Recreational benefits from improved water quality: A random utility model of Swedish seaside recreation.

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This version: 14 May 1998

Abstract
In this paper, a random utility maximization (RUM) model of Swedish seaside recreation is used to estimate the benefits from reduced eutrophication of the seas around Sweden. Sight depth data from around the Swedish coast are used as a quality index related to eutrophication. The model is estimated using the nested multinomial logit (NMNL) and conditional logit (CL) specifications.

In order to test the relationship between this quality variable and the nutrient concentration in the water, a regression of sight depth on the concentration of phosphorus and nitrogen has been run. The results are used to make policy simulations.

Two sets of such simulations have been undertaken. One set assumes a uniform change of the nutrient load along the entire Swedish coastline. The consumer surplus from a reduction of the nutrient load by 50 percent is estimated to be around 240 mSEK if the NMNL model is used, and 540 mSEK if the CL model is used.

The other set of policy simulations assumes a change in the nutrient load in the Laholm Bay in south-west Sweden. The consumer surplus for a 50 percent reduction in the nutrient load in the bay is estimated to be 12 mSEK if the NMNL model is used, and 32 mSEK if the CL model is used.

* I am indebted to Professor Lars Bergman and Professor Per-Olov Johansson at the Stockholm School of Economics. Professor Bengt Kriström at the Department of Forest Economics, Swedish University of Agricultural Sciences, Umeå has provided invaluable advise. The analysis of the Tourism and Travel Database has been carried out in cooperation with, and with assistance from, Professor Lars Hultkrantz and Reza Mortazavi, CTS, Dalarna University, Borlänge. The work would not have been possible without the scores of people who have kindly assisted me with data on water quality and other data. Seminar participants at the Stockholm School of Economics, at CTS, and at the Department of Forest Economics, Swedish University of Agricultural Sciences, Umeå have given clear-sighted comments on an earlier version of the paper. Any remaining errors are the responsibility of the author. Financial support from the National Swedish Environmental Protection Board is gratefully acknowledged.
1 Introduction

Seas, lakes and rivers provide a large number of services. This paper focuses on one of these, namely their recreational function. The travel cost method is applied to estimate recreational benefits from water quality improvements.

We would suspect water quality changes caused by environmental degradation to have important effects on the recreationists' benefit from a trip to, for example, a lake or a sea-side resort. Chemical substances or pathogenic bacteria in the water may have health consequences. High concentration of algae or other biological substances can be unpleasant. Oilspills may make bathing impossible. Conversely, improved recreational quality may account for a substantial part of the benefits from water clean-up programs. Bockstael, Hanemann and Strand (1987) cite Freeman’s (1979) assertion that over half the value from improved water quality is usually due to recreational values.

In some instances, water pollution will have only local effects. More often, however, entire aquatic systems are affected. Also, demand for recreation at a certain site cannot be studied in isolation. How the consumers' decisions are affected by quality changes at one or several sites will intimately depend on the availability of substitutes. For these reasons, a study of recreational costs or benefits from policies that may change water quality should ideally include 1) all sites that are affected by the proposed policy and 2) all sites that are possible substitutes to any site that is affected by the proposed policy.
Violating the first of these conditions will simply mean that we measure only part of
the total recreational benefits, which may be what we are interested in, anyway.
However, violations of the second conditions may have more important consequences.
Interpreting the condition in the light of Hanemann and Morey (1992) gives some
insight into why that is. They analyze the case where data is available only on a
subset of the commodities that enter the individual’s utility function. If the group of
data commodities is, using the term of Blackorby, Primont and Russel (1978),
recursively separable from all other commodities, a set of demand functions can be
constructed based only on the prices and quality aspects of the separable group of
commodities. Terming such a demand system a partial demand system, a compensated
(equivalent) variation measure based on this demand system is consequently called a
partial compensated (equivalent) variation.

Hanemann and Morey (1992) show that this partial compensated variation is a lower
bound on compensated variation calculated from the complete demand system. If the
data commodities have zero income effects, then the two measures will be identical. In
other cases the size of the difference will roughly depend on the marginal rate of
substitution between the data commodities and the other commodities – the smaller
the degree of substitutability, the smaller the difference. If, on the other hand, some of
the non-data commodities are close substitutes to the data commodities the divergence
can be substantial.

In a recreational demand model, we would thus like to isolate a category of recreation
for which we can reasonably assume that the individual would not easily substitute,
e.g., with other forms of recreational activities. If we think that sea-side recreation on
the French Mediterranean coast is quite similar to such recreation in Spain or Italy, then we would make a mistake by only studying sites on the French side of the boarders.

