SUCOZOMA
Project 1.2.1, subproject on benefits

20 January, 2000
Draft

Beijer Discussion paper No. 128

The regional willingness to pay for a reduced eutrophication in the Stockholm archipelago

by

Tore Söderqvist[a] and **Henrik Scharin**[a,b]

[a] Beijer International Institute of Ecological Economics, The Royal Swedish Academy of Sciences, Box 50005, SE-104 05 Stockholm, Sweden. E-mail: tore@beijer.kva.se.
[b] Department of Economics, Swedish University of Agricultural Sciences, Box 7013, SE-750 07 Uppsala, Sweden. E-mail: henrik@beijer.kva.se.

Abstract

The benefits of reduced eutrophication effects in the Stockholm archipelago, Sweden, are estimated by an application of the contingent valuation method. The mean willingness to pay per adult resident in the counties of Stockholm and Uppsala is estimated to SEK 436-725 per year. This corresponds to a population estimate of SEK 506-842 million per year.

Acknowledgements

This paper describes work carried out in the research project *Sustainable Coastal Zone Management (SUCOZOMA*, project 1.2.1*)* and *Ecological-Economic Analysis of Wetlands: Functions, Values and Dynamics (ECOWET).* Funding from the Swedish Foundation for Strategic Environmental Research (MISTRA), the EU/DGXII Environment and Climate Programme (Contract No. ENV4-CT96-0273) and the Swedish Council for Planning and Coordination of Research (FRN) is gratefully acknowledged.

1. Introduction

Atmospheric and waterborne nutrient emissions to the Baltic Sea have increased considerably during the 20th century; estimates suggest a fourfold increase due to human activities for nitrogen and eightfold increase for phosphorus (Larsson et al. 1985). The eutrophication effects caused by this inflow include an increased water turbidity, a changed composition of the algae flora, an increased frequency of anoxic situations, a disturbed cod reproduction, and possibly more algal blooms (Bernes 1988, Hansson and Rudstam 1990). Concern about the ecological conditions of the Baltic Sea was manifested already in the early 1970's by the signing of the Helsinki Convention in 1974. However, the problems remained, and international agreements were made in the end of the 1980's to reduce the nutrient emissions by 50% by 1995 (cf. Swedish Cabinet Bill 1990/91:90). While various measures have been taken, the objective was not met in Sweden or the majority of the other countries around the Baltic Sea and the North Sea. Additional efforts for reducing the nutrient emissions have therefore been proposed and, to some extent, carried out (Naturvårdsverket 1997). Possible measures include creation of wetlands and buffer zones along watercourses, improved purification in sewage treatment plants, changed agricultural methods, and reduced traffic emissions. See, e.g., Gren (1993), Gren et al. (1996, 1997) for how such measures might be combined in a cost-effective way.

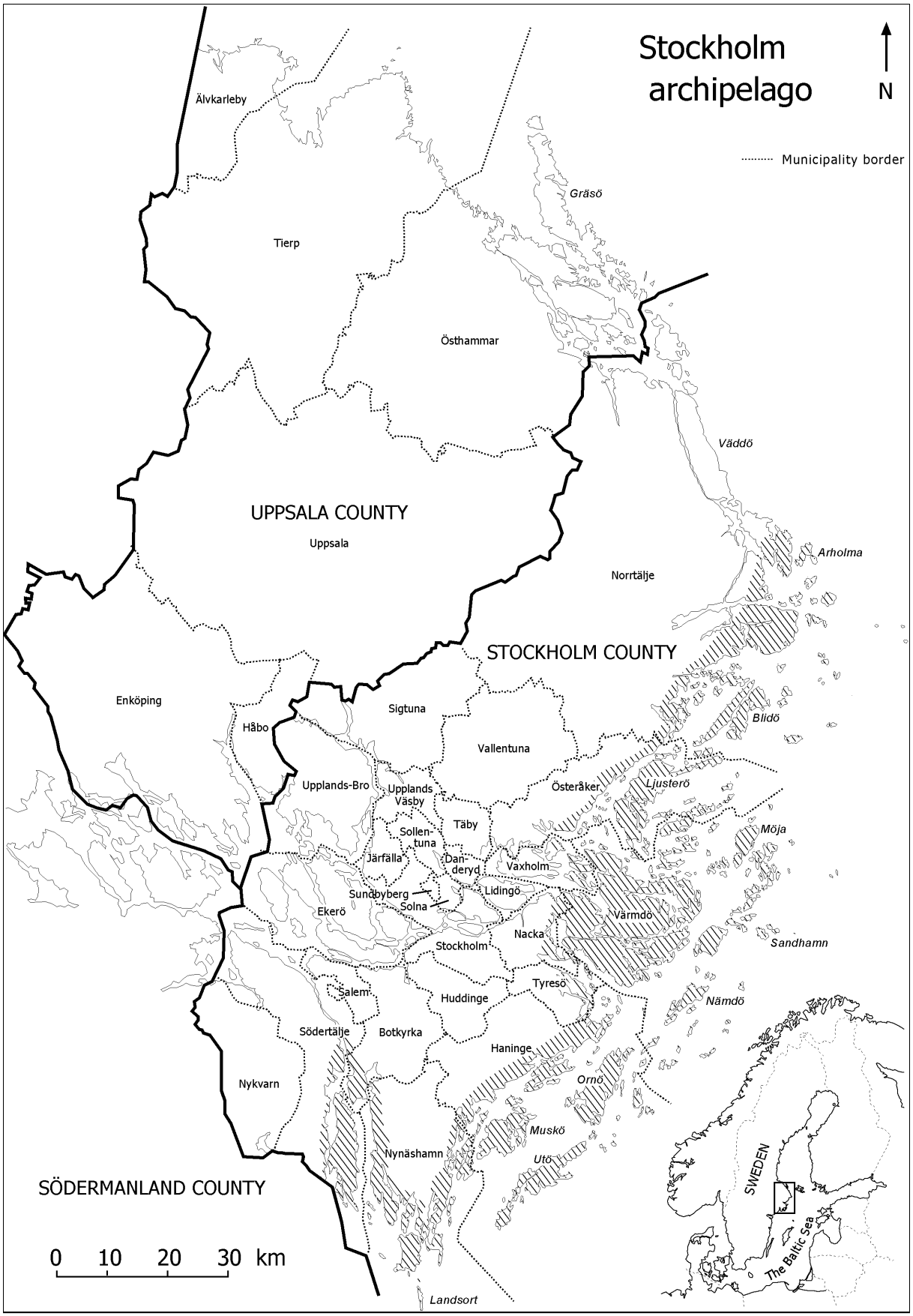
Some of the eutrophication effects are easily perceptible and likely to decrease the quality of seaside recreation. An increased amount of nutrients in the water stimulates the biological production, with an increased turbidity as a consequence. This influences in turn the algae flora along the shores: different fine-threaded (and slippery) algae (e.g., *Cladophora glomerata*) tend to replace bladder-wrack (*Fucus vesiculosus*). To reduce the nutrient load is

