1116	0.1482	0.0548	0.0630
Significant at the *** 1%, ** 5% and * 10% level									
DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden									

The results are robust across countries, as the signs of the (significant) coefficients are consistent. Of the use-related factors, respondents who were frequent users of the Baltic Sea were less likely to be willing to pay in Denmark and Poland. A possible explanation is that frequent visitors may consider that the state of the sea good enough as they already spend a good deal of leisure time there. Another possible explanation can be that the frequent users in Denmark visit the Danish sea areas most often, and these areas are assumed to be in a good quality already in the baseline. There is therefore no need for improvements. If the respondent stated s/he will definitely visit the Baltic Sea in the next five years, s/he was more likely willing to pay. In Germany, Lithuania and Poland, a belief that there were no appropriate substitute sites for the Baltic Sea increased the probability of a respondent being willing to pay. In most cases, the distance between the respondent's place of residence and the Baltic Sea did not affect the probability of willingness to pay, but perhaps surprisingly, in Germany those living further away from the sea were more likely to be willing to pay than those living closer to it.

With regards to attitudes and experience, prior knowledge of the effects of eutrophication increased the probability of a respondent being willing to pay in Lithuania, Poland and Russia. In the majority of countries, respondents with personal experience of the effects of eutrophication were more likely to be willing to pay.

Also, if the respondent felt that the environmental problems in the Baltic Sea were amongst the three most important problems in their country, then the probability of them being willing to pay was higher.

Of the socio-demographic factors, high income increased the probability of being willing to pay in Lithuania and Poland, and low income decreased it in Latvia. Age had a negative effect on the probability of being willing to pay in most countries. Women were in general more likely to be willing to pay than men, and a larger household size decreased the probability of being willing to pay in Finland. In Finland, Germany and Poland, respondents with high education were more likely to be willing to pay. The survey mode used had an effect in Poland, as people who responded to the internet survey were more likely to be willing to pay.

The interval regression estimates[11] and the spike model estimates[12] of the mean annual WTP per person, together with the 95% confidence intervals are presented in Tables 11 and 12 for the ½BSAP and BSAP eutrophication reduction scenarios, respectively. The willingness to pay figures, presented in 2011 euros in the questionnaire, were adjusted using purchasing power parity (PPP) conversion rates[13], to facilitate comparison of the estimates between countries. As the interval regression included only those who were willing to pay, we multiplied the proportion of people willing to pay for each of the scenarios (see Table 8) with the mean WTP obtained from the interval regression to obtain a sample mean WTP which is comparable with the spike model results. This is reported in the fourth column of Tables 11 and 12 as "Sample mean WTP".

The interval regression model and the spike model produced similar estimates of mean WTP after the raw interval regression WTP values for those willing to pay were adjusted by the proportion of respondents who were actually WTP for the relevant scenario. This indicates that our results are robust to various model specifications. There were substantial differences in the PPP-corrected mean WTP between countries. WTP was notably higher in Sweden than in other countries, followed by Finland and Denmark. Lowest mean WTP values were observed in Latvia, Lithuania and Russia. For all countries, the WTP was higher for the large reduction in eutrophication, i.e. the BSAP scenario, than for the ½BSAP scenario, although for some countries this difference in WTP is rather small.

Table 13 shows that the respondents considered different effects of eutrophication when answering the WTP question. Overall, water turbidity and blue-green algal blooms were the most prominent effects in people's minds when stating their WTP. However, the respondents also clearly considered effects which they might not have observed directly in the past. This is a further indication that, to a large extent, people care for the Baltic Sea environment in general, and not only for specific components within that environment.

[11] Using the intreg and bootstrap commands in STATA 10, code available from authors on request.
[12] Using NLOGIT 5.0, code available from authors on request.
[13] The data on purchasing power parities originates from Eurostat and OECD (Russia). The point of comparison is Euro27 countries' currency in 2010, figures 2011

Table 11. Mean annual WTP per person for the ½BSAP eutrophication reduction scenario (in 2011 Euros, PPP-corrected Euros, Euro27=1)

	Interval regression			Spike model		
Country	Mean WTP (s.e)	95% CI	Sample mean WTP	Mean WTP (s.e)	95% CI	Spike probability
Denmark	63.68 (3.08)	57.65 – 69.71	34.39	35.15 (2.356)	30.54 – 39.77	0.47 (0.0002)
Estonia	35.71 (3.03)	29.76 – 41.65	19.25	19.95 (1.67)	16.68 – 23.22	0.50 (0.0005)
Finland	54.20 (1.99)	50.31 – 58.09	33.66	32.40 (1.03)	30.38 – 34.42	0.41 (0.0001)
Germany	33.39 (1.39)	30.68 – 36.10	18.26	18.24 (0.44)	17.37 – 19.10	0.48 (0.0001)
Latvia	10.67 (0.82)	9.07 – 12.28	5.24	4.91 (0.08)	4.75 – 5.07	0.54 (0.0003)
Lithuania	13.65 (1.15)	11.39 – 15.92	7.38	12.42 (0.58)	11.28 – 13.56	0.53 (0.0005)
Poland	19.25 (0.78)	17.72 – 20.77	10.45	11.15 (0.13)	10.90 – 11.40	0.49 (0.0001)
Russia	29.58 (2.80)	24.09 – 35.06	9.20	10.65 (0.31)	10.04 – 11.26	0.70 (0.0001)
Sweden	90.72 (4.37)	82.16 – 99.28	67.22	63.06 (4.98)	53.30 – 72.82	0.32 (0.0002)

CI=confidence interval

Table 12. Mean annual WTP per person for the BSAP eutrophication reduction scenario (in 2011 Euros, PPP-corrected Euros, Euro27=1)

	Interval regression			Spike model		
Country	Mean WTP (s.e)	95% CI	Sample mean WTP	Mean WTP (s.e)	95% CI	Spike probability
Denmark	67.00 (3.41)	60.31 – 73.67	35.98	36.27 (2.5256)	31.32 - 41.22	0.48 (0.0002)
Estonia	46.20 (3.80)	38.76 – 53.65	26.06	25.76 (2.6407)	20.58 - 30.93	0.48 (0.0005)
Finland	71.56 (2.80)	66.07 – 77.04	45.08	42.49 (1.7542)	39.05 - 45.93	0.40 (0.0001)
Germany	45.66 (2.02)	41.69 – 49.62	25.66	25.15 (0.8019)	23.57 - 26.72	0.46 (0.0001)
Latvia	12.74 (1.06)	10.66 – 14.82	6.34	5.89 (0.1148)	5.66 - 6.11	0.54 (0.0003)
Lithuania	18.60 (1.50)	15.65 – 21.55	10.25	16.51 (0.9441)	14.66 - 18.36	0.51 (0.0004)
Poland	23.90 (0.90)	22.13 – 25.67	13.15	13.39 (0.1761)	13.04 - 13.73	0.48 (0.0001)
Russia	35.97 (2.93)	30.22 – 41.72	11.58	11.67 (0.3613)	10.96 - 12.38	0.69 (0.0001)
Sweden	111.78 (5.75)	100.52 – 123.04	83.39	77.14 (8.2254)	61.01 - 93.26	0.33 (0.0002)

CI=confidence interval

Table 13. Effects of eutrophication considered when stating WTP (in % of participants) (N=7251)

	DK	EE	FI	DE	LV	LT	PL	RU	SE	Overall
Water turbidity	22.7	58	51.6	28.8	66.0	76.3	62.7	90.2	32.2	47.3
Blue-green algal blooms	38.1	77.4	74.8	37.8	66.0	67.8	70.3	83.2	54.5	58.6
Underwater meadows loss	27.6	53.1	29.4	27.2	31.7	59.1	37.6	64.1	34.2	35.0
Fish species composition changes	33.2	71.5	54.4	40.3	53.4	68.4	53.9	81.3	55.6	51.4
Lack of oxygen in deep sea bottom areas	43.6	47.2	49.3	39.2	36.9	54.7	37.5	62.3	50.6	44.5

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

3.4 Determinants of willingness to pay

The final stage of our analysis was to identify the factors determining the size of WTP in each country. In addition to the variables used in the logit models, we added variables from responses that followed the WTP question. These variables included the respondent's certainty in their own WTP statement, *Cert½BSAP and CertBSAP.* In the survey, the respondents were asked to primarily think about open-sea areas when answering the WTP question. To see if they did so, a follow-up question asked respondents to state how much they considered the open-sea areas relative to the coastal areas, *ccoast*, and the extent to which they considered the whole Baltic Sea compared to specific areas or basins of the sea, *whole*. The results show that respondents did not restrict their focus to open-sea areas; hence, coastal areas were also considered. In addition, a large share of the respondents considered the whole Baltic Sea rather than specific areas. These results indicate that both use and non-use values play a role as determinants of WTP, and in particular that the share of non-use values in the WTP estimates is likely to be substantial. The survey was conducted so that the order of scenario presentation was randomized. This was taken into account by the dummy variable *ordeff*, where 1 signifies that the more extensive BSAP scenario was shown before the ½BSAP scenario in the survey. This variable was used in all models except for Denmark and Lithuania.[14] Tables 14 and 15 presents the descriptive statistics for the dependent variables as well as the additional explanatory variables included in the models explaining the size of the WTP.

Table 14. Descriptive statistics for the variables included in the interval regression models explaining the size of WTP for the ½BSAP scenario (standard deviations in parenthesis)

Variable	DK	EE	FI	DE	LV	LT	PL	RU	SE
Dependent	n=494	n=265	n=997	n=641	n=316	n=287	n=995	n=389	n=713
log(lowWTP)	3.511	2.806	3.275	2.955	1.386	2.029	2.275	1.798	3.744
½BSAP	(1.031)	(1.356)	(1.220)	(0.928)	(1.353)	(0.991)	(1.253)	(2.124)	(1.346)
log(upWTP)	3.796	3.154	3.662	3.245	1.833	2.309	2.593	2.638	4.169
½BSAP	(1.024)	(1.061)	(1.006)	(0.917)	(1.220)	(0.971)	(0.989)	(1.442)	(1.018)
Independent									
WTP: ordeff[15]		0.460	0.523	0.487	0.491		0.473	0.468	0.498
		(0.499)	(0.500)	(0.500)	(0.501)		(0.500)	(0.500)	(0.500)
WTP: whole	0.704	0.604	0.715	0.757	0.538	0.718	0.644	0.602	0.815
	(0.457)	(0.490)	(0.452)	(0.429)	(0.499)	(0.451)	(0.479)	(0.490)	(0.389)
WTP: ccoast	0.397	0.219	0.267	0.323	0.304	0.143	0.310	0.285	0.202
	(0.490)	(0.414)	(0.443)	(0.468)	(0.461)	(0.351)	(0.463)	(0.452)	(0.402)
WTP: Cert½BSAP	8.287	6.170	7.132	6.933	7.611	7.446	7.887	7.964	6.823
	(2.098)	(2.416)	(2.165)	(2.232)	(2.205)	(2.241)	(2.093)	(2.111)	(2.475)

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

[14] We could not discern the order of the scenarios in the questionnaire from the Lithuanian data. We assumed a positive scope effect, Lithuanians being willing to pay more for the BSAP scenario than the ½BSAP scenario, and those who had the same willingness-to-pay for both scenarios were randomly assigned to either of the scenarios. The assumption was based on the evidence of scope effect from other countries' data and from the Lithuanian pilot study. In Denmark, the order of the scenarios was not randomized.