The present study makes use of the Tourism and Travel Database, the TDB, which is based on telephone interviews with a random sample of 2000-4000 Swedes each month. Information is assembled on recreational and business travel during each month (Swedeline, 1995). From the TDB, all data on summer recreation to the Swedish coast is selected. It is reasonable to expect that this provides us with a thorough coverage of this form of recreational travel.

It is also fair to believe that, for Swedes sea-side recreation to sites at the Swedish coast is a group of commodities that have no close substitutes. Recreation by a lake is quite different in character. Traveling abroad can also reasonably be thought to be very different from domestic recreation. On the other hand, different Swedish coastal sites may be close substitutes to each other.

The seas around Sweden are the Skagerrak, the Kattegat, the Öresund, and the Baltic sea. Especially the last three of these have been heavily affected by eutrophication, which is in the focus of this study. Eutrophication is caused by an oversupply of nutrients to the water and has been suspected of causing changes in the macroalgal flora (Wennberg, 1987) and more frequent algal blooms (Granéli et alii, 1989). Also, a higher nutrient load decreases the transparency of the water by increasing primary production (Rosenberg, 1990). Eutrophication can thus be expected to have a negative impact on the quality of seaside recreation. A random utility maximization (RUM) model is used to evaluate hypothetical changes in the emissions of nutrients. A simple
quality measure related to eutrophication, sight depth, is employed in the estimations. Even though this particular class of travel cost models has been widely used as an evaluation tool in the USA (Kaoru, 1995 and Hausman, Leonard and McFadden, 1995 are two recent examples.) this is, to the knowledge of the author, the first European application of discrete choice models to recreational demand.

From the discussion above, it follows that to asses the recreational benefits from policy measures that have only a local effect we would still need to take account of recreation to most of the Swedish coast. To evaluate any policy measures that have recreational effects, similar problems are likely to occur. The method used in this study should thus have many applications.

Section 2 is a presentation of the model and the data. In any travel cost study, the definition of the travel cost variable will be of principal significance. Section 3 addresses this issue. To be able to use a recreational demand model to evaluate environmental change, another factor will also be crucially important. If the variable linking pollution to recreational behavior is not well chosen, the valuation exercise will be fruitless. The choice of quality variable is dealt with in section 4. Sections 5 and 6 present estimation results and the results from two policy simulations. The last section offers a few concluding remarks.
In a RUM model, the individual is seen as choosing between a finite number, say N, of mutually exclusive alternatives (See, e.g., Smith, 1989, Bockstael, McConnell and Strand, 1991, Small and Rosen, 1981, Maddala, 1983 or McFadden, 1976). The alternatives are such that the individual either consumes a fixed quantity of an alternative, or he does not consume it at all. In the travel cost framework, each alternative corresponds to a recreational site. The utility of an individual, conditional on choosing site j, is determined by a row vector of characteristics of the site, \( \mathbf{b}_j \), the individual’s income, \( y \), the cost of visiting the site and of a random component, \( \varepsilon_j \).

Thus, his conditional utility can be written:

\[
\tilde{v}_j = \tilde{v}(y - p_j, \mathbf{b}_j, \varepsilon_j)
\]

where use is made of Hanemann’s (1982) result that in a pure discrete choice model, price and income must enter the utility function as \( y - p \).

The individual will visit the site from which he derives the highest utility. In recreational demand models, it is usually assumed that \( \tilde{v}_j \) is composed of a deterministic part, \( V(y - p_j, \mathbf{b}_j) \), and a random term that is additive, and independently and identically distributed. The function \( V \) is commonly taken to be linear in the row vector \( y - p_j, \mathbf{b}_j \).

Suppose the N alternatives can be divided into S subgroups, such that each alternative belongs to exactly one subgroup. The individual is then seen as choosing first among subgroups, then among alternatives within each subgroup. For a thorough discussion of the model used in this paper, and the underlying theoretical considerations, see Sandström (1996).
the subgroups, and then between the alternatives belonging to the chosen subgroup. The decisions are assumed to be independent over decision levels. In other words, different factors affect the decisions at the two levels. In the travel cost framework, the subgroups would be groups of similar sites, e.g., sites within the same region.