thus likely to imply recreational and other benefits that should be balanced against the costs of taking measures against nutrient emissions.

One area where eutrophication is likely to have reduced the recreational quality significantly during the last 30 years is the Stockholm Archipelago. This has probably affected a substantial number of people, since the archipelago is one of the most important recreational areas along the Swedish Baltic Sea coast. It consists of a cluster of approximately 24,000 island, in all-different sizes and shapes. It is situated in Stockholm County (see Figure 1), which has about 1.8 million inhabitants, i.e., about 20% of the total Swedish population. Stockholm County is also the most densely populated county in Sweden (272 inhabitants per km^2 in 1997) (SCB 1999:34). A large proportion of these inhabitants visit the archipelago for recreational purposes; see below and Sandström et al. (2000). It is primarily during the second part of this century that the archipelago has transformed from being a place of permanent residents to a place for recreation and tourism. Structural changes in the agricultural and fishing industries are the main reason for this transformation. The central and especially the outer part of the archipelago is a sleeping community most part of the year until the summer when it is invaded by tourists and cottage owners.

This paper will report the results of an effort to quantify the benefits of a reduced eutrophication by studying people's response to a hypothetical nutrient abatement programme in a survey setting. The particular response that we investigate is people's potential willingness to sacrifice a part of their income for the sake of such an environmental programme, i.e., their willingness to pay (WTP). We apply the contingent valuation method for this purpose, see, e.g., Mitchell and Carson (1989) and Bateman and Willis (1999). See, e.g., Freeman (1993) on the links between WTP and theoretical measures of welfare change.

Figure 1. Map of Stockholm archipelago, as specified in the questionnaire



As far as we know, our study is the first attempt to a systematic study of the benefits of a reduced eutrophication of the Stockholm Archipelago. There are some related studies, however: Sandström (1996) developed a travel cost model in order to study recreational benefits of a reduced eutrophication along the entire Swedish Baltic Sea coast. This study indicated that there is indeed a relationship between the demand for seaside recreation and water turbidity. A contingent valuation study by Söderqvist (1996a) gave some indications about the size of the total benefits of a reduced eutrophication of the Baltic Sea, see also Gren et al. (1997). Frykblom (1998) also followed the contingent valuation approach in an estimation of people's willingness to pay for reduced nutrient emissions to the Laholm Bay, SW Sweden.

The rest of this paper is organised as follows. Section 2 presents the survey and its execution. Respondents' answers to the WTP questions are analysed and related to various determinants in Section 3. An aggregate, regional WTP is estimated in Section 4. In the paper's final section (5), the findings are compared with results from earlier contingent valuation studies, and the relationship between sight depth and nutrient concentration in the Stockholm archipelago is described.

2. Respondents and non-respondents to the survey

2.1. Execution of the survey

The survey had the double purpose of collecting data both about people's recreational behaviour in the archipelago and their willingness to pay for a reduced eutrophication. The recreation data are used for a travel cost study still in progress on recreational benefits of a

reduced eutrophication, see Sandström et al. (2000) for some preliminary results. The relatively large amount of data that had to be collected and budgetary considerations called for the use of a mail questionnaire as the survey instrument. Questionnaire drafts were tested in focus group settings and among boat passengers in June, July and August 1998. The design of the questionnaire followed Dillman's (1978) Total Design Method in all essentials.