[15] Not used in the Lithuanian models, as the order effect was pre-determined assuming the scope effect, or in the Danish models, as the order was not randomized there.

Table 15. Descriptive statistics for the variables included in the interval regression models explaining the size of WTP for the BSAP scenario (standard deviations in parenthesis)

Variable	DK	EE	FI	DE	LV	LT	PL	RU	SE
Dependent	n=500	n=280	n=1013	n=675	n=320	n=299	n=1020	n=415	n=717
log(lowWTP) BSAP	3.531	3.071	3.570	3.223	1.573	2.262	2.497	2.167	3.994
	(1.047)	(1.131)	(1.024)	(0.981)	(1.229)	(1.038)	(1.165)	(1.594)	(1.048)
log(upWTP) BSAP	3.815	3.361	3.915	3.508	1.982	2.538	2.784	2.861	4.356
	(1.038)	(1.099)	(1.032)	(0.967)	(1.249)	(1.024)	(1.006)	(1.380)	(1.037)
Independent									
WTP: ordeff[15]		0.468	0.522	0.505	0.488		0.484	0.499	0.497
		(0.500)	(0.500)	(0.500)	(0.501)		(0.500)	(0.501)	(0.500)
WTP: whole	0.698	0.600	0.718	0.760	0.531	0.709	0.640	0.583	0.815
	(0.460)	(0.491)	(0.450)	(0.427)	(0.500)	(0.455)	(0.480)	(0.494)	(0.389)
WTP: ccoast	0.404	0.218	0.267	0.326	0.309	0.140	0.311	0.289	0.205
	(0.491)	(0.414)	(0.442)	(0.469)	(0.463)	(0.348)	(0.463)	(0.454)	(0.404)
WTP: CertBSAP	8.287	6.300	7.249	7.119	7.622	7.518	7.970	8.188	6.958
	(2.031)	(2.389)	(2.124)	(2.223)	(2.164)	(2.321)	(2.088)	(1.984)	(2.449)

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

Tables 16 and 17 show the interval regression results for respondents' WTP for both of the eutrophication reduction scenarios, ½BSAP and BSAP, respectively. Results suggest that the survey likely identified considerable non-use values associated with eutrophication reduction in the Baltic, as in the majority of countries respondents were willing to pay for improvements to the whole Baltic Sea, with the lowest share of such respondents in Estonia, Denmark, Latvia, Poland and Russia. In Germany and Russia people who stated they thought mostly of coastal conditions were willing to contribute less money. In almost all countries, respondents who were more certain about their WTP responses were willing to pay more. Frequent current use and plans to visit the Baltic Sea in the future increased WTP. A perceived lack of substitutes did not, in general, increase WTP. Distance to the Baltic Sea was only affected WTP significantly for Latvia and Poland, suggesting no distance decay in the values (see e.g. Bateman et al. 2006). Of the attitudinal variables, if the respondent felt that the environmental problems in the Baltic Sea were amongst the three most important problems in their country, then the willingness to pay was higher.

High income increased WTP, especially for the more extensive change (BSAP). The effect of age varied between countries, being positive for some and negative for others. In Finland, Poland and Russia, high education level increased WTP.

Results from Germany, Poland and Russia suggest that when the large improvement scenario was presented first in the survey, the willingness to pay was typically lower for both scenarios.

It is interesting to examine which areas of the Baltic Sea the respondents considered when answering the willingness to pay question. Figure 3 shows the relative weights of different sea basins for those respondents who were willing to pay. The weights express the share of respondents that considered the particular basin in relation to all respondents with positive WTP. Those respondents who stated that they thought of the whole Baltic Sea were assumed to include all basins in their considerations.

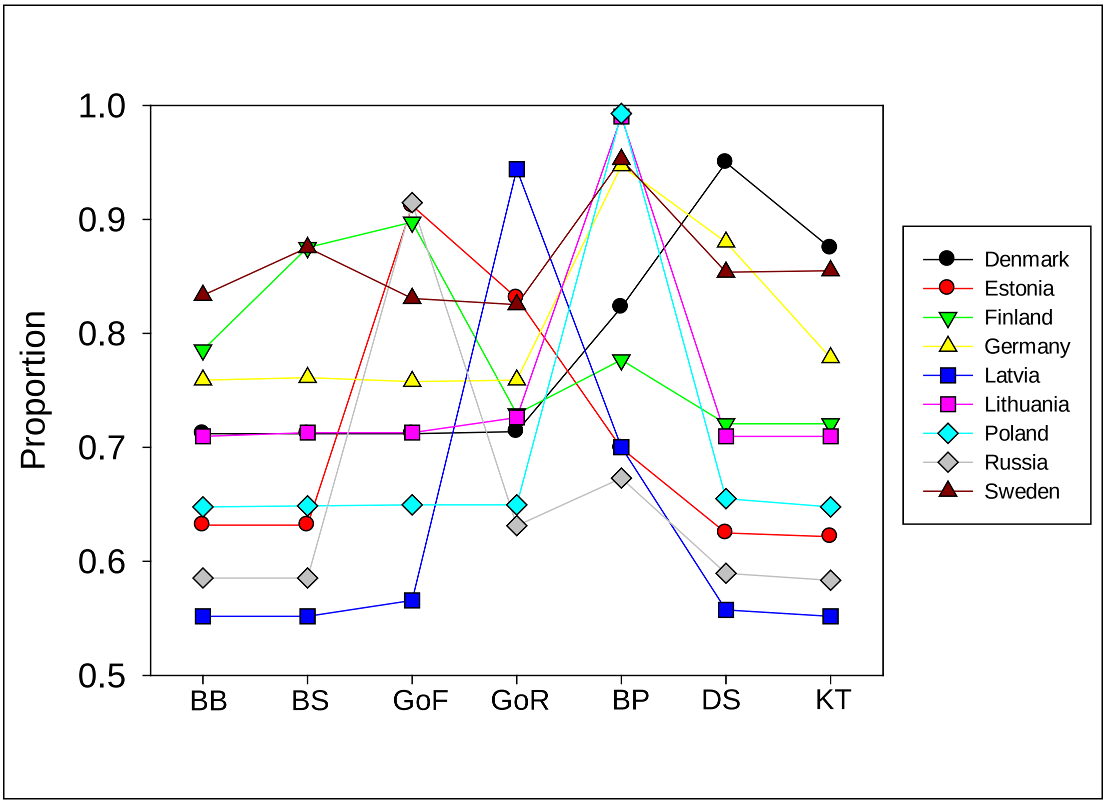

Figure 3. The relative weights of the different basins of the Baltic Sea by countries. The basins are: BB=Baltic Bay, BS=Baltic Sea, GoF=Gulf of Finland, GoR=Gulf of Riga, BP=Baltic Proper, DS=Danish Straits (including the Belt and the Sound), KT=Kattegat

A majority of all respondents (76%) considered the Baltic Sea as a whole, while the rest considered some smaller region consisting of one or several sea basins. As a result, all sea regions have high weighting exceeding 55%. On the other hand, there was a clear tendency amongst those who considered only a certain part of the Baltic Sea to focus on those sea basins adjacent to their country. Thus, the differences in how the respondents considered and weighed different sea regions can be explained by geography. The citizens of Sweden, for example, have direct access to most of the Baltic Sea regions, and as an obvious consequence, the weights were evenly distributed across the sea basins. In Russia, the Gulf of Finland received more weight compared to other areas, and in Poland, the Baltic Proper was considered most often.

Table 16. Interval regression of the determinants of willingness to pay for the ½BSAP scenario

	DK	EE	FI	DE	LV	LT	PL	RU	SE
Ordeff		0.006	-0.062	-0.174**	-0.002		-0.206***	-0.337***	-0.097
		(0.12)	(0.059)	(0.07)	(0.121)		(0.062)	(0.139)	(0.071)
Whole	0.151	-0.074	0.067	0.116	0.427***	0.053	0.123*	0.324**	0.112
	(0.103)	(0.128)	(0.069)	(0.09)	(0.13)	(0.128)	(0.069)	(0.145)	(0.095)
Ccoast	-0.088	0.288*	-0.021	-0.234***	-0.07	-0.05	-0.002	-0.336**	0.035
	(0.095)	(0.153)	(0.071)	(0.083)	(0.142)	(0.163)	(0.072)	(0.158)	(0.092)
Cert½BSAP	0.050**	0.144***	0.109***	0.040**	-0.006	0.043*	0.039***	0.109***	0.046***
	(0.021)	(0.026)	(0.014)	(0.016)	(0.029)	(0.025)	(0.015)	(0.033)	(0.015)
Frequser	0.134	0.017	0.250***	0.198	0.345**	0.251	-0.114	0.094	0.235***
	(0.103)	(0.162)	(0.092)	(0.202)	(0.171)	(0.258)	(0.183)	(0.236)	(0.084)
Vissure	0.282**	0.235	-0.088	0.124	0.255*	0.171	0.134*	0.339*	0.042
	(0.117)	(0.146)	(0.071)	(0.084)	(0.141)	(0.135)	(0.068)	(0.182)	(0.097)
Nosub	-0.029		-0.07	0.101	0.282**	0.189	0.022	-0.29	-0.002
	(0.129)		(0.065)	(0.125)	(0.135)	(0.119)	(0.113)	(0.247)	(0.084)
BSdist	0.153	-0.224	-0.032	0.002	-0.465***	0.091	-0.050**		0.07
	(0.320)	(0.139)	(0.045)	(0.023)	(0.114)	(0.067)	(0.02)		(0.08)
RusCoast								0.11	
								(0.208)	
Know	-0.001	0.114	0.035	0.094	0.345***	-0.046	0.101	0.179	-0.102
	(0.103)	(0.126)	(0.094)	(0.08)	(0.127)	(0.119)	(0.076)	(0.151)	(0.091)
Exper	0.095	0.062	0.131*	-0.025	0.11	0.013	-0.111	0.275	0.148*
	(0.108)	(0.136)	(0.069)	(0.086)	(0.128)	(0.121)	(0.069)	(0.201)	(0.083)
Impor	0.109**	0.013	0.082**	0.01	0.033	0.207***	0.098***	0.136*	-0.132**
	(0.054)	(0.07)	(0.041)	(0.039)	(0.064)	(0.063)	(0.035)	(0.072)	(0.053)
HINC	0.184	0.113	0.226**	0.288***	0.420**	0.288*	0.143	0.181	0.211**
	(0.127)	(0.157)	(0.089)	(0.094)	(0.179)	(0.149)	(0.099)	(0.203)	(0.084)
LINC	-0.130	-0.232	-0.330***	0.088	0.222	0.165	-0.061	-0.143	-0.281**
	(0.134)	(0.172)	(0.078)	(0.091)	(0.181)	(0.163)	(0.07)	(0.21)	(0.125)
Age	0.012***	0.009*	-0.001	0.006**	-0.004	-0.015***	0.006**	-0.013***	0.004
	(0.004)	(0.005)	(0.002)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)
Female	-0.081	-0.158	0.032	0.011	-0.107	0.057	-0.036	-0.371***	-0.396***
	(0.094)	(0.125)	(0.062)	(0.074)	(0.125)	(0.115)	(0.066)	(0.142)	(0.074)
Hhsize	0.034	0.056	0.007	0.000	0.096**	-0.014	-0.016	0.141**	0.019
	(0.043)	(0.052)	(0.026)	(0.029)	(0.049)	(0.052)	(0.025)	(0.058)	(0.036)
highedu	0.129	-0.122	0.151**	0.005	-0.2	0.08	0.129*	0.478***	0.114
	(0.094)	(0.126)	(0.064)	(0.075)	(0.155)	(0.132)	(0.07)	(0.141)	(0.074)
CAWI							0.261***		
							(0.075)		
Constant	1.759***	1.498***	2.310***	2.417***	0.897**	1.117**	1.492***	0.721	2.767***
	(0.337)	(0.428)	(0.246)	(0.238)	(0.419)	(0.451)	(0.246)	(0.455)	(0.308)
lnsigma	-0.043	-0.044	-0.085***	-0.136***	0.043	-0.100**	-0.031	0.257***	-0.068**
N	494	265	997	641	316	287	995	389	713
AIC	2677.177	1465.421	4856.905	3291.998	1561.489	1540.565	5495.997	1963.048	3457.194
LR χ2	64.41***	55.65***	160.53***	63.25***	87.58***	43.03***	87.35***	99.72***	122.19***
McFadden's R^2	0.011	0.037	0.032	0.019	0.054	0.028	0.016	0.049	0.035