Suppose further that the vector of site characteristics can be divided into regional characteristics, which are constant over sites belonging to the same region, and site specific characteristics, which vary also within the regions. Denote the set of choices \( j \) belonging to subgroup \( s \) by \( \Sigma_s \), for \( s=(1,2,\ldots,S) \) and write the deterministic part of the conditional utility of site \( j \in \Sigma_s \), \( V_{j,s} \), as:

\[
V_{j,s} = Y_s \beta_a + Z_{j,s} \beta_b,
\]

where \( Y_s \) is the vector of regional characteristics of region \( s \), \( Z_{j,s} \) are the characteristics of site \( j \), and \( \beta_a \) and \( \beta_b \) are the associated column vectors of parameters. It can then be shown that the probability that the individual will choose subgroup \( s \) can be written (see, e.g., Anderson, de Palma and Thisse, 1992 or McFadden, 1976):

\[
\pi_s = \frac{e^{Y_s \beta_a + I_s (1-\sigma)}}{\sum_{t=1}^S e^{Y_t \beta_a + I_t (1-\sigma)}}
\]

where

\[
I_s = \ln \left( \sum_{j \in \Sigma_s} e^{Z_{j,s} \beta_b / (1-\sigma)} \right), \text{ for } t=1,2,\ldots,S.
\]

Given that the individual has chosen subgroup \( s \), the probability that he will choose alternative \( j \in \Sigma_s \) can be written:
\[ \pi_{j,t} = \frac{e^{Z_{j,t} \beta_{t} / (1 - \sigma)}}{\sum_{k \in \Sigma_s} e^{Z_{k,t} \beta_{t} / (1 - \sigma)}} \]

\( I_t \) is termed an inclusive value and can be seen as a measure of the attractiveness of region \( t \). The coefficient on the inclusive value, \( 1 - \sigma \), is often called the dissimilarity parameter, as it can be seen as a measure of the degree of similarity of alternatives belonging to each group. McFadden (1981) has shown that this coefficient must lie in the unit interval for the model to be consistent with stochastic utility maximization. A value close to zero implies great similarity between the alternatives in the subgroup, and a value close to one denotes little similarity. Restricting \( 1 - \sigma \) to one reduces the NMNL model to the conditional logit model of McFadden (1973). In this paper, results are presented both from NMNL and conditional logit models.

The NMNL model can be estimated “from the bottom up”. Thus, we first estimate (5) to obtain the parameters of the lowest level. Using these, the inclusive values of equation (4) are calculated. Treating the inclusive values as an independent variable, we can then estimate the top level using (3).

The function \( V \) is assumed to have the following form:

\[ V_j = \beta_1 \text{TTC}_{j,s} + \beta_2 \text{LNSIGHT}_{j,s} + \beta_3 \text{BEACH}_{j,s} + \beta_4 \text{LICENCE}_{j,s} + \beta_5 \text{SUN}_s \]

where \( \text{TTC}_{j,s} \) is the total cost of visiting site \( j \) in region \( s \) and \( \text{LNSIGHT}_{j,s} \) is the natural logarithm of an index of sight depth at the site. \( \text{BEACH}_{j,s} \) is the number of beaches, \( \text{LICENCE}_{j,s} \) is the number of alcohol serving licenses per thousand inhabitants and \( \text{SUN}_s \) is the average hours of sunlight per month. The variable \( \text{SUN}_s \) is thus taken to be a regional variable, while all the others are site specific.
The reason for taking the natural logarithm of sight depth is that it is reasonable to assume the marginal benefit of increased sight depth to be decreasing. The difference between one and two meters of sight depth is certainly going to be more noticeable than the difference between eleven and twelve meters.

To use the estimated model to evaluate policy, we need some measure of the change in welfare from a change in the characteristics of one or several sites. Assume that the marginal utility of income is approximately independent of prices and characteristics of the sites and that income effects are negligible. Further, assume that the recreational trip is non-essential and that the characteristics of the sites satisfies weak complementarity in the sense of Mäler (1974). (See also Bockstael and McConnell, 1993). Under these conditions, Small and Rosen (1981) show that the following expression gives a valid measure of the compensating variation for a change in the characteristics of one or several sites:

\[
CV(V^1, V^0) = \frac{1}{\lambda} \ln \left( \sum_{j=1}^{N} e^{V^0_j} \right)^{\lambda V^1}
\]

where \( \lambda \) is the (constant) marginal utility of income and the vector \( V_i \), \( i \in \{0,1\} \), is the vector of values of the deterministic part of utility of all alternatives, evaluated at the initial \((i=0)\) and final \((i=1)\) values of the site characteristics. Thus, \( V^i = \{V^i_1, V^i_2, \ldots, V^i_N\} \), where \( V^0_j \) (\( V^1_j \)) is deterministic utility from visiting site \( j \) with initial (final) values of site characteristics. Silberberg (1972) has shown that this line integral is path independent.
As can be seen from (3) and (5), the parameters of any characteristic that is constant over alternatives will cancel out of the expression of the probabilities and hence will not be possible to estimate. The individual’s income will, naturally, be the same regardless of which site he chooses. However, marginal utility of income can still be obtained as the negative of the parameter on price, due to the Hanemann (1982) result referred to above.