The population for the survey was defined as the inhabitants in the county where the Stockholm Archipelago is situated (Stockholm County) and the inhabitants in one neighbouring county (Uppsala County). The inhabitants in Uppsala County are in general likely to have less contact with the archipelago, but a large part of the county is included in the drainage basin of the archipelago and would thus be affected by measures against the nutrient emissions to the archipelago. There were 1,431,700 adult (18-75 years of age) inhabitants in the counties of Stockholm and Uppsala in September 1998. The survey sample consisted of 4,000 inhabitants in 18-75 years of age. The response rate after three reminders was 47.2%, see Table 1.

Table 1. Sample sizes and response rates

	Number of individuals	*Per cent*
Gross sample	4,000	100.0
Deceased, abroad, at hospital, etc.	99	2.5
Net sample	3,901	100.0
Respondents	1,840	47.2
Respondents to follow-up questionnaire	89	2.3
Non-respondents	1,972	50.5

2.2. Follow-up survey of non-respondents

A follow-up questionnaire was sent by mail to 500 randomly selected non-respondents in March 1999. This questionnaire focussed on the contingent valuation part of the original

questionnaire. The non-respondents were also asked to answer a question on why they did not respond to the original questionnaire. 108 answers to the non-response question and 89 completed follow-up questionnaires were obtained, see Table 2. Table 3 shows that no interest in or no experience of the archipelago only accounts for about one fourth of the reasons for non-response. The results of the follow-up survey will be used for making hypotheses of the opinions of the whole group of non-respondents when population estimates are computed in Section 4.

Table 2. Follow-up survey response

	Number of individuals	*Per cent*
Random sample of non-respondents	500	100.0
Respondents to follow-up questionnaire	88	17.6
Respondents to non-response question	108	21.6

Table 3. Reasons for non-response, as stated by the respondents of the follow-up survey

Reason	*Proportion of respondents (per cent)*
1. I'm not interested in/not a visitor to the archipelago	24.1
2. The questionnaire was too difficult	23.1
3. I hadn't enough time to answer the questionnaire	19.4
4. As a principle, I never answer any questionnaires	13.9
5. I forgot to answer the questionnaire	8.3
6. I didn't receive the questionnaire (due to travel, illness, etc.)	6.5
7. Other reasons	4.6
Total	99.9

Number of observations: 108.

2.3. Non-respondent characteristics

The information gained from the follow-up survey can be complemented by a few pieces of information available about all individuals in the original sample: sex, age and place of living, see Table 4. It turns out that females were relatively more willing to respond to the questionnaire; a null hypothesis of independence between sex and being a respondent or a

non-respondent could be rejected.[1] However, respondents and non-respondents do not seem to differ with respect to age and place of living. A null hypothesis of independence between age and being a respondent or not could be rejected.[2] Moreover, there were no rejection of hypotheses of independence in three tests related to the place of living of respondents and non-respondents. For the willingness to respond to the questionnaire, it did not seem to make any difference whether one lives (1) in Stockholm County or Uppsala County; (2) in a municipality in Stockholm County with coastline to the Baltic Sea or not; or (3) in a municipality included in the Stockholm archipelago as defined in Figure 1 or not.[3] Hence, this analysis of non-respondents suggests that due attention should be paid to systematic differences between respondents and non-respondents whenever sex turns out to be a crucial variable. Any other systematic difference could not be found.

Table 4. Sample, respondent and non-respondent characteristics

Characteristic	*Sample*	*Respondents*	*Non-respondents*
Proportion females	0.502	0.538	0.471
Mean age	43.2	43.5	43.0
Proportion living in Uppsala County	0.140	0.140	0.140
Proportion living in a coastal municipality in Stockholm County	0.683	0.678	0.688
Proportion living in an archipelago municipality	0.235	0.236	0.235

[1] $\chi^2(1)=17.7$, $p<0.001$.

[2] $\chi^2(5)=4.38$, $p=0.496$. In the test, age was defined by six groups: ≤25, 26-35, 36-45, 46-55, 56-65 and ≥66 years old respectively.

[3] $\chi^2(1)<0.001$, $p=0.985$; $\chi^2(1)=407$, $p=0.524$; and $\chi^2(1)=0.005$, $p=0.943$ respectively.

3. Respondents' WTP and its determinants

3.1. Valuation scenario and responses to the WTP questions

The valuation scenario included in the questionnaire described a nutrient abatement programme, followed by one closed-ended question about WTP>0 or not, and one open-ended WTP question, see Figure 2.[4] For simplicity, the response options given in the first WTP question will henceforth be referred to as "yes, definitely", "yes, probably" and "no" respectively. Those respondents who chose the first or the second response option subsequently met the open-ended WTP question. An alternative would have been to have yet a closed-ended WTP question that included a "bid">0. It has been shown that the WTP elicited by open-ended WTP questions is on average lower than the WTP elicited from such closed-ended questions (Kriström 1993). An entirely different and not resolved issue is what elicitation method is most successful in making respondents reporting their true WTP.

The payment vehicle chosen was increased expenses due to higher prices of tap water and agricultural products. Increased tax was tested as a payment vehicle in the pilot work, but resulted in a relatively high amount of protest answers. People believed that it would be difficult to ear-mark such tax payments for measures against the eutrophication, and expressed scepticism against introducing yet another tax in Sweden.