Significant at the *** 1%, ** 5% and * 10% level

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

Table 17. Interval regression of the determinants of willingness to pay for the BSAP scenario

	DK	EE	FI	DE	LV	LT	PL	RU	SE
Ordeff		0.062	0.024	-0.055	0.088		-0.147**	-0.203*	-0.038
		(0.122)	(0.059)	(0.073)	(0.122)		(0.061)	(0.123)	(0.071)
Whole	0.151	-0.098	0.101	0.03	0.494***	-0.032	0.049	0.176	0.069
	(0.103)	(0.130)	(0.069)	(0.094)	(0.131)	(0.129)	(0.068)	(0.128)	(0.096)
Ccoast	-0.082	0.283*	0.041	-0.316***	-0.054	-0.057	-0.051	-0.276**	0.119
	(0.096)	(0.155)	(0.071)	(0.086)	(0.142)	(0.166)	(0.071)	(0.14)	(0.092)
CertBSAP	0.053**	0.145***	0.138***	0.051***	0.006	0.034	0.047***	0.135***	0.053***
	(0.022)	(0.027)	(0.014)	(0.017)	(0.029)	(0.025)	(0.015)	(0.033)	(0.015)
frequser	0.216**	0.04	0.259***	0.248	0.483***	0.332	-0.063	0.032	0.263***
	(0.104)	(0.156)	(0.092)	(0.207)	(0.173)	(0.251)	(0.183)	(0.207)	(0.084)
Vissure	0.242**	0.264*	-0.07	0.149*	0.229	0.049	0.104	0.307*	0.116
	(0.117)	(0.151)	(0.071)	(0.087)	(0.142)	(0.137)	(0.067)	(0.16)	(0.098)
Nosub	0.006		0.110	0.299**	0.299	0.268**	0.006	-0.457**	-0.046
	(0.131)		(0.065)	(0.13)	(0.135)	(0.121)	(0.112)	(0.222)	(0.084)
BSdist	0.207	-0.047	-0.016	0.016	-0.414***	0.062	-0.051**		0.105
	(0.321)	(0.142)	(0.045)	(0.024)	(0.114)	(0.066)	(0.02)		(0.08)
RusCoast								0.205	
								(0.184)	
Know	0.042	0.118	-0.005	0.121	0.350***	-0.092	0.107	0.215	-0.106
	(0.103)	(0.129)	(0.093)	(0.083)	(0.129)	(0.121)	(0.075)	(0.134)	(0.092)
Exper	0.072	0.137	0.198***	-0.018	0.098	0.008	-0.075	0.367**	0.238***
	(0.109)	(0.136)	(0.069)	(0.089)	(0.128)	(0.122)	(0.068)	(0.175)	(0.083)
Impor	0.127**	-0.009	0.063	0.036	0.035	0.201***	0.077	0.072	0.147***
	(0.055)	(0.071)	(0.04)	(0.041)	(0.065)	(0.064)	(0.035)	(0.064)	(0.053)
HINC	0.187	0.214	0.230***	0.186*	0.350*	0.388***	0.202**	0.425**	0.239***
	(0.127)	(0.157)	(0.089)	(0.097)	(0.18)	(0.15)	(0.098)	(0.178)	(0.085)
LINC	-0.130	-0.207	-0.266***	0.037	-0.018	-0.087	-0.045**	-0.047	-0.141
	(0.136)	(0.179)	(0.077)	(0.094)	(0.18)	(0.163)	(0.069)	(0.194)	(0.126)
Age	0.006*	0.009*	-0.006***	0.002	-0.007	-0.019***	0.004	-0.013***	-0.001
	(0.004)	(0.005)	(0.002)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)
Female	-0.094	-0.163	-0.051	-0.033	-0.094	0.15	-0.080	-0.176	-0.416***
	(0.094)	(0.127)	(0.062)	(0.076)	(0.125)	(0.117)	(0.065)	(0.127)	(0.074)
Hhsize	0.056	0.044	-0.011	-0.005	0.086*	-0.009	0.011	0.063	0.000
	(0.044)	(0.054)	(0.026)	(0.029)	(0.048)	(0.05)	(0.025)	(0.053)	(0.036)
highedu	0.137	-0.2	0.175***	0.07	-0.098	0.09	0.170**	0.637***	0.119
	(0.095)	(0.127)	(0.064)	(0.078)	(0.155)	(0.134)	(0.069)	(0.126)	(0.074)
CAWI							0.434***		
							(0.074)		
Constant	1.872***	1.699***	2.592***	2.695***	0.999**	1.714***	1.622***	0.819*	2.986***
	(0.347)	(0.44)	(0.246)	(0.253)	(0.423)	(0.452)	(0.246)	(0.422)	(0.31)
lnsigma	-0.026	-0.003	-0.080***	-0.073***	0.056	-0.063	-0.031	0.178***	-0.060**
N	500	280	1013	675	320	299	1020	415	717
AIC	2755.446	1601.004	4988.266	3611.312	1603.357	1635.24	5727.52	3530.719	3530.719
LR χ2	63.20***	59.28***	205.05***	55.86***	94.97***	52.24***	116.79***	135.63***	135.77***
McFadden's R^2	0.010	0.036	0.040	0.015	0.057	0.032	0.020	0.065	0.037

Significant at the *** 1%, ** 5% and * 10% level

DK = Denmark, EE = Estonia, FI = Finland, DE = Germany, LV = Latvia, LT = Lithuania, PL = Poland, RU = Russia, SE = Sweden

3.5 Aggregate benefit estimates

For all countries, the samples were drawn to represent the entire country with best possible accuracy. With representative data the sample mean WTP can be multiplied with the population to estimate the aggregate national benefits (Bateman et al. 2006). To assess the representativeness of the sample, we examined the change in the probability of being willing to pay predicted by the logit model that results from replacing the variable sample means in the model with the corresponding population statistics (see e.g. Harrison & Lesley 1996). We used the population statistics for age, percent female, household size, and the proportion of people with higher level education, high income and low income for this purpose (see Table 2).

Table 18 shows that the predicted shares of people willing to pay using the sample means and the population means are similar, falling in the 95% confidence intervals[16]. For five countries, the predicted share is lower using the sample means, and the situation is reversed for four countries, with the largest differences being a few percentage points. Nevertheless, to calculate the aggregate benefit estimates, we employed the predicted shares of willing to pay based on the population statistics.

As there seems to be no major difference between the proportion of willingness to pay based on the sample and the population means, we assumed the willingness to pay of the non-respondents, i.e. people declining to answer the questionnaire, to be the same as the WTP of the respondents. In other words, we assumed that the WTP of those who did not respond does not differ from the WTP of those who responded. In estimating the aggregate benefits of the policy scenarios, we used the interval regression mean values (see Tables 11 and 12).[17]

Table 18. Share of people willing to pay as predicted by the logit model

Country	Predicted share of those willing to pay Pr(y=1|x), using sample mean values [95% CI]	Predicted share of those willing to pay Pr(y=1|x), using the population statistics [95% CI]	Difference
Denmark	0.5541 [0.5219, 0.5863]	0.5648 [0,5266, 0,6030]	-0.0107
Estonia	0.5846 [0.5402, 0.6290]	0.5517 [0,4896, 0,6138]	0.0329
Finland	0.6552 [0.6301, 0.6804]	0.6515 [0,6238, 0,6791]	0.0037
Germany	0.5865 [0.5570, 0.6161]	0.5694 [0,5342, 0,6045]	0.0171
Latvia	0.5118 [0.4700, 0.5537]	0.5156 [0,4716, 0,5595]	-0.0047
Lithuania	0.5580 [0.5155, 0.6005]	0.5685 [0,5241, 0,6129]	-0.0105
Poland	0.5674 [0.5425, 0.5923]	0.6095 [0,5658, 0,6533]	-0.0421
Russia	0.3084 [0.2834, 0.3333]	0.3183 [0,2869, 0,3497]	-0.0099
Sweden	0.7689 [0.7413, 0.7966]	0.7631 [0,7242, 0,8020]	0.0058

CI = confidence interval, by delta method

Table 19 presents the population figures corresponding to the sampled part of the population for each country. The aggregate WTP values are quoted in 2011 euros, converted using exchange rates, instead of the previously used PPP-corrected values. The justification for using the exchange rates is that if the money would actually be collected, exchange rates would be used. Also, if the benefits are compared to the costs of the policies, they need to be commensurate.