There is no obvious way to decide what should constitute a ”site” in a travel cost model. In the present study, the data dictates the definition. The lowest useful distinction of the destination of a trip in the TDB is municipality (kommun). Thus, each coastal municipality in Sweden is treated as a separate site.

The island of Gotland is excluded from the study, as are the four northern coastal counties of Sweden, that is, the coast of Norrland. The reason for not including Gotland is, firstly that it is an island, with the consequence that the travel patterns for visitors to Gotland are very different from those of visitors to the mainland coast, and secondly, that data on sight depth is not available. Norrland is excluded because, due to climate and demography, a very small fraction of seaside recreation takes place in this part of the country. In addition, water discharged from the large rivers of northern Sweden often makes the water in the northern Baltic sea muddy. As a consequence, sight depth may be less functional as a quality measure in this area. In total, 66 municipalities are included in the study. In the NMNL model, the recreationist is assumed to first choose among four coastal regions, and then between the municipalities in that region.
The characteristic of the sites in which we are most interested is the sight depth. The use of this variable as a measure of water quality, and how it is constructed, will be discussed in section 4. The number of beaches is included as an explanatory variable to control for differences in the general attractiveness of different sites, and for their varying size. Data was obtained from an ordinary road map (K.A.K. Bilatlas Sverige, 1992). The number of alcohol serving licenses per thousand inhabitants is included as a proxy for the night life at the site, to control for other possible attractions than just the sea. Data on the number of licenses were obtained from the Swedish Alcohol Inspection Board (Alkoholinspektionen, 1996), and population statistics were obtained from the Swedish Federation of Municipal Councils (Svenska Kommunförbundet, 1994). Naturally, the number of hours of sunlight will have an impact on site attractiveness. Data on this variable, which is calculated as an average for each month of the year over the years 1961-1990, were obtained from the Swedish Institute for Meteorology and Hydrology, SMHI (1994).

A key issue in travel cost research has been how travel cost should be measured. In particular, much attention has been given to the question of how the cost of travel time should be included in the analysis. (See, e.g., Randall, 1994, Englin and Shonkwiler, 1995 and Bockstael, Hanemann and Strand, 1987.) The next section describes how the travel cost variable is constructed.

3 Travel cost

The standard method of calculating travel cost in travel cost studies is to multiply the distance to the different sites with a hypothetical kilometer price, usually calculated
on the basis of vehicle operating cost, gas price, etc. To this cost, a cost of travel time is added. In this study, a cost function is instead estimated based on stated cost (This approach is basically the same as that of Boonstra, 1993). A regression was run with stated cost as the dependent variable, and mode of travel, distance traveled, duration of the trip, choice of accommodation and number of household members participating in the trip as explanatory variables. Setting the model in the household production function framework provides a justification for this approach. (Sandström, 1996)

All data used in this regression are from the TDB, except the distance variable, which was obtained from a distance matrix from the Swedish Road Authority (Vägverket). The regression equation and estimation results are presented in appendices A and B, respectively.

The coefficients on the distance traveled for the different modes of transport are interpreted as the kilometer price of travel, and were multiplied with the distance to each site to obtain the out of pocket cost of traveling to each site. To account for the cost of time, the results from Johansson and Mortazavi (1995) were used. They use the TDB to estimate the time cost of recreational travel for different modes of transport, using a RUM model. Their assumptions on the time it takes to travel a certain distance, and their estimates of the cost per hour of recreational travel were used to calculate the time cost to each destination. This cost was added to the out of pocket cost of travel to obtain total travel cost.

A number of specifications of the model for the cost of a trip were tested. In some of the regressions, the cost of a trip is allowed to be non-linear in distance traveled. However, the results from these estimations were hard to interpret. With the
assumption that the kilometer price of travel is independent of distance traveled, other alterations of the model do not appear to have any noteworthy effect on this kilometer price. The model thus appears reasonably robust to specification.

Hopefully, this approach leads us some way towards meeting the criticism expressed by Randall (1994). He claims that a fundamental problem with the travel cost method is that travel cost is unobservable. Using the stated cost, and the detailed data available from the TDB, may hopefully help us to come closer to a true measure of travel cost.