The responses to the two WTP questions are summarised in Tables 5 and 6. 39% of the respondents reported that they were definitely willing to accept increased expenses because of the abatement programme, and an additional 44% answered "yes, probably". The answers to

the open-ended WTP question emphasise the greater conviction of the former group; the mean WTP of those who answered "yes, definitely" (SEK 110 per month) is twice as high as the mean WTP of the "yes, probably" group (SEK 55 per month). The difference between these mean WTPs exceeds by far two standard deviations. "No" answers are simply interpreted as zero WTPs.

Figure 2. Valuation scenario and WTP questions in the questionnaire

The water in the Stockholm archipelago might be improved if measures are taken against nutrient emissions from, e.g., agriculture and household sewage.

Suppose that an abatement programme has been proposed. According to this programme, farmers and sewage treatment plants in the counties of Stockholm, Södermanland and Uppsala have to put money into measures against the nutrient emissions. This would in turn result in increased prices of agricultural products and tap water in these three counties. The following would also happen:

- The measures would improve the water quality in the archipelago. For example, the sight depth in the inner and central parts of the archipelago would on average increase about 1 metre in 10 years. This would mean that, for example, in the inner parts of the archipelago, the sight depth would increase from the present average of about 1 metre in summers to about 2 metres in 10 years.
- As a rule, it would thus in 10 years be possible to discern one's feet on the bottom wherever one bathes in the archipelago.

- If no measures are taken, the water quality continues to get worse, and the water gradually becomes more turbid.

X. Would you accept or not accept to pay something in terms of increased expenses in order to make it possible to carry out this nutrient abatement programme?

☐ I WOULD DEFINITELY ACCEPT ➔ **go to question Y**
☐ I WOULD PROBABLY ACCEPT ➔ **go to question Y**
☐ I WOULD NOT ACCEPT ➔ **go to question Z**

Y. What is the maximum increase in expenses that you would accept for this purpose? Please remember that your income has to suffice for other expenses too!
Answer: NOT MORE THAN SEK _____PER MONTH DURING 10 YEARS

[4] There was a variation in the valuation scenario in terms of the degree of certainty of the outcome of the abatement programme. The analysis of this variation is still in progress. The variation is however disregarded here, since it did not introduce any significant differences in responses.

Table 6 provides more details on the answers to the open-ended WTP question. 115 protesters against the valuation scenario were identified from the answers to an open-ended question about motives for the way to respond to the WTP questions, see Table 7. In addition, three respondents reported extraordinary high monthly WTPs in the open-ended WTP question: SEK 6,000, 10,000 and 12,000 respectively. Also these three respondents will be regarded as protesters in the following, since they did not report any reasons for these unusually high WTP amounts. As is shown in Table 6, the exclusion of these 118 protesters from the analysis results in a mean monthly WTP of SEK 71 per person. The corresponding median WTP is SEK 50. Figure 3 illustrates the distribution of WTP amounts; about 90% of the stated amounts are ≤ SEK 100. Table 6 also reports the results that would follow from an assumption that WTP answers of the "yes, probably" group are so uncertain that they should be counted as zero WTP. Such a conservative assumption results in a mean monthly WTP of SEK 43 per person.

Table 5. Answers to the question on WTP>0 or not

Answer	*Number of cases*	*Per cent*	*Mean open-ended WTP in SEK*[a]	*Std dev of mean open-ended WTP in SEK*
Yes, definitely	728	39.1	110	5.66
Yes, probably	822	44.2	55	3.11
No	310	16.7	0	0
Total	1,860	100.0		
Non-responses	69	3.6		

[a] 118 protest answers excluded, cf. Table 7.