The Baltic Sea-wide estimate of the total benefits of reducing eutrophication is approximately 3000M€ for the ½BSAP and 4000M€ for the BSAP per year. These figures are prone to some uncertainties, but they suggest that the benefits of reducing eutrophication in the Baltic Sea may be substantial.

[16] Due to missing values for the explanatory variables, some observations were dropped from the logit models. Therefore the share of people willing to pay predicted by the models differs from the shares presented in Table 8.
[17] As the interval regression (adjusted by the proportion of those willing to pay) and the spike model results are similar, either of the mean estimates could be chosen as the basis for aggregation.

Table 19. Aggregate benefit estimates for the ½BSAP and BSAP scenarios (in 2011 euros)

Country	Adult population (in millions)	Annual mean WTP per person for ½BSAP (€)	Annual mean WTP per person for BSAP (€)	National WTP per year for ½BSAP (M€)	National WTP per year for BSAP (M€)
Denmark	3.958	49.34	51.91	195.3	205.5
Estonia	0.989	13.41	17.35	13.3	17.2
Finland	3.617	42.11	55.60	152.3	201.1
Germany	68.321	20.01	27.37	1367.4	1869.8
Latvia	1.690	3.54	4.23	6.0	7.1
Lithuania	2.516	4.63	6.32	11.7	15.9
Poland	24.624	6.90	8.57	170.0	211.1
Russia	119.696	4.77	5.80	571.1	694.5
Sweden	7.564	89.89	110.76	679.9	837.7
Total	232.976			3166.9	4059.9

Conversion to euros using the mean exchange rates in 2011 from the European Central Bank

4. Discussion and conclusions

Our results show that the populations of the nine Baltic Sea littoral states attach great value to achieving the policy targets specified by the BSAP. The aggregate willingness to pay for fulfilling the ½BSAP and BSAP scenarios amounts to 3000 million and 4000 million Euros, respectively. Notably, the differences between the WTP in various countries are large, with mean WTP per person in Sweden being the highest and the mean WTP of Latvians is the lowest. Our approach is unique in the sense that the estimates rely on primary data in all countries, and the environmental improvements which are valued are derived from extensive ecological models that predict the state of the Baltic Sea under various future nutrient abatement scenarios. This makes the results appropriate for inclusion in future cost-benefit analyses. Further, our usage of two scenarios with varying nutrient reductions allow for interpolations and incremental WTP estimations for different levels of abatement.

Compared to previous attempts to estimate the benefits of reduced eutrophication in the Baltic Sea (see Introduction and e.g. SEPA 2008b), our results show an aggregate WTP that is somewhat lower. There are several differences between the studies which may have contributed to the discrepancy. One possible explanation is that the present estimates are based on primary valuation studies instead of benefit transfer. Benefit transfer seems to have resulted in higher benefits for some countries, e.g. the Baltic countries. In addition, the differences in the formulation of the valuation scenarios may have induced dissimilarity. In the present study, the improvement in the state of the Baltic Sea varies between the sea basins and good status is not attained everywhere, whereas in the Baltic Drainage Basin Project (see e.g. Söderqvist 1996; Gren et al. 1997; Turner et al. 1999; and Markowska & Zylicz 1999)), the level of eutrophication was specified to decrease to a sustainable level. Also the time frame required to deliver the environmental change differs, being 40 years in this study and 20 years in the BDBP study.

Interestingly, there are several indications that non-use values are important in the case of the Baltic Sea. Respondents seem to care not only for their own area of the sea, but generally for the whole sea. In addition, the effect of distance on WTP is not significant in many countries, suggesting that the Baltic Sea environment is important throughout the littoral countries. Further, all types of eutrophication effects are perceived important, and not only the 'visible' effects such as blue-green algal blooms or water clarity. This suggests that the non-use component of the valuation estimates may be large – the citizens of the Baltic Sea littoral states regard improving the Baltic Sea environment important as whole to be valuable and important.

As usual, the results are subject to a certain amount of uncertainty. The most important sources of uncertainty originate from sampling and models. We took care to attain a representative sample in each country with enough observations for the econometric analysis. Despite these efforts, the population differed from the average respondent by the size of the household, income and education level. These overrepresentations were corrected using the population mean figures in the aggregation of the benefits. We also employed two modeling methods to assess the willingness to pay, i.e. the interval regression model and the spike model. The two models gave similar results, giving confidence in using the results for the aggregation.

Previous empirical studies have provided evidence that internet surveys responses are of similar quality to face-to-face interviews, and may thus be a reliable alternative (Lindhjem & Navrud 2011, Nielsen 2011). This is also of interest to the present study, as the survey modes differed between countries. The Polish results seem to indicate that the respondents of the internet survey were more likely to be willing to pay and their WTP was higher than those interviewed face-to-face. More thorough examination of the survey mode effect is needed, for example, regarding the possible sample composition effects, before anything conclusive may be said of the choice of the data collection mode.

The size of the population to whom the WTP figures are aggregated is also an issue that may cause controversy, especially in the case of Russia, Poland and Germany. These countries have large populations, and a substantial number of people live far away from the Baltic Sea coast and have more direct access to other sea areas. Our survey was set to encompass whole nations, since the payment vehicle was tax-based and we were interested in knowing if distance would affect WTP. Other than Poland, we did not find a significant distance decay effect on the willingness to pay in the analysis. In this sense, using the full population for estimating the aggregate benefits should not lead to biased results, but further analysis is needed to ascertain the validity our assumptions especially in the case of Poland. On the other hand, we did not remove the protest zero responses from the analysis, which would most likely lower the mean and aggregate willingness to pay estimates, as these respondents may hold positive values for reducing eutrophication even though they have given a zero WTP. In addition, we assumed zero WTP for respondents unsure about their willingness to pay, which is a conservative assumption.

Our results provide a strong message to the decision makers about the need for ensuring fulfillment of the policy targets in the BSAP. Failure to fulfill the targets may imply that society foregoes substantial benefits, as reflected by our WTP estimates. Another important message is that achieving the marine policy objectives (e.g. the good environmental status in the MSFD) in all basins of the Baltic Sea can take decades due to slow recovery rate of the ecosystem. It stresses the importance of urgent actions to follow the set timelines for reaching policy objectives, e.g. year 2020 to reach the GES required by the MFSD (European Parliament 2008) and 2021 a required by the BSAP (HELCOM 2007). An important next step is to compare the WTP estimates with the costs of reducing nutrient loads to the Baltic Sea. Cost minimization can be applied to determine cost-effective combinations of nutrient abatement measures to achieve specified targets for water protection. If cost and benefit estimates are available for different effort and target levels, it is possible to assess the optimal level of abatement effort (i.e. the level where the net benefits are the highest) at the scale of the entire Baltic Sea. The remaining task is to reach an agreement on a distribution of the costs and efforts across different countries and economic sectors, and to let national policy makers design a set of policy instruments that put the required programme of measures into action.

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Appendix A: Pre-testing procedure

The survey was a product of a careful pre-testing procedure including an expert review, individual cognitive interviews, and focus group testing before a pilot test of the survey. Table A.1 presents the testing taken in each country during the spring, summer and fall of 2011.

Early pre-testing was done in Denmark, Finland, Poland and Sweden. Marine ecosystem and environmental valuation experts were invited to comment on the survey, and especially on the valuation scenario and the presentation of eutrophication-related issues in the survey. After the expert revisions, the survey was presented to small focus groups consisting of citizens with different backgrounds to provide representativeness. In the focus groups, the survey and especially the valuation questions were discussed to obtain information on how respondents would react to the information, wording and scenario setting provided. Furthermore, cognitive interviews were conducted in Finland and Sweden. In these interviews, individual, randomly chosen respondents from market research panels filled out the survey and were probed to comment on how the perceived the questions and information presented in the survey.

The revised questionnaire was translated to all languages required for the final survey as identically as possible, with the main purpose being to preserve the intended meaning of questions and descriptions (Presser et al. 2004). After the translation, a pilot survey was conducted in all countries to test the actual performance of the survey and possible caveats in the survey design in different countries. Piloting was conducted during the spring and summer of 2011 in Denmark, Finland, Germany, Poland and Sweden, and in the fall 2011 in Estonia, Latvia, Lithuania and Russia.

After the pilot, final revisions were made to the questionnaire, including minor revisions to the bid vectors in the payment cards in each country. The actual data collection was conducted between October and December 2011 in a combination of internet panels and face-to-face interviews to provide a representative sample from each country. As the number of responses from each country was paramount for successful analysis, a minimum of 500 respondents were acquired from each country, reaching up to over 2000 respondents in Poland.

Table A.1. The pretesting procedure.

Country	Expert testing	Focus group	Cognitive interviews	Pilot survey
Denmark	Yes	Yes	No	Yes
Estonia	No	No	No	Yes
Finland	Yes	Yes	Yes	Yes
Germany	Yes	No	No	Yes
Latvia	No	No	No	Yes
Lithuania	No	No	No	Yes
Poland	Yes	No	No	Yes
Russia	No	No	No	Yes
Sweden	Yes	Yes	Yes	Yes

Appendix B: Description of the effects of eutrophication on water quality and biodiversity

First, a detailed description of eutrophication-related changes in the five ecosystem characteristics was synthesized using existing knowledge (Table B.1). A five-class gradient of changes caused or clearly related to eutrophication was described for each ecosystem characteristic. While doing this, the non-eutrophication-related changes in the environment were expected to remain constant, also in cases where an ecosystem change could simultaneously be affected by both eutrophication-related and other components. Sufficient information could not be found to be able to scale all of the five classes to describe exactly the equivalent HELCOM eutrophication class. In order to achieve best available fit under the circumstances, an attempt was made to approximate at least the extreme classes 'high' and 'bad' for each ecosystem characteristic to describe the related HELCOM eutrophication class. The description of changes in the five ecosystem characteristics used in the valuation study was generalized and approximated from the detailed description (Table B.1).

Table B.1. Detailed description of changes in five ecosystem characteristics caused or related to progressing eutrophication.