4 Water quality

The crucial factor in the travel cost model is the sight depth variable, as it provides the link with the nutrient load. In other words, it is the link between the environmental variable that can be influenced by policy, the concentration of phosphorus and nitrogen in the water, and recreational behavior. If this link does not hold, the whole exercise will be meaningless. Data on sight depth had to be acquired from a number of sources, but turned out to be available for most stretches of the coast. (Full details are available in Sandström, 1996)

There is little doubt that a link does exist between nutrient load and sight depth. An increase in inflow of nutrients increases primary production, i.e., the content of organic material in the water, which reduces the transparency of the water (Rosenberg, Larsson and Edler, 1986). In an attempt to quantify this connection, a simple regression was run. Data on sight depth, water temperature and concentration of phosphorus and nitrogen from nine observation points in three municipalities in
Östergötlands län (county) for the years 1975-1993 were obtained from Motala Ströms Vattenvårdsförbund, and the following model was estimated using OLS:

\[
\text{LNSIGHT} = 5.62 - 0.0156 \times \text{WTEMP} - 0.625 \times \ln(\text{TN}) - 0.177 \times \ln(\text{TP})
\]

\[
(18.8) \quad (-4.47) \quad (-12.7) \quad (-3.37)
\]

where LNSIGHT is the natural logarithm of sight depth, WTEMP is water temperature, TN is total nitrogen content and TP is total phosphorus content. Water temperature was included to control for seasonal variations. The figures within parenthesis are t-values calculated from White’s consistent covariance matrix (See e.g. Greene, 1993).

The parameters on TN and TP have the expected negative signs and are significant at more than the 99 percent level of significance. Thus, the link between the quality index chosen for this study and the physical entities that can be affected by environmental policy measures seems to be validated.

A number of specifications of the sight depth model were estimated. The model with the highest adjusted $R^2$ was chosen. That turned out to be the log-log model. Such a relationship between sight depth and nitrogen and phosphorus also accords well with the results from marine biological research. (Larsson)

### 5 Estimation results

Separate models were estimated for, on the one hand, those traveling by car or public means of transportation and, on the other hand, for those traveling by private boat.

For the first group, both a conditional logit and an NMNL model were estimated, while the small number of observations on boat recreationists allowed only the
estimation of a conditional logit. The total size of the sample is 2,425 trips, of which 217 were made by private boat. The estimation results are presented in table 1 below.

Figures within parenthesis are the asymptotic standard errors of the coefficients. In the top level of the NMNL model, the inclusive value is a random variable. The standard errors are adjusted to take account of this. Naturally, no inclusive value coefficient was estimated in the conditional logit models.

Table 1 – Estimation results for the travel cost model

<table>
<thead>
<tr>
<th>Variable</th>
<th>NMNL</th>
<th>Conditional logit (boat)</th>
<th>Conditional logit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top decision level (X_{x})</strong>:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>0.997</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.0632)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUN</td>
<td>0.283</td>
<td>0.299</td>
<td>0.612</td>
</tr>
<tr>
<td></td>
<td>(0.0420)</td>
<td>(0.0444)</td>
<td>(0.424)</td>
</tr>
<tr>
<td><strong>Lower decision level (Y_{y})</strong>:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTC</td>
<td>-0.00108</td>
<td>-0.00101</td>
<td>-0.00213</td>
</tr>
<tr>
<td></td>
<td>(0.0000639)</td>
<td>(0.0000309)</td>
<td>(0.000201)</td>
</tr>
<tr>
<td>LNSIGHT</td>
<td>0.269</td>
<td>0.575</td>
<td>-0.172</td>
</tr>
<tr>
<td></td>
<td>(0.0702)</td>
<td>(0.0627)</td>
<td>(0.163)</td>
</tr>
<tr>
<td>BEACH</td>
<td>0.0164</td>
<td>0.0207</td>
<td>0.0420</td>
</tr>
<tr>
<td></td>
<td>(0.00229)</td>
<td>(0.00199)</td>
<td>(0.0116)</td>
</tr>
<tr>
<td>LICENCE</td>
<td>0.583</td>
<td>0.544</td>
<td>0.478</td>
</tr>
<tr>
<td></td>
<td>(0.0205)</td>
<td>(0.0186)</td>
<td>(0.0704)</td>
</tr>
</tbody>
</table>

All coefficients in the models for non-boat travel are significant at least at the 99 percent level of significance, and have expected signs. The inclusive value coefficient is almost exactly one, so that we would expect the conditional logit and NMNL models to be identical. All coefficients are indeed quite close, except for the sight depth coefficient. The results seem to suggest that the sight depth affects recreational behavior. However, the magnitude of this effect is rather uncertain.
In the boat model, the coefficients for TTC, BEACH and LICENCE are significant at least at the 99 percent level of significance, while LNSIGHT and SUN are not even significant at the 10 percent level. The coefficient for LNSIGHT does not have the expected sign. This may be due in part to the small sample size. However, it is also reasonable that boat travelers are less affected by water quality. In addition, boat recreation often implies travel through several different municipalities. It is therefore doubtful whether the data on this category of recreationists are reliable in this respect.