Table 6. Answers to the open-ended WTP question

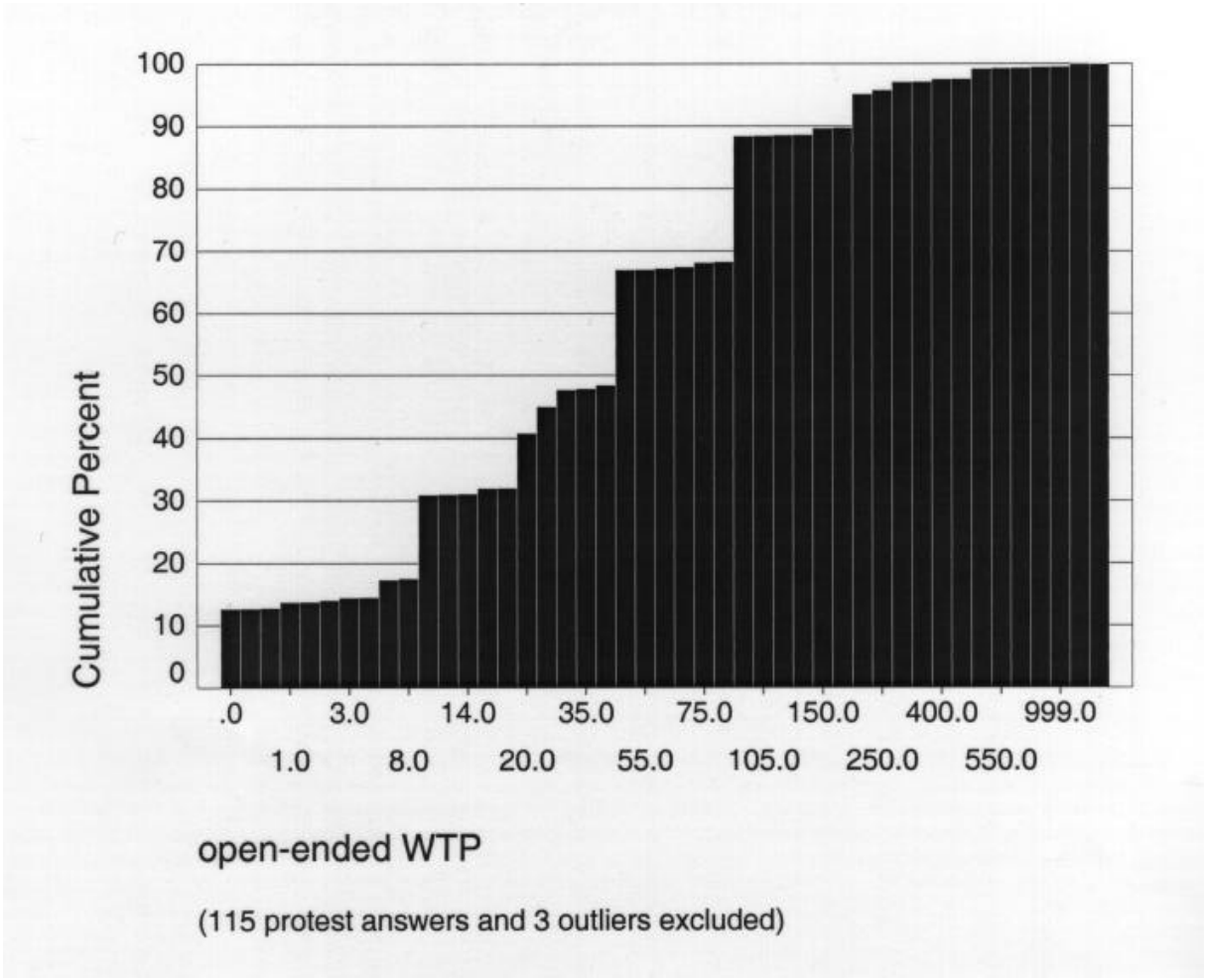
Variable	*n*	*Mean*	*Median*	*Std dev*	*Range*
WTP in SEK per month and person (all observations)	1,655[a]	83.0	30	424	0-12,000
WTP in SEK per month and person (118 protest answers excluded)	1,537	71.2	50	115	0-1,500
WTP in SEK per month and person ("yes, probably" group assumed to have zero WTP, 116 protest answers excluded)	1,670	43.0	0	105	0-1,500

[a] 1,655 observations correspond to a item non-response rate of 14.2%.

Table 7. Protests against the valuation scenario

Type of protest	*Per cent of all respondents (n=1,929)*
"Use the tax I already pay"	3.4
"Others must pay, not me"	2.2
"Changes in the programme are necessary"	0.4
"I have the right to a clean environment"	0.1
No protest	94.0
Total	100.1

Figure 3. The distribution of stated WTP amounts



3.2. Potential determinants of WTP

Table 8 gives a statistical description of variables whose relationship with respondents WTP for realising the programme will be investigated. The last column of the table reports the results of χ^2 tests of independence between each of these explanatory variables and whether the answer on the first WTP question was "yes, definitely" or not. It turns out that the following respondents tended to be relatively more likely to answer "yes, definitely":

- those who owns (or have a family member who owns) a cottage in the archipelago
- those who owns (or have a family member who owns) a boat
- those who visited the archipelago in the summer of 1998
- those who assessed the importance of clean and clear water in the archipelago as relatively high
- those who belong to neither the youngest (≤ 25 years) nor the oldest (≥ 66 years) age group
- those who stated reasons for their answers to the WTP questions
- those who have a relatively high income
- those who live in Stockholm County, not in Uppsala County
- those who live in one of the coastal municipalities in Stockholm County

In contrast, the hypothesis of independence could not be rejected for the case of sex. This indicates that the systematic difference between respondents and non-respondents with respect to sex is not of importance for conclusions about population WTP. It also seems to be independence in the case of residence in the archipelago, which may seem counterintuitive at first glance, but may indicate that those who live in the archipelago is far from a homogeneous group of people. The relationships between the explanatory variables and WTP are further analysed by regressions in the next subsection.

3.3. Multiple regressions

The estimation results from three simple linear regression models with WTP as dependent variable are reported in Table 9. For all models, F tests strongly rejects a null hypothesis that

all coefficients are equal to zero, but the joint explanatory power is low; adjusted R^2 does not exceed 5%. The explanatory variables RESI, COTT, BOAT and VISIT are all related to the respondents' degree of contact with the archipelago, and the positive sign of their coefficients is the expected one. Only the coefficient of VISIT is however significantly different from zero.