Water clarity and colour	Cyanobacterial blooms	Underwater meadows	Fish species	Deep sea bottoms
High - The water is clear, and rarely green in colour. Near the open sea, the bottom can be seen from the surface at depths over 8 m.	*High* - Cyanobacteria occurs in the water seldom in visible amounts, and the rarely accumulate in to thick mats at the surface.	*High* - Eelgrass and other perennial plants form nearly gapless meadows where providing shelter for an abundant invertebrate community. Some sedimentation gathers to the base of the plants. The meadow provides feeding- and spawnging grounds for several fish species.	*High* - The fish community consists of several species. Cod, herring and perch are common (Northern Baltic).	*High* - Oxygen deficiency might occur due to stratification. However, benthic communities are diverse, and their recovery potential is high.
Good - The water is mostly clear, and rarely green in colour. Near the open sea, the bottom can be seen from the surface at depths between 6 and 8 m.	*Good* - Cyanobacteria occurs the water at times in visible amounts, and the usually do not accumulate in to thick mats at the surface.	*Good* - Some gaps with slight filamentous algae growth are formed within the underwater meadows. They still provide shelter for an abundant invertebrate community, as well as feeding- and spawnging grounds for fish.	*Good* - The fish community consists of several species. Cod, herring and perch are common (Northern Baltic).	*Good* - There is an initial organic enrichment of the sediment, and short periods of oxygen deficiency might occur. Increases in benthic abundance and biomass are seen as a response to the increased food supply.
Moderate - The water is somewhat turbid, and often greenish in colour. Near the open sea, the bottom can be seen from the surface at depths between 4 and 6 m.	*Moderate* - Cyanobacteria accumulates as surface blooms during most of the summers, sometimes in thick mats and/or covering large areas.	*Moderate* - The eelgrass- and other perennial plants and form patchy meadows. A lot of sediment accumulates at the base of the plants, leading to increase in invertebrate biomass. Epiphytic filamentous algae may be seen growing on the plants.	*Moderate* - Some changes have occurred in the fish community. Cod reproduction suffers of oxygen decrease in spawning area. Cyprinids have increased (Northern Baltic).	*Moderate* - Increased sediment organic enrichment. Sediment oxygen consumption is elevated, and seasonal hypoxia might occur. Changes in benthic composition take place, as sensitive taxa are reduced, while tolerant taxa increases. Benthic abundance is elevated, while biomass might become reduced.
Poor - The water is turbid, and during spring and summer greenish in colour. Near the open sea, the bottom can be seen from the surface at depths between 2 and 4 m.	*Poor* – Cyanobacteria accumulates to surface blooms practically every summer,sometimes in thick mats and/or covering large areas.	*Poor* - Eelgrass occurs in fragmented patches, collecting a abundant sediment at the plant bases. The vegetation is covered by abundant filamentous algae. The invertebrate diversity is low, but abundance may be high and varies considerably.	*Poor* - The fish community is poor. Cod has decreased due to lack of oxygen in spawning area. Perch is not common, cyprinids have increased. Herring suffers from decreased visibility and reduced spawning grounds (Northern Baltic).	*Poor* - The seafloor is exposed to frequent periods of extensive oxygen deficiency. There is a severe organic enrichment of the sediment. Only the most tolerant benthic taxa survive, and the reduction of diversity, abundance and biomass results in an impaired ecosystem functioning.
Bad - The water is turbid, and often greenish in colour. Near the open sea, the bottom can rarely be seen from the surface at depths over 2 m.	*Bad* – Cyanobacteria accumulates to surface blooms every summer in thick mats and covering large areas.	*Bad* - Where meadows once existed, the bottom is now covered by sedimented organic matter, loose plants and filamentous algae. The vegetation consists of single perennial plants covered by filamentous algae and diatoms, or of massive growths of filamentous algae. The invertebrate diversity is low, but abundance may be high and varies considerably.	*Bad* - The fish community is poor. Perch is not common, cod is rare. Herring suffers from reduced spawning grounds and foodweb effects caused by cod reduction. Cyprinids have increased permanently (Northern Baltic).	*Bad* - Severe oxygen debt and widespread hypoxia/anoxia. Elimination of benthic macrofauna. The absence of benthic bioturbation may result in laminated sediments. Delayed and hysteresis-like recovery pattern.
References: Fleming-Lehtinen and Laamanen 2012	*References: Hansson, M. and Öberg, J. 2010; M. Viitasalo pers.comm.*	*References: HELCOM 2009; Kirsi Kostamo, pers.comm.*	*References: Lappalainen et al. 2000; Uusitalo et al. 2012; Antti Lappalainen and Heikki Peltonen pers.comm.*	*References: Pearson and Rosenberg 1978; Rumohr et al. 1996; Villnäs and Norkko 2011; Anna Villnäs and Alf Norkko pers.comm.*

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Appendix C: The full questionnaire

THE BALTIC SEA

This survey is about your relation to the Baltic Sea and its environment. Your answers will help governments around the Baltic Sea to develop appropriate water quality improvement programmes. All answers are important – it is not necessary at all that you have specific knowledge of water quality or even the Baltic Sea.

By the Baltic Sea we mean the whole sea from the Bothnian Bay in north to the Gulf of Finland in east and Kattegat in west. Around the sea you find Finland, Russia, Estonia, Latvia, Lithuania, Poland, Germany, Denmark and Sweden. The Baltic Sea is depicted with light blue colour in the map below.

1. Do you feel that you live close to the Baltic Sea?

- ◯ Yes
- ◯ No

2. To what extent do you agree or disagree with the following statements about the Baltic Sea? Please tick one, and only one box on each row.

Statement	I totally agree	I agree rather than disagree	I neither agree or disagree	I disagree rather than agree	I totally disagree
I am worried about the Baltic Sea environment	○	○	○	○	○
Baltic Sea environmental problems belong to the three most important environmental problems in Country	○	○	○	○	○
I can myself play a role in improving the Baltic Sea environment	○	○	○	○	○
The protection of the Baltic Sea requires an international agreement	○	○	○	○	○
The environmental degradation of the Baltic Sea has been exaggerated	○	○	○	○	○
It is my duty to get involved in protecting the Baltic Sea	○	○	○	○	○

THE BALTIC SEA AND LEISURE TIME ACTIVITIES

3. Have you ever been to the Baltic Sea or its coast to spend leisure time there?

- ◯ Yes, in the last 12 months
- ◯ Yes, in the last 5 years, but not in the last 12 months
- ◯ Yes, more than 5 years ago
- ◯ No

4. On how many days, during the last 12 months, did you visit the Baltic Sea or its coast for leisure time/purposes?
on about ________days during the last 12 months

5. Which activities do you usually take part in on your leisure visits to the Baltic Sea? You can choose one or several alternatives.

- ☐ Swimming (in the sea)
- ☐ Fishing
- ☐ Boating
- ☐ Being at the beach or seashore for walking, picnicking, sunbathing
- ☐ Water sports (diving, wind surfing, water skiing)
- ☐ Going on a cruise
- ☐ Other, please specify: ____

6. Compared to the Baltic Sea, how often do you visit other water bodies (such as lakes, rivers, fjords, other sea areas) in Country or other countries for water recreation?

- ◯ Visit the Baltic Sea more often than other water bodies
- ◯ Visit the Baltic Sea about as much as other water bodies
- ◯ Visit other water bodies more often than the Baltic Sea
- ◯ Don't know

7. Is it possible to have a similar recreational experience at other water bodies as in the Baltic Sea? You can mark one or several alternatives.

- ☐ Yes, at another sea (for example: the Mediterranean Sea, the North Sea, the Red Sea)
- ☐ Yes, at a lake or a river or a fjord
- ☐ Yes, somewhere else, where: ____
- ☐ No, the Baltic Sea is the only place for such an experience

8. How far from your home is the nearest place where you can have a similar recreational experience as in the Baltic Sea?

- ◯ Closer than the Baltic Sea
- ◯ About as far as the Baltic Sea
- ◯ Farther than the Baltic Sea
- ◯ Don't know

9. Are you going to spend leisure time at the Baltic Sea in the next 5 years?

- ○ Definitely
- ○ Probably
- ○ Probably not
- ○ Definitely not
- ○ Don't know

EUTROPHICATION IN THE BALTIC SEA

Eutrophication means accelerated growth of algae in water bodies. Eutrophication is caused by an excessive amount of nutrients, phosphorus and nitrogen, which the Baltic Sea receives from the rivers and the air. Nutrients originate from agriculture, municipal and industrial waste waters, and marine transportation. Eutrophication concerns the whole Baltic Sea. We all contribute to nutrient emissions, for example by consuming agricultural and industrial products, and producing wastewaters.

In addition to eutrophication, there are other environmental problems present in the Baltic Sea such as overfishing, litter, toxic environmental pollutants and a risk of oil spills. In this survey, we focus only on eutrophication. The following includes some information on the impacts of eutrophication, and we would like to know whether you are familiar with these impacts.

Eutrophication causes *water clarity* to decrease. Water turbidity is caused by the excessive amount of nutrients in the water.

10. Have you heard prior to this survey that water clarity in the Baltic Sea is affected by eutrophication?

- ○ Yes
- ○ No

Algae increase with eutrophication. *Blue-green algae* accumulate on the surface at some parts of the sea causing visible algal blooms.

11. Have you heard prior to this survey about blue-green algal blooms caused by eutrophication in the Baltic Sea?

- ○ Yes
- ○ No

Underwater meadows are important reproduction areas for many fish species. As eutrophication increases, perennial plants give way to overcrowding of algae.

12. Have you heard prior to this survey that underwater meadows in the Baltic Sea are affected by eutrophication?

- ○ Yes
- ○ No

Fish species composition changes due to eutrophication. For example, the stocks of cod, herring and perch decline with eutrophication and the number of fish like roach and bream increases.

13. Have you heard prior to this survey about changes in fish species composition caused by eutrophication in the Baltic Sea?

- ○ Yes
- ○ No

Eutrophication causes *lack of oxygen in deep sea bottoms* in some regions and times of year. As a result these areas become lifeless: plants and bottom animals cannot survive there.

14. Have you heard <u>prior to this survey</u> that eutrophication causes lack of oxygen in deep sea bottoms in the Baltic Sea?

- ○ Yes
- ○ No

15. When did you first hear about the effects of eutrophication in the Baltic Sea?

- ○ In the 1960s or earlier
- ○ In the 1970s
- ○ In the 1980s
- ○ In the 1990s
- ○ In the 2000s
- ○ In the 2010s
- ○ I heard about them the first time from this survey

16a. Have you personally experienced the effects of eutrophication in the Baltic Sea?

- ○ Yes, often
- ○ Yes, sometimes
- ○ No, never
- ○ Don't know

16b. What kind of effects have you experienced? You can choose one or several effects.

- ☐ Water turbidity
- ☐ Blue-green algal blooms
- ☐ Loss of underwater meadows
- ☐ Fish species composition changes
- ☐ Other, please specify____

The effects of eutrophication on water quality in open sea areas

Marine scientists have prepared a colour scale to show <u>how serious eutrophication is in the different parts of open Baltic Sea</u>. Before answering to the following questions, we would like you to familiarise with the colour scale below.