6 Policy simulations

Our models of the households’ recreational behavior, and the sight depth model, make it possible to estimate the benefits from policy measures that change the nutrient levels in waters around the Swedish coast. Below, two experiments are presented. The first is an attempt to calculate the results of a uniform change in quality along the entire Swedish coast. The second deals with a change in quality in just one small region, the Laholm Bay.

The Laholm Bay has been seriously affected by eutrophication (See Rosenberg, Larsson and Edler, 1986 and Wennberg, 1987). The area is also one of the most popular seaside recreation areas in Sweden. Of the 2208 trips in the sample made to all sites (boat recreationists excluded), 238 were made to the three municipalities around the Laholm Bay, i.e., over 10 percent.

The estimated sight depth equation (8) was used to construct a quality index for hypothetical changes in the nutrient load. The welfare change for each individual in the sample is then easily calculated using equation (7) and the parameter estimates of table
1. The sum over all individuals in the sample was then multiplied by the inverse of the sampling ratio to obtain an estimate of the national welfare change. The resulting changes in consumers’ surplus are displayed in diagrams 1 and 2. The differences between the conditional logit (CL) and NMNL models are due to the different estimates of the sight depth coefficient.

**Diagram 1 – Policy experiment, entire Swedish coast**

At a meeting in 1990 of the prime ministers of the states around the Baltic sea, a reduction target of 50 percent was set up for the nutrient load to the Baltic sea (Wulff and Niemi, 1992). The estimated recreational benefit from such a reduction is thus 240 mSEK and 540 mSEK in, respectively, the NMNL and conditional logit models. Even the highest of these figures correspond to less than ten percent of the estimated cost of such a reduction (Gren, Elofsson and Jannke, 1995). Considering this study alone, a drastic reduction of emissions of nutrients to the Baltic sea can thus not be justified.
It should be noted that this model only captures part of the possible values from reduced eutrophication. Other forms of use values, e.g., for commercial fishing, are not taken into account. Non-use values are certainly not included in the benefit estimates. Also, daytrips of less than 100 km are not included in the TDB. Further, the data precludes the estimation of a model that takes account of changes in the total number of trips (See Morey, 1991 for a discussion of this issue). However, since it is usually thought that recreational benefits constitute a major part of total benefits from improved water quality, the very low estimates are still striking. (See, e.g., Bockstael, Hanemann and Strand, 1987.)

**Diagram 2 – Policy experiment, Laholm Bay**

The benefit from a 50 percent reduction of the nutrient load to the Laholm Bay was estimated to be around 12 mSEK per year from the NMNL model, and 32 mSEK per year from the conditional logit model. The highest of these figures, 32 mSEK, comes close to the cost of a 50 percent reduction of the nutrient load in the Laholm Bay.
Gren and Zylicz (1993) estimate that the cost of an efficient reduction by this proportion would be around 45 mSEK per year.

7 Concluding remarks

To be able to use models of recreational behavior to evaluate a policy measure, we must attempt to include not only recreation to the sites that are directly affected by the policy, but also all sites that are likely to be close substitutes. The present study covers almost all domestic Swedish sea-side recreation, and should thus meet up to this criterion.

To the knowledge of the author, the study is the first RUM travel cost model applied to European data. Previous European travel cost studies have either been single-site models (e.g., Bojö, 1985 and Strand, 1981), or have treated visits to all sites as a single good (e.g., Boonstra, 1993). Even though the issue dealt with is quite specific – eutrophication of the seas around Sweden – the method should have numerous other applications.

Perhaps the most important result in this paper is that the sight depth variable performs so well as a quality index. Also, instead of just assuming a relation between the quality variable and pollution, it has been shown that the link between this quality index and nutrient concentration can be established with simple econometric methods. Naturally, a more elaborate model could be developed.

In most travel cost studies, the travel cost variable is constructed by using some assessment of vehicle operating cost. In this study, a cost function is instead
estimated, based on the stated cost for the trip. This approach goes some way towards solving the problem of defining the ”true” cost of traveling to a site.