Table 8. Survey data: Statistical description

Variable	*n*	*Mean*[a]	*Median*	*Std dev*	*Range*[b]	*Tendency to wtp>0*[c]
Residence in the archipelago (RESI)	1,896	0.062	0	0.243	0/1	$\chi^2(1)=0.012$
Cottage in the archipelago (COTT)	1,894	0.159	0	0.366	0/1	$\chi^2(1)=19.7$***
Boat owner (BOAT)	1,803	0.297	0	0.457	0/1	$\chi^2(1)=55.0$***
Visitor to the archipelago in the summer of '98 (VISIT)	1,890	0.520	1	0.500	0/1	$\chi^2(1)=41.7$***
Importance of good water quality in the archipelago (WQ)	1,881	75.1	71	20.5	0-100	$\chi^2(4)=119$***
Reasons for wtp answer stated (REASON)	1,929	0.561	1	0.496	0/1	$\chi^2(1)=16.2$***
Female (FEM)	1,929	0.544	1	0.498	0/1	$\chi^2(1)<0.001$
Age (AGE)	1,928	43.3	42	15.1	16-78	$\chi^2(5)=11.4$**
Monthly household net income in SEK (HINC)	1,748	19,800	19,000	11,600	0-75,000	$\chi^2(5)=34.1$***
Monthly personal net income in SEK (PINC)	1,828	11,600	11,250	5,930	0-60,000	$\chi^2(5)=34.1$***
Place of residence in Uppsala County (UCOUNTY)	1,830	0.140	0	0.347	0/1	(neg) $\chi^2(1)=6.77$***
Residence in a coastal municipality in Stockholm County (COAST)	1,830	0.678	1	0.467	0/1	$\chi^2(1)=5.60$**
Residence in an archipelago municipality (ARCH)	1,830	0.236	0	0.424	0/1	$\chi^2(1)=0.004$

[a] The mean corresponds to proportion "yes" answers for all 0/1 questions.

[b] For 0/1 questions: code 1 is used for "yes" and 0 for "not yes".

[c] χ^2 tests of independence between each variable and to answer "yes, definitely" or not on the question about zero WTP. Rejection of independence is denoted by *, ** and *** ($p<0.1$, $p<0.05$ and $p<0.01$ respectively). In the test, WQ was turned to five groups (0-20, 21-40, 41-60, 61-80 and 81-100 points), AGE to six groups (≤25, 26-35, 36-45, 46-55, 56-65 and ≥66 years), HINC to six groups (SEK <6,000, 6,000-11,999, 12,000-17,999, 18,000-23,999, 24,000-29,999 and ≥30,000), and PINC to six groups (SEK <4,000, 4,000-7,999, 8,000-11,999, 12,000-15,999, 16,000-19,999 and ≥20,000).

The importance of VISIT is increased in model B, where RESI, COTT and BOAT have been excluded due to the substantial correlation between these four variables. The positive relationships between WQ and WTP and PINC and WTP respectively are expected, and they are also significant. Given model B and mean values of the explanatory variables, the income elasticity of WTP ($\partial WTP/\partial PINC \cdot PINC/WTP$) is 0.27. This can be interpreted as the prediction that a 1% increase in PINC would result in a 0.27% increase in WTP, other things being equal.

In models A and B, FEM does not turn out to have any significance influence on WTP, but AGE has a significant and negative impact. In order to study if the relationship between AGE and WTP is more complex than a linear and negative one, AGE squared was included in model C. While AGE^2 indeed turned out to have a positive coefficient, the estimate is not large enough to reverse the negative relationship between AGE and WTP for reasonable values of AGE.

Table 9. OLS estimation results for three regression models; dependent variable: WTP

Explanatory variable	*Coefficient estimates (t values within parentheses)*[a]		
	Model A	*Model B*	*Model C*
Constant	13.1 (0.839)	14.0 (0.943)	28.3 (1.11)
RESI	1.04 (0.083)	..	..
COTT	12.1 (1.32)	..	..
BOAT	6.60 (0.906)	..	..
VISIT	20.2 (3.09***)	24.4 (4.30***)	24.4 (4.31***)
WQ	0.698 (4.66***)	0.678 (4.78***)	0.690 (4.83***)
FEM	-0.828 (-0.141)	-2.86 (-0.506)	-2.74 (-0.484)
AGE	-0.704 (-3.47***)	-0.634 (-3.26***)	-1.47 (-1.20)
AGE^2	..	..	0.00922 (0.689)
PINC	0.00160 (3.01***)	0.00161 (3.25***)	0.00173 (3.29***)
F	F(8,1463)=9.73***	F(5,1546)=15.0***	F(6,1545)=12.5***
Adjusted R^2	0.045	0.043	0.043
Number of observations	1,472	1,552	1,552

[a] *** denotes rejection of a zero coefficient at $p<0.01$.

4. Estimation of population WTP

To aggregate sample mean WTP estimates to population estimates requires information or at least assumptions about the group of non-respondents. Non-response is due to two sources: non-response to the questionnaire as a whole, and item non-response to the open-ended WTP question. In the former case, we make the assumptions that (1) the results concerning reasons for non-response gained from the follow-up survey are representative for the whole group of non-respondents, (2) the non-respondents who were not interested in the archipelago or were not a visitor to the archipelago have a zero WTP, and (3) the WTP of the non-respondents who reported other reasons for non-response is on average not different from the WTP of respondents.

In the case of item non-response, we assume that the answers to the closed-ended WTP question indicate the WTP of these non-respondents. More precisely, their WTP will be imputed as the mean WTP of the "yes, definitely" and "yes, probably" groups of respondents respectively. The WTP of the item non-respondents who did not answered the closed-ended is assumed to not differ from the WTP of the respondents. The respondents who protested against the open-ended WTP question are however assigned a zero WTP.