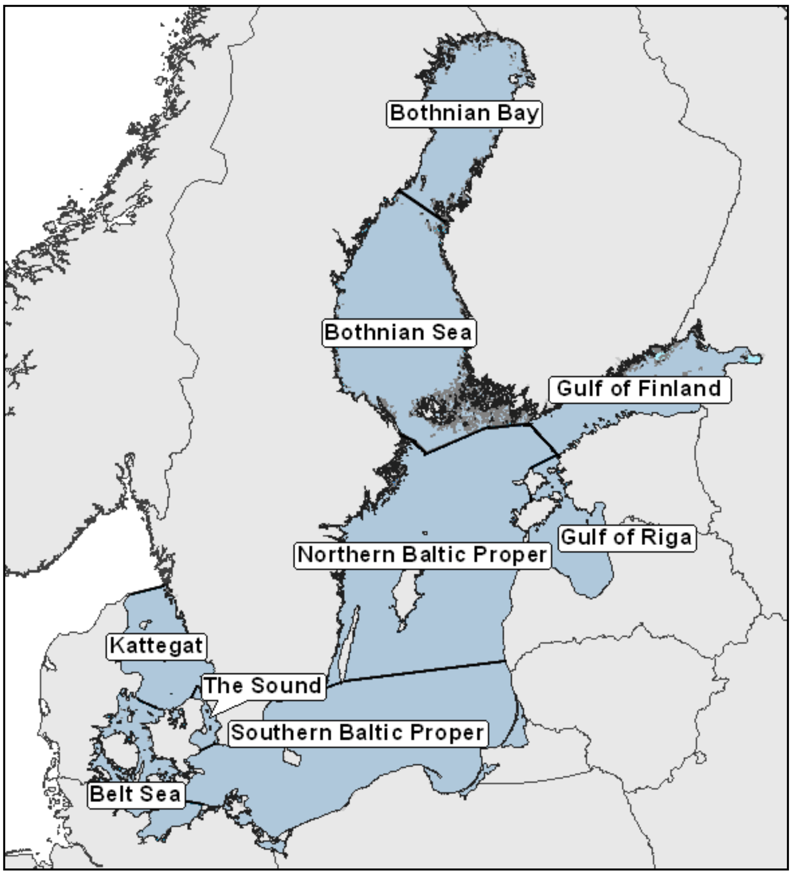
Description of the effects of eutrophication						
Water quality	***Water clarity***	***Blue-green algal blooms***	***Underwater meadows***	***Fish species***	***Deep sea bottoms***	**Water quality**
Best possible water quality	**Clear**	**Seldom**	**Excellent condition Good for fish spawning and feeding**	**Cod, herring and perch common**	**No oxygen deficiency Bottom animals common**	Best possible water quality
	Mainly clear	**Sometimes**	**Patchy vegetation Good for fish spawning and feeding**	**Cod, herring and perch common**	**Oxygen deficiency in large areas Bottom animals common**	
	Slightly turbid	**In most summers**	**Cover a small area Less good for fish spawning**	**Fewer cod, but herring and perch common More roach, carp and bream**	**Oxygen shortages often in large areas Some bottom animals rare**	
	Turbid	**Every summer**	**Cover a small area Bad for fish spawning**	**Fewer cod, herring and perch More roach, carp and bream**	**Oxygen shortages often in large areas Some bottom animal groups have disappeared**	
Worst possible water quality	**Very turbid**	**On large areas every summer**	**Almost gone Not suitable for fish spawning**	**Almost no cod, fewer herring and perch Lots of roach, carp and bream**	**Oxygen shortages always in large areas No bottom animals in many areas**	Worst possible water quality

17a. In your opinion, to which of the colours in the before-mentioned water quality scale does the current water quality <u>in the area of the Baltic Sea that you are most familiar with</u> correspond?

- ◯ Blue (best)
- ◯ Green
- ◯ Yellow
- ◯ Orange
- ◯ Red (worst)
- ◯ Don't know

17b. Which area(s) of the Baltic Sea did you have in mind (see map below)? You can choose one or several areas.

- ☐ Bothnian Bay
- ☐ Bothnian Sea
- ☐ Gulf of Finland
- ☐ Gulf of Riga
- ☐ Northern Baltic Proper
- ☐ Southern Baltic Proper
- ☐ Belt Sea
- ☐ The Sound
- ☐ Kattegat
- ☐ The whole Baltic Sea



18. How do you believe water quality in the Baltic Sea will develop in the next 40 years?

- ○ Water quality will improve
- ○ Water quality will stay the same
- ○ Water quality will deteriorate
- ○ Don't know

19. To what extent do you personally view the following effects of eutrophication in the Baltic Sea as problems or not?

	Not at all a problem	Rather small problem	Neither small nor big problem	Rather big problem	A very big problem
Water turbidity	○	○	○	○	○
Blue-green algal blooms	○	○	○	○	○
Underwater meadows loss	○	○	○	○	○
Fish species composition change	○	○	○	○	○
Lack of oxygen in deep sea bottom areas	○	○	○	○	○

EUTROPHICATION OF THE BALTIC SEA IN 2050

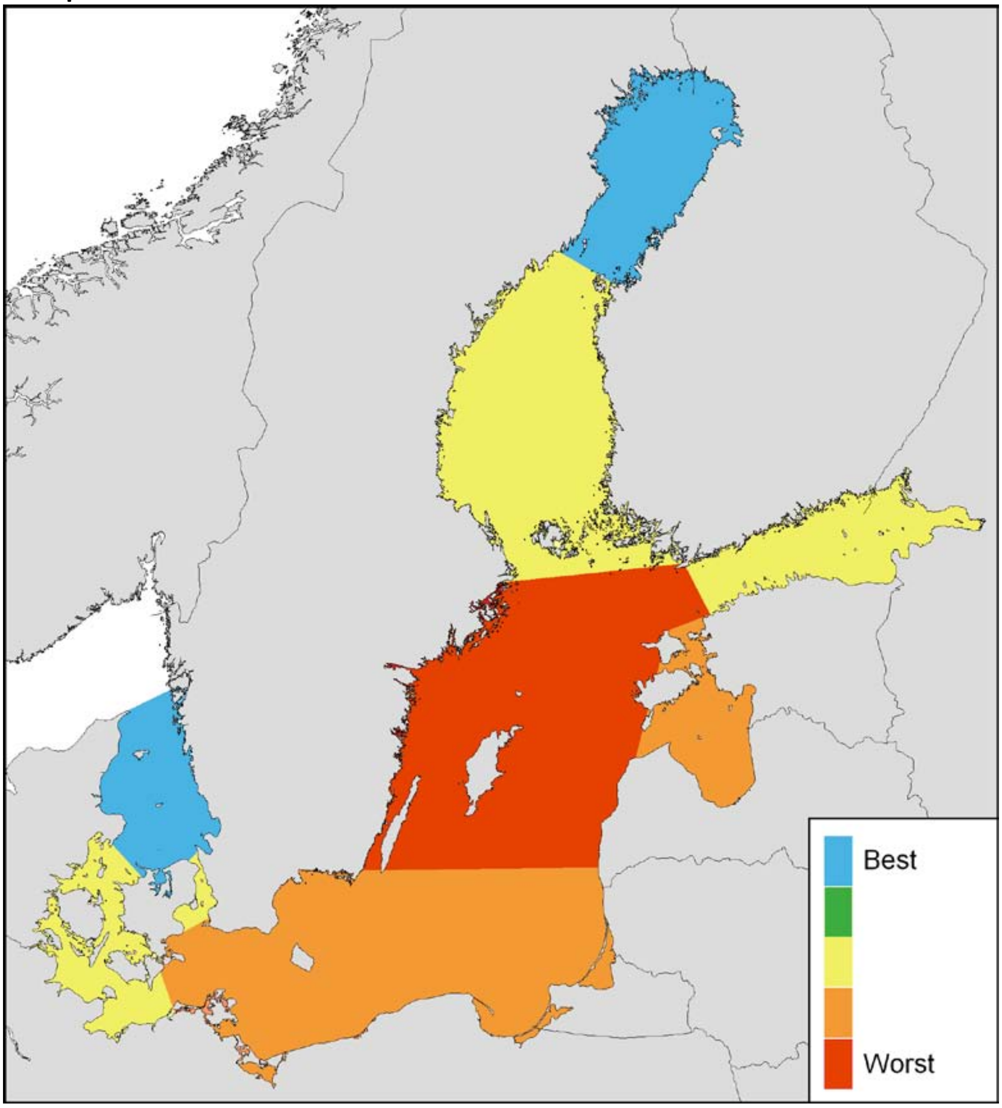
In this survey, the level of eutrophication is presented using maps. The maps have been prepared by marine scientists and they are based on the best available knowledge on the development of eutrophication in the Baltic Sea. We describe the level of eutrophication using the water quality scale described to you previously. The colours on the map correspond to the water quality scale (blue = best level, red = worst level). Click here if you want to see the water quality scale.

We want your opinion on reducing eutrophication in the entire Baltic Sea area. This means that we present eutrophication as an average for large areas. Local conditions can be slightly better or worse from the regional averages shown in the maps.

Eutrophication in open sea areas in 2050

The map below presents the level of eutrophication of the Baltic Sea in 2050 <u>if no additional measures are taken</u> to reduce eutrophication. The current measures will be continued, and hence the state of the Baltic Sea in 2050, presented below, is better than the present state.

Eutrophication of the Baltic Sea in 2050 without additional measures



New international programs to reduce eutrophication in the Baltic Sea

In the following, we present programs to reduce eutrophication in the Baltic Sea.

In these programs, nutrient loads to the Baltic Sea would be reduced for example by reducing the use of fertilizers, changing to phosphate-free detergents and increasing the efficiency of wastewater treatment. Measures that reduce nutrient emissions the most efficiently would be taken. All Baltic Sea countries would agree upon implementing these measures and the chosen program would be internationally binding.

Additional measures to reduce eutrophication costs money, and some of the costs accrue every year. More funds are needed to be able to implement a program. The chosen program would be financed by collecting a special Baltic Sea tax from each individual and firm in all Baltic Sea countries. The payments would be mandatory for all individuals and firms, and they would only be used for reducing eutrophication in the Baltic Sea.

20. Other issues than reducing eutrophication also require attention in the society. **Which two of the following issues do you personally consider the most important in Country?** Please choose two most important issues.

☐ Healthcare
☐ Education
☐ Climate change mitigation
☐ Public safety
☐ Public infrastructure
☐ Water protection
☐ Another issue, please specify____

We would like to know if you would be willing to pay for a program to reduce eutrophication in the Baltic Sea.

When you answer, please remember that:

- You would have to pay the special Baltic Sea tax every year for the rest of your lifetime that would leave you with less money to spend on other things.
- Reducing eutrophication will not improve other environmental problems in the Baltic Sea, such as toxic environmental pollutants, litter, overfishing and the risk of oil spills.
- You have the possibility to use other water bodies, such as lakes, rivers and other sea areas for recreation.

21. Would you be willing to pay anything at all to reduce eutrophication in the Baltic Sea?

○ Yes
○ No
○ Don't know

Next we will present two alternative international programs to reduce eutrophication in the Baltic Sea. The programs differ with respect to the extent of nutrient load reductions, and they lead to different changes in the level of eutrophication. These programs are alternatives to each other, and we wish you to consider them separately.