The benefit estimates from the trans-Baltic policy experiments are surprisingly low. Contingent valuation studies on reduced eutrophication of the Baltic sea yield willingness to pay estimates around ten times higher (Söderqvist, 1996). Inherent differences between the travel cost and the contingent valuation methods certainly account for some of the disparity. Still, more research is called for to explain the large divergence between the results.

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Östergötlands län. Nyköpings kommun, Teknik, vattenlaboratoriet.


Stockholms län. Stockholm Vatten. Christer Lännergren.


Miscellaneous observations along the south and east coast. SMHI, Forskning och utveckling. Per Sandén.
10 Appendix A – Regression equation for the cost function

The regression equation used to obtain the kilometer cost of travel can be described as follows:

\[ \text{COST} = \gamma_0 + \gamma_{1,0} \text{PERS} + \sum_{k \in K} \gamma_{1,k} \text{PERS} + \]
\[ + \gamma_{2,0} \text{DIST} + \sum_{m \in M} \gamma_{2,m} \text{T}_m \text{DIST} + \]
\[ + \gamma_{3,0} \text{TNIGHTS} + \sum_{n \in N} \gamma_{3,n} \text{NIGHTS}_n + \gamma_{4,0,0} \text{DAYTRIP} + \]
\[ + \sum_{k \in K} \left( \gamma_{4,k,0} \text{D}_k \text{TNIGHTS} + \sum_{n \in N} \gamma_{4,k,n} \text{D}_k \text{NIGHTS}_n \right) + \eta \]

where COST is the total stated monetary cost of the trip, PERS is the number of persons participating, DIST is distance traveled and TNIGHTS the total number of trips away from home. NIGHTS\(_n\) is the number of nights spent in accommodation category \(n \in N, N=\{\text{hotel, family and friends, caravan, rented house}\}\), and DAYTRIP is a dummy variable equal to one if the trip is a day-trip, zero otherwise. The D\(_k\):s are dummy variables equal to one if the length of the stay away from home falls in the range \(k \in K, K=\{3-28,8-28,15-28\}\), and zero otherwise. The T\(_m\):s are dummy variables equal to one if the mode of transport \(m \in M, M=\{\text{public transport, private boat}\}\) is chosen, and zero otherwise. The \(\gamma\):s are parameters and \(\eta\) is a random term.

Two regressions were run, an ordinary least square regression, and a regression assuming the dependent variable to be lognormally distributed. (See Amemiya, 1973 for a discussion of the log-normal distribution.) The second of these was run to take account of the non-negativity constraint on the dependent variable. As can be seen below, the coefficient estimates hardly differ between the two regressions, while the t-values do. To take account of heteroskedasticity in the OLS regression, White’s consistent covariance matrix was used to calculate the t-values. (See any econometrics textbook, e.g., Greene, 1993.) The sample used for estimation of the cost function comprised of 1770 observations. Estimation was carried out in Limdep.
## Appendix B – Regression results for the cost function