The sample WTP estimates that result from these assumptions are reported in Table 10. SEK 60 is the mean monthly WTP per person if all responses to the open-ended WTP question are taken into account as stated by the respondents. SEK 60 corresponds to about 0.5% of the respondents' mean monthly personal net income. A more conservative procedure is to assign a zero WTP to the respondents who were uncertain about their WTP in the sense that they answered "yes, probably" to the closed-ended WTP question. The result is a sample mean

WTP estimate of SEK 37 per person and month, or about 0.3% of the respondents' mean monthly personal net income.

Table 10. Sample mean WTP

Sample group[c]	*Number of obs.*	*Per cent*	*Non-conservative case*[a] *Mean WTP*	*Non-conservative case*[a] *Sample mean WTP*	*Conservative case*[b] *Mean WTP*	*Conservative case*[b] *Sample mean WTP*
R, r(oe), np	1,534	39.3	71	28	43	17
R, r (oe), p	118	3.0	0	0	0	0
R, nr (oe), "y, def."	74	1.9	110	2	110	2
R, nr (oe), "y, prob."	131	3.4	55	2	0	0
R, nr (oe), nr (ce)	72	1.8	71	1	43	1
NR, nv/ni	475	12.2	0	0	0	0
NR, or	1,497	38.4	71	27	43	17
Total	3,901	100		60		37

[a] The answers to the open-ended WTP question given by the respondents who answered "yes, probably" in the closed-ended WTP question are treated as equally valid as the respondent who answered "yes, definitely" in the closed-ended WTP question.

[b] A zero WTP is assigned to all respondents who answered "yes, probably" in the closed-ended WTP question

[c] R: respondent to the questionnaire; r (oe): respondent to the open-ended WTP question; np: non-protester to the open-ended WTP question; p: protester to the open-ended WTP question; nr (oe): non-respondent to the open-ended WTP question; "y, def.": answered "yes, definitely" to the closed-ended WTP question; "y, prob.": answerd "yes, probably" to the closed-ended WTP question; nr (ce): non-respondent to the closed-ended WTP question, NR: non-respondent to the questionnaire; nv/ni: no visitor to the archipelago or not interested in the archipelago (estimate based on the follow-up questionnaire); or: other reasons to non-response (estimate based on the follow-up questionnaire).

The sample mean WTP estimates can now be aggregated to population benefits, see Table 11. Since the population is the adult inhabitants in a region consisting of the counties of Stockholm and Uppsala, we will refer to these benefits as the regional WTP for a reduced eutrophication in the Stockholm archipelago. Depending on the interpretation of the WTP answers of the respondents in the "yes, probably" group, the regional WTP amounts to about SEK 500-850 million per year.

Table 11. The regional WTP for a reduced eutrophication in the Stockholm archipelago

Case	*Mean WTP per adult resident, year 1 (SEK)*	*Regional WTP*[a]*, year 1 (SEK million)*	*Regional WTP, present value*[b] *(SEK million)*	*Regional WTP, present value per year (SEK million)*
Conservative	436	624	5,057	506
Non-conservative	725	1,038	8,419	842

[a] The population is the 1,431,700 residents of age 18-75 years in the counties of Stockholm and Uppsala.

[b] Time horizon: 10 years (as specified in the valuation scenario). Discount rate: 4%.

5. Discussion

The results of the present study and the two earlier Swedish contingent valuation studies mentioned in Section 1 should be compared. Söderqvist (1996a) estimated the benefits of a reduced eutrophication in the entire Baltic Sea based on a quite vague valuation scenario because of the large-scale nature of this issue. Parallel mail surveys were carried out in Sweden and Poland, and they resulted in estimates of a mean annual WTP per person of about SEK 3,000 and 300 respectively. Frykblom (1998) studied the benefits of halved emissions to the Laholm Bay in SW Sweden by a mail survey to inhabitants in three coastal municipalities. The mean annual WTP per person was estimated to SEK 747. Table 11 showed that the corresponding estimates of the present study are SEK 436-725. The estimated income elasticity of WTP of the three studies are 0.24 (Söderqvist 1996a), 0.35 (Frykblom 1998) and 0.27 (present study).

The WTP estimates of Söderqvist (1996a) and Frykblom (1998) are both based on respondents' answers to a closed-ended WTP question, where different group of respondents have considered different WTP "bids". As was mentioned in Section 3.1, this question format usually results in higher mean WTP estimates than open-ended WTP questions; 1.5-7 times higher (average: 3) in a survey of Swedish contingent valuation studies (Söderqvist 1996b). Just for the sake of comparison, let us for a moment apply the average and convert the estimates of the present study to SEK 1,308-2,175. This is an interval in between the estimates of Frykblom (1998) and Söderqvist (1996a). This is reasonable finding, since the Stockholm archipelago is a larger recreational area than the Laholm Bay, at the same time as the eutrophication effects in the Stockholm archipelago is only a subset of the eutrophication

effects in the entire Baltic Sea. Differences in the valuation scenarios of the three studies make however the comparison of the estimates less straightforward.

The regional WTP estimates computed in Section 4 constitute benefits from a reduced eutrophication that may justify a nutrient abatement programme that is consistent with that described in the valuation scenario. The question is whether the costs of accomplishing such a programme would be smaller than the benefits or not. How large-scale does the programme have to be? In order to achieve a given increase in sight depth, one would wish to know what reduction in nutrient concentration in the sea is required, and also what reduction in the nutrient load from land to sea is needed for accomplishing these reduced nutrient concentrations.