22. What was the most important reason for you not to be willing to pay for reducing eutrophication in the Baltic Sea? Choose the most important reason.

- ○ The current level of eutrophication in the Baltic Sea is satisfactory
- ○ I can't afford to pay
- ○ I do not believe a program to reduce eutrophication would work
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but not by paying an extra tax
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but I think that those who pollute more should pay more
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but I think that the payment should be income dependent
- ○ I do not care about the Baltic Sea
- ○ I have received too little information
- ○ Other problems are more significant
- ○ I do not believe the money will be used for the purpose
- ○ Other reason, please specify ____

Program option 1

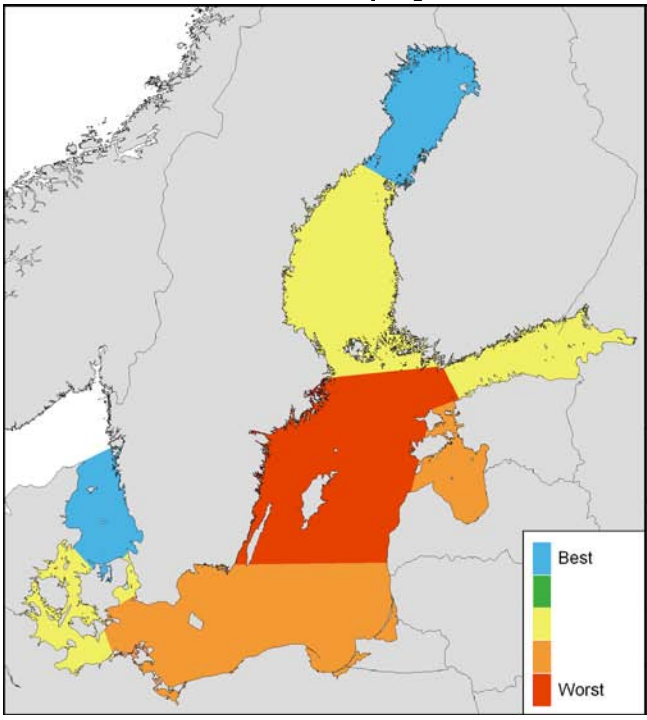
Please compare the following two maps, and think about how much it is worth to you to reduce the level of eutrophication in the Baltic Sea as presented in the maps.

On the left you can see the level of eutrophication in the Baltic Sea in 2050 without a program to reduce eutrophication.
On the right you can see the level of eutrophication in 2050 with program 1 to reduce eutrophication.

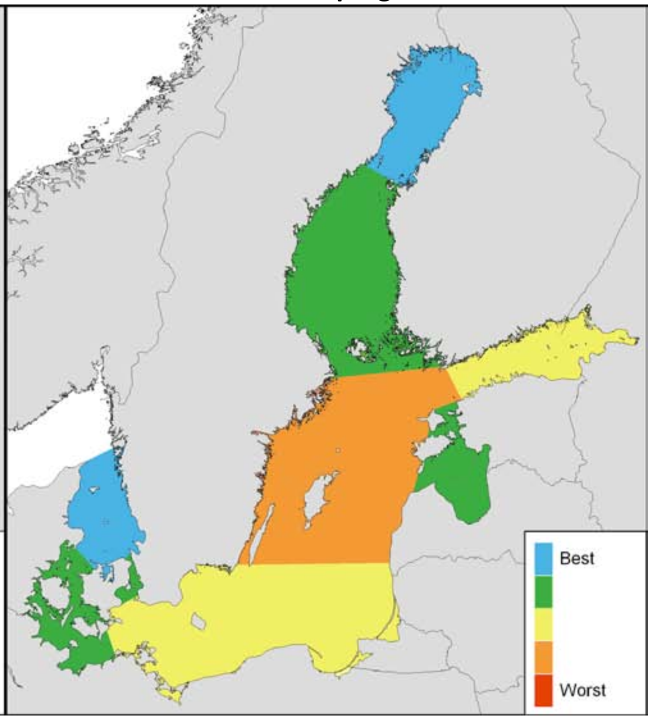
Eutrophication will gradually decrease and water quality improve until it reaches the state in the map on the right in 2050.

Click here if you want to see the water quality scale.

Baltic Sea in 2050 without the program



Baltic Sea in 2050 with program 1



23. What is the most you would be willing to pay every year to reduce eutrophication in the Baltic Sea as shown in the maps? Please consider your disposable income carefully before answering the question.

○	**0 €**	○	**€**	○	**€**	○	**€**	○	**€**
○	**smallest bid €**	○	**€**	○	**€**	○	**€**	○	**highest bid €**
○	**€**	○	**€**	○	**€**	○	**€**	○	**over highest bid €**
○	**€**	○	**€**	○	**€**	○	**€**	○	**don't know**

24. How certain are you about your willingness to pay for reducing eutrophication in the Baltic Sea?
Please circle the level of certainty you have regarding your willingness to pay.

Very uncertain									Very certain
1	2	3	4	5	6	7	8	9	10

25a. What was the most important reason for you to be willing to pay for reducing eutrophication in the Baltic Sea? Choose the most important reason.

- ○ I have used the Baltic Sea for nature experiences and recreation
- ○ I plan to use the Baltic Sea for nature experiences and recreation in the future
- ○ The existence of healthy marine ecosystems and plants and animals is important
- ○ Other people in my generation are able to enjoy the water quality improvements
- ○ Future generations will be able to enjoy the water quality improvements
- ○ You can do a lot for environmental protection with a small contribution
- ○ Other reason, please specify ____

25b. What was the most important reason for you not to be willing to pay for reducing eutrophication in the Baltic Sea? Choose the most important reason.

- ○ The current level of eutrophication in the Baltic Sea is satisfactory
- ○ I can't afford to pay
- ○ I do not believe a program to reduce eutrophication would work
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but not by paying an extra tax
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but I think that those who pollute more should pay more
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but I think that the payment should be income dependent
- ○ I do not care about the Baltic Sea
- ○ I have received too little information
- ○ Other problems are more significant
- ○ I do not believe the money will be used for the purpose
- ○ Other reason, please specify ____

25c. What was the most important reason for you to answer "don't know" in the willingness to pay question? Choose the most important reason.

- ○ I am not sure whether I can afford to pay
- ○ I am not sure whether the program to reduce eutrophication would work
- ○ I am not sure that I care about the Baltic Sea that much
- ○ I have received too little information
- ○ The question was unclear
- ○ I am not sure whether the money will be used for the stated purpose
- ○ Other reason, please specify ____

Program option 2

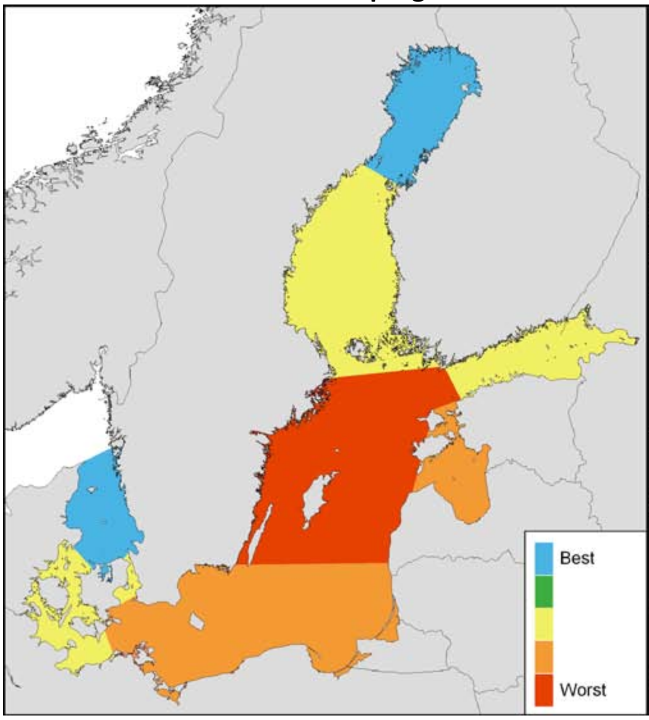
As an alternative policy option, the following program could be implemented instead of the previous program. Please compare again the maps and think about how much it is worth to you to reduce the level of eutrophication in the Baltic Sea as presented in the maps.

On the left you can again see the level of eutrophication in the Baltic Sea in 2050 without a program to reduce eutrophication.
On the right you can see the level of eutrophication in 2050 with program 2 to reduce eutrophication.

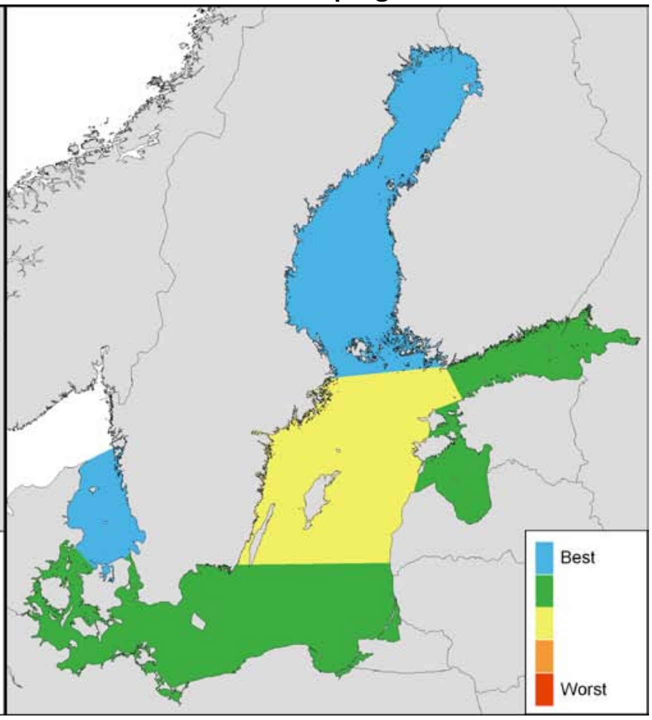
Eutrophication will gradually decrease and water quality improve until it reaches the state in the map on the right in 2050.

Click here if you want to see the water quality scale.

Baltic Sea in 2050 without the program



Baltic Sea in 2050 with program 2



26. What is the most you would be willing to pay every year to reduce eutrophication in the Baltic Sea as shown in the maps? Please consider your disposable income carefully before answering the question.

○	**0 €**	○	**€**	○	**€**	○	**€**	○	**€**
○	**smallest bid €**	○	**€**	○	**€**	○	**€**	○	**highest bid €**
○	**€**	○	**€**	○	**€**	○	**€**	○	**over highest bid €**
○	**€**	○	**€**	○	**€**	○	**€**	○	**don't know**

27. How certain are you about your willingness to pay for reducing eutrophication in the Baltic Sea?
Please circle the level of certainty you have regarding your willingness to pay.