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-value</th>
<th>Coefficient</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-795.65**</td>
<td>(-4.097)</td>
<td>-795.65**</td>
<td>(-27.336)</td>
</tr>
<tr>
<td>PERS</td>
<td>115.29***</td>
<td>(6.049)</td>
<td>115.29***</td>
<td>(27.219)</td>
</tr>
<tr>
<td>$D_{3-28}*PERS$</td>
<td>294.63***</td>
<td>(5.411)</td>
<td>294.63***</td>
<td>(3.805)</td>
</tr>
<tr>
<td>$D_{8-28}*PERS$</td>
<td>258.13^*</td>
<td>(1.759)</td>
<td>258.13</td>
<td>(1.365)</td>
</tr>
<tr>
<td>$D_{15-28}*PERS$</td>
<td>-119.40**</td>
<td>(-0.477)</td>
<td>-119.40</td>
<td>(-0.162)</td>
</tr>
<tr>
<td>DIST</td>
<td>2.0031**</td>
<td>(9.082)</td>
<td>2.0031**</td>
<td>(27.341)</td>
</tr>
<tr>
<td>$T_p*DIST_j$</td>
<td>-1.6639***</td>
<td>(-3.293)</td>
<td>-1.6640***</td>
<td>(-27.414)</td>
</tr>
<tr>
<td>$T_b*DIST_j$</td>
<td>0.74100</td>
<td>(0.944)</td>
<td>0.74101**</td>
<td>(2.489)</td>
</tr>
<tr>
<td>TNIGHTS</td>
<td>495.44***</td>
<td>(4.986)</td>
<td>495.44***</td>
<td>(23.991)</td>
</tr>
<tr>
<td>NIGHTS$_H$</td>
<td>516.94***</td>
<td>(2.879)</td>
<td>516.94**</td>
<td>(2.016)</td>
</tr>
<tr>
<td>NIGHTS$_F$</td>
<td>-135.26***</td>
<td>(-2.814)</td>
<td>-135.26***</td>
<td>(-25.256)</td>
</tr>
<tr>
<td>NIGHTS$_C$</td>
<td>-56.255</td>
<td>(-1.129)</td>
<td>-56.255***</td>
<td>(-20.996)</td>
</tr>
<tr>
<td>NIGHTS$_R$</td>
<td>412.04***</td>
<td>(2.899)</td>
<td>412.04***</td>
<td>(4.320)</td>
</tr>
<tr>
<td>DAYTRIP</td>
<td>530.88***</td>
<td>(2.960)</td>
<td>530.88***</td>
<td>(24.540)</td>
</tr>
<tr>
<td>$D_{3-28}*TNIGHTS$</td>
<td>-260.21***</td>
<td>(-3.215)</td>
<td>-260.21***</td>
<td>(-7.492)</td>
</tr>
<tr>
<td>$D_{3-28}*NIGHTS_H$</td>
<td>41.902</td>
<td>(0.205)</td>
<td>41.902</td>
<td>(0.117)</td>
</tr>
<tr>
<td>$D_{3-28}*NIGHTS_F$</td>
<td>85.885</td>
<td>(1.434)</td>
<td>85.885**</td>
<td>(2.253)</td>
</tr>
<tr>
<td>$D_{3-28}*NIGHTS_C$</td>
<td>158.95**</td>
<td>(2.240)</td>
<td>158.95**</td>
<td>(2.616)</td>
</tr>
<tr>
<td>$D_{3-28}*NIGHTS_R$</td>
<td>-98.684</td>
<td>(-0.676)</td>
<td>-98.684</td>
<td>(-0.843)</td>
</tr>
<tr>
<td>$D_{8-28}*TNIGHTS$</td>
<td>-100.10**</td>
<td>(-1.922)</td>
<td>-100.10**</td>
<td>(-2.019)</td>
</tr>
<tr>
<td>$D_{8-28}*NIGHTS_H$</td>
<td>28.027</td>
<td>(0.117)</td>
<td>28.027</td>
<td>(0.042)</td>
</tr>
<tr>
<td>$D_{8-28}*NIGHTS_F$</td>
<td>-39.016</td>
<td>(-0.742)</td>
<td>-39.016</td>
<td>(-0.775)</td>
</tr>
<tr>
<td>$D_{8-28}*NIGHTS_C$</td>
<td>0.35732</td>
<td>(0.006)</td>
<td>0.35732</td>
<td>(0.003)</td>
</tr>
<tr>
<td>$D_{8-28}*NIGHTS_R$</td>
<td>-41.421</td>
<td>(-0.696)</td>
<td>-41.421</td>
<td>(-0.342)</td>
</tr>
<tr>
<td>$D_{15-28}*TNIGHTS$</td>
<td>57.405</td>
<td>(1.026)</td>
<td>57.405</td>
<td>(0.543)</td>
</tr>
<tr>
<td>$D_{15-28}*NIGHTS_H$</td>
<td>-765.43**</td>
<td>(-2.702)</td>
<td>-765.43***</td>
<td>(-0.614)</td>
</tr>
<tr>
<td>$D_{15-28}*NIGHTS_F$</td>
<td>93.500</td>
<td>(0.922)</td>
<td>93.500</td>
<td>(0.976)</td>
</tr>
<tr>
<td>$D_{15-28}*NIGHTS_C$</td>
<td>-56.559</td>
<td>(-0.976)</td>
<td>-56.559</td>
<td>(-0.274)</td>
</tr>
<tr>
<td>$D_{15-28}*NIGHTS_R$</td>
<td>-175.26**</td>
<td>(-2.188)</td>
<td>-175.26</td>
<td>(-0.709)</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>-</td>
<td>-</td>
<td>1.3377***</td>
<td>(82.135)</td>
</tr>
</tbody>
</table>

Sub-indices H, F, C and R denote hotel, family and friends, caravan and rented house, respectively. The sub-indices on the D variables indicate the range of duration of the trips. P and B indicate travel by public means of transportation and private boat, respectively. The asterisks indicate significance at the 99 percent, 95 percent and 90 percent levels of significance, in a two tail t-test.