One important step towards a full comparison of costs and benefits is to translate the one metre sight depth increase specified in the valuation scenario into the necessary reductions in nutrient concentrations. A preliminary analysis of summer field data from Stockholm archipelago on sight depth and its determinants indicate the following relationship:

$\log S = 4.274 - 1.438(\log N)$

where S is sight depth in metres and N is total nitrogen concentration in mg/m^3 (Ulf Larsson, Department of Systems Ecology, Stockholm University, pers. comm.). This relationship is valid for summer months and for $200<N<750$. It shows a considerable explanatory power ($R^2=0.88$). In this case of the Stockholm archipelago, an inclusion of other explanatory variables such as phosphorus concentration and water temperature does not increase the explanatory power. The estimated sight depth equation indicates, for example, that a 30% nitrogen concentration reduction (from 708 to 496 mg/m^3) (496 to 392 mg/m^3) is necessary in order to accomplish a sight depth increase from 1.5 to 2.5 metres. As another example, a sight

depth increase from 2.5 to 3.5 metres requires a 21% nitrogen concentration reduction (from 496 to 392 mg/m^3). These are thus examples of the reductions in nutrient concentrations that are implied by the abatement programme of the valuation scenario. Models of water flows that would make it possible to link such reductions to the necessary reductions in the nutrient load from land exist for coastal areas such as the Himmer Bay SW of Stockholm (Engqvist and Larsson 1997), but at present not for the Stockholm archipelago as a whole. This is an important area for further research.

References

Bateman, I. J. and K. G. Willis, eds., (1999), *Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU and developing countries*. Oxford University Press, Oxford.

Bernes, C., ed., (1988), *Monitor 1988: Sweden's marine environment – ecosystems under pressure*. Swedish Environmental Protection Agency, Solna.

Dillman, D. A. (1978), *Mail and telephone surveys: the total design method*. John Wiley & Sons, New York.

Engqvist, A. and U. Larsson (1997), "Vattenomsättning och närsaltbudgetar", pp. 118-158 in R. Elmgren and U. Larsson (eds.), *Himmerfjärden: förändringar i ett näringsbelastat kustekosystem i Östersjön*. Report 4565, Swedish Environmental Protection Agency, Stockholm.

Freeman III, A. M. (1993), *The measurement of environmental and resource values: theory and methods*. Resources for the Future, Washington, D.C.

Frykblom, P. (1998), "Halved emissions of nutrients, what are the benefits? A contingent valuation method survey applied to Laholm Bay", in *Questions in the contingent valuation mehtod – five essays*. PhD Thesis, Agraria 100, Department of Economics, Swedish University of Agricultural Sciences, Uppsala.

Gren, I-M. (1993), "Alternative nitrogen reduction policies in the Mälar region, Sweden", *Ecological Economics* **7**, 159-172.

Gren, I-M., K. Elofsson and P. Jannke (1996), "Cost-effective nutrient reductions to the Baltic Sea", *Environmental and Resource Economics* **10**, 341-362.

Gren, I-M, T. Söderqvist and F. Wulff (1997), "Nutrient loads to the Baltic Sea: Ecology, costs and benefits", *Journal of Environmental Management* **51**, 123-143.

Hansson, S. and L. G. Rudstam (1990), "Eutrophication and Baltic fish communities", *Ambio* **19**, 123-125.

Kriström, B. (1993), "Comparing continuous and discrete contingent valuation questions", *Environmental and Resource Economics* **3**, 63-71.

Larsson, U., R. Elmgren and F. Wulff (1985), "Eutrophication and the Baltic Sea: causes and consequences", *Ambio* **14**, 9-14.

Mitchell, R. C. and R. T. Carson (1989), *Using surveys for valuing public goods: the contingent valuation method*. Resources for the Future, Washington, D.C.

Naturvårdsverket (1997), "Nitrogen from land to sea: main report". Report 4801, Swedish Environmental Protection Agency, Stockholm.

Sandström, M. (1996), ”Recreational benefits from improved water quality: A random utility model of Swedish seaside recreation”, Licentiate Thesis, Working Paper in Economics and Finance No. 121, Stockholm School of Economics.

Sandström, M., H. Scharin and T. Söderqvist (2000), “Seaside recreation in the Stockholm archipelago: travel patterns and costs”. Mimeo, SUCOZOMA Project 1.2.1, Beijer International Institute of Ecological Economics, The Royal Swedish Academy of Sciences, Stockholm.

SCB, Statistiska Centralbyrån (1999), *Statistisk årsbok 1999*. Statistics Sweden, Stockholm

Söderqvist, T. (1996a), “Contingent valuation of a less eutrophicated Baltic Sea”, Beijer Discussion Paper Series No. 88, Beijer International Institute of Ecological Economics, The Royal Swedish Academy of Sciences, Stockholm.

Söderqvist, T. (1996b), “Ekonomisk värdering av miljön: metoder och svenska erfarenheter”, pp. 5-73 in *Expertrapporter från Skatteväxlingskommittén, SOU 1996:117*. Ministry of Finance, Stockholm.

Swedish Cabinet Bill 1990/91:90, *Ny miljöpolitik [New environmental policy]*. Stockholm.