Very uncertain									Very certain
1	2	3	4	5	6	7	8	9	10

28a. What was the most important reason for you to be willing to pay for reducing eutrophication in the Baltic Sea? Choose the most important reason.

- ○ I have used the Baltic Sea for nature experiences and recreation
- ○ I plan to use the Baltic Sea for nature experiences and recreation in the future
- ○ The existence of healthy marine ecosystems and plants and animals is important
- ○ Other people in my generation are able to enjoy the water quality improvements
- ○ Future generations will be able to enjoy the water quality improvements
- ○ You can do a lot for environmental protection with a small contribution
- ○ Other reason, please specify ____

28b. What was the most important reason for you not to be willing to pay for reducing eutrophication in the Baltic Sea? Choose the most important reason.

- ○ The current level of eutrophication in the Baltic Sea is satisfactory
- ○ I can't afford to pay
- ○ I do not believe a program to reduce eutrophication would work
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but not by paying an extra tax
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but I think that those who pollute more should pay more
- ○ I am prepared to pay for reducing eutrophication in the Baltic Sea, but I think that the payment should be income dependent
- ○ I do not care about the Baltic Sea
- ○ I have received too little information
- ○ Other problems are more significant
- ○ I do not believe the money will be used for the purpose
- ○ Other reason, please specify ____

28c. What was the most important reason for you to answer "don't know" in the willingness to pay question? Choose the most important reason.

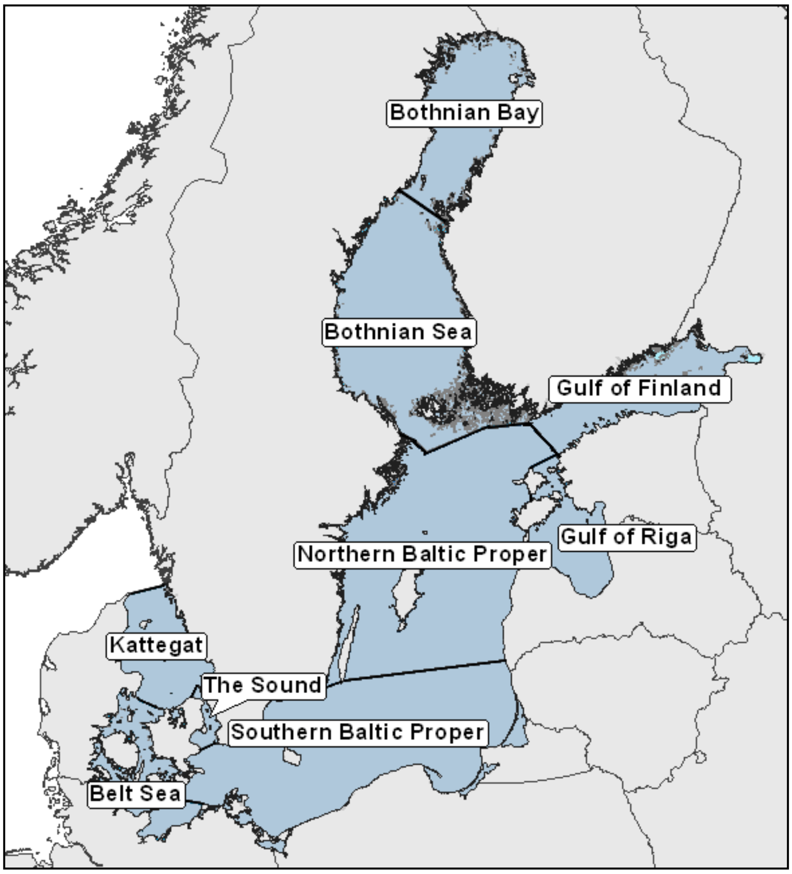
- ○ I am not sure whether I can afford to pay
- ○ I am not sure whether the program to reduce eutrophication would work
- ○ I am not sure that I care about the Baltic Sea that much
- ○ I have received too little information
- ○ The question was unclear
- ○ I am not sure whether the money will be used for the stated purpose
- ○ Other reason, please specify ____

29. Did you consider the whole Baltic Sea or a certain area of the Baltic Sea when answering how much you were willing to pay?

- ○ Whole Baltic Sea
- ○ A certain area of the Baltic Sea

30. Which area(s) of the Baltic Sea did you have in mind when answering how much you were willing to pay (see map below)? You may choose one or several areas.

- ☐ Bothnian Bay
- ☐ Bothnian Sea
- ☐ Gulf of Finland
- ☐ Gulf of Riga
- ☐ Northern Baltic Proper
- ☐ Southern Baltic Proper
- ☐ Belt Sea
- ☐ The Sound
- ☐ Kattegat



31. To what extent did you consider open sea and coastal areas when answering how much you were willing to pay? Please circle the extent you considered the open sea areas or the coast, given that 1 = open sea areas only, 4 = equally and 7 = coastal areas only.

Open-sea areas only			Equally			Coastal areas only
1	2	3	4	5	6	7

32a. Which of the effects of eutrophication did you have in mind when answering how much you were willing to pay? You may choose one or several alternatives.

- ☐ Water turbidity
- ☐ Blue-green algal blooms
- ☐ Underwater meadows loss
- ☐ Fish species composition changes
- ☐ Lack of oxygen in deep sea bottom areas

32b. (To those who marked blue-green algal blooms). **To what extent did you consider blue-green algal blooms in comparison to other effects of eutrophication, when answering how much you were willing to pay?** Please circle your response below, given that 1 = Only blue green algal blooms and 7 = Only other effects of eutrophication.

Only blue-green algal blooms						Only other effects of eutrophication
1	2	3	4	5	6	7

BACKGROUND INFORMATION

To help us understand your answers, we need to know a little bit about you. The information you provide in this survey is completely confidential – this information cannot be connected to you personally. Please provide this information; otherwise we <u>cannot</u> use your other answers.

33. In what year were you born?

____

34. Are you

- ○ Female
- ○ Male

35. How many people live in your household, including yourself?

____

36. How many people in your household are under 18 years old?

____

37. What is your highest level of education?

- ○ Compulsory school
- ○ Vocational education
- ○ High school
- ○ University/Polytechnic
- ○ Other, please specify ___________________________________

38. What is your current occupational status? Please choose only one option that best describes your occupational status.

- ○ Employed full-time
- ○ Employed part-time
- ○ Retired
- ○ Student
- ○ Home-employed/Homemaker
- ○ Self-employed
- ○ Unemployed

39. What is the postal code area you live in?

____

40. What is your monthly net income (after taxes)? Please include all sources of income, including benefits, stipends, pension etc.

- ○ 1st quintile and less
- ○ 2nd quintile
- ○ 3rd quintile
- ○ 4th quintile
- ○ 5th quintile and up

41a. Now that you have completed the questionnaire on the Baltic Sea, we would like to hear opinion on a final question. Think about the **questions about your willingness to pay** for reducing eutrophication in the Baltic Sea. **To which extent do you agree or disagree with the following statements?**

	I totally agree	I agree rather than disagree	I neither agree or disagree	I disagree rather than agree	I totally disagree
I read the questions thoroughly	○	○	○	○	○
I understood the questions completely	○	○	○	○	○
It was easy to answer to the questions	○	○	○	○	○

41b. Now think back to the programs to reduce eutrophication. **To which extent do you agree or disagree with the following statements?**

	I totally agree	I agree rather than disagree	I neither agree or disagree	I disagree rather than agree	I totally disagree
It was easy to understand the maps depicting eutrophication level	○	○	○	○	○
I received enough information about the programs and their effects	○	○	○	○	○
I believe it is possible to implement a program to reduce eutrophication	○	○	○	○	○
I believe countries will commit to a program to reduce eutrophication	○	○	○	○	○
I find it likely that a program to reduce eutrophication will be implemented	○	○	○	○	○

42. Any further comments?

If you would like to make a comment on the survey or anything else, please do so below.

____
____
____
____
____
____

Appendix D. Description of the variables used in the logit and interval regression models

Variable	Description
Dependent	
dWTP	1 if the respondent is willing to pay for either (or both) of the scenarios, 0 otherwise
log(lowWTP) ½BSAP	Natural logarithm of the lower bound for the willingness to pay for the ½BSAP scenario
log(upWTP) ½BSAP	Natural logarithm of the upper bound for the willingness to pay for the ½BSAP scenario
log(lowWTP) BSAP	Natural logarithm of the lower bound for the willingness to pay for the BSAP scenario
log(upWTP) BSAP	Natural logarithm of the upper bound for the willingness to pay for the BSAP scenario
Independent	
Recreation	
frequser	1 if the respondent visited the Baltic Sea at least 25 times during the last 12 months, 0 otherwise
vissure	1 if the respondent states that s/he is definitely going to spend leisure time ate the Baltic Sea in the next 5 years, 0 otherwise
nosub	1 if the respondent feels it is not possible to have a similar recreation experience at other water bodies as in the Baltic Sea, 0 otherwise
BSdist	Distance in hundreds of kilometres between the respondent's place of residence and the Baltic Sea, continuous
RusCoast	1 if the respondent lives in the coastal region (Kaliningrad, Leningrad or Saint Petersburg region), 0 otherwise, only for Russia
Attitudinal and knowledge	
know	1 if the respondent has heard of four out of the five effects of eutrophication, 0 otherwise
exper	1 if the respondent has personally experienced the effects of eutrophication, 0 otherwise
impor	1 if the respondent feels that the environmental issues of the Baltic Sea are among the three most important environmental problems in the respondent's country, 0 otherwise
Socio-demographic factors	
HINC	1 if the respondent's income is in the highest category/categories depending on the country, 0 otherwise
LINC	1 if the respondent's income is in the lowest category/categories depending on the country, 0 otherwise
age	Respondent's age, continuous
female	1 if the respondent is female, 0 if male
hhsize	Household size, continuous
highedu	1 if the respondents has a university level or other higher education, 0 otherwise
Survey mode	
CAWI	1 if the survey mode was computer-aided web interviews, 0 if computer-assisted personal interviews, only for Poland
Other	
ordeff	1 if the more extensive BSAP scenario was shown before the ½BSAP scenario in the survey, 0 if ½BSAP was shown before the BSAP
whole	1 if the respondents considered the whole Baltic Sea instead of some specific area(s) of the Baltic Sea when answering the WTP questions, 0 otherwise
ccoast	1 if the respondent considered coastal areas more than open-sea areas when answering the WTP question, 0 otherwise
Cert½BSAP	Respondent certainty of his/her WTP for the ½BSAP scenario, measured on a scale of 1-10 where 1=very uncertain and 10= very certain
CertBSAP	Respondent certainty of his/her WTP for the BSAP scenario, measured on a scale of 1-10 where 1=very uncertain and 10= very certain

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