

# **Impacts of changes in water quality on recreation behavior and benefits in Finland**

## **Abstract**

The Water Framework Directive requires nationally generalizable benefit estimates of the protection of inland and coastal waters. As an alternative to benefit transfers and meta-analyses, we utilize national recreation inventory data combined with water quality data to model participation in swimming, fishing and boating and estimate benefits from water quality improvements. We find that improved water clarity affects close-to-home water recreation behavior positively. We also estimate the consumer surplus of a water recreation day using a travel cost approach. The consumer surplus for swimmers and fishers would increase 6 and 15 percent, respectively, for a one-meter improvement in water clarity.

*Keywords:* Water Framework Directive, recreation benefits, travel cost, hurdle model, water clarity, national recreation inventory.

*EAERE codes:* Environmental valuation + CBA: Other valuation techniques

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## 1. Introduction

The EU Water Framework Directive (WFD) (European Commission 2000) aims to harmonize water protection in the EU countries. Its goal is to ensure that all aquatic ecosystems achieve 'good ecological status' by 2015. However, the objectives set out in the Directive are not intended to be met for every water body at any cost: the implementation should avoid costs that are disproportionate to the achievable benefits. The need to find a balance between costs and benefits has created demand for both benefit and cost studies connected with the WFD in several European countries (Bateman et al. 2006, Hanley et al. 2006).

Meta-analysis and benefit transfer have been the most appealing methods to generate value estimates for planning national environmental policies. However, one problem associated with the use of single-site studies in benefit transfer is the uniqueness of the valuation situations; it is often "interesting hot-spot-areas" that are chosen to be valued. Lindhjem and Navrud (2007) showed that using benefit transfer studies from another country, even a culturally similar one, increases transferring error considerably. We suggest an alternative approach that draws on national recreation inventory data to produce nationwide valuation information. Especially in countries with few transferable prior studies, existing recreational inventory data (Dehez et al. 2008, Cordell 2005) combined with water quality data may provide an accessible and reliable basis for producing nationally consistent benefit estimates. In general, recreation is considered the most important reason for conserving water bodies (Söderqvist 1998) and is estimated to account for over 60 percent of the total benefits from water protection (Rodgers et al 1990). Here, we illustrate the usability of inventory data for the valuation of recreational benefits from water protection in Finland, the country often called "the land of a thousand lakes".

Most studies of recreation demand that consider water quality focus on site choice (e.g. Parsons et al. 2003, Egan et al. 2004). Water quality improvements

were valued before the implementation of the WFD on the Swedish coast, an area with water conditions similar to those in Finnish coastal areas, using the travel cost method (Sandström 1996; Soutukorva 2005). In these studies, water quality was valued as an attribute affecting an individual's choice of destination site or destination region. However, an abundance of water recreation opportunities has an effect on the applicability of various types of recreation demand models. When modeling water recreation demand in a water-rich country like Finland, the focus should be on understanding the prerequisites for everyday close-to-home water activities - which form a significant proportion of recreation - rather than the choice of remote sites. Site choice approaches are not relevant when the aim is to evaluate the effects of a wider water policy affecting citizens' everyday living environment on a national scale. EU-wide policies, such as the WFD, aim to improve water quality on a national level. Therefore, national scale policies require a wider focus than the demand for water quality at a single lake or in small regions. Assessing the impacts of policy on the national level makes it particularly important to link water quality to general recreation behavior (Ribaud and Piper 1991). Site-based approaches would be difficult in this kind of setting since the WFD is supposed to affect many lakes in various regions simultaneously. Instead, national recreation inventory data, which include data on participation in activities, frequency of participation, and information on the respondents' home municipality, can provide a solution to evaluate the effects of policy. To the best of our knowledge, only one study has analyzed water recreation in relation to close-to-home water quality prior to this one (Ribaud and Piper 1991).

Improvements in water quality, and, consequently, the everyday living environment, may affect water recreation behavior in two ways: the likelihood of non-users becoming recreational users and of current users increasing the number of days spent on the activity. For some individuals the decision on the number of use days is irrelevant, due to personal preferences or a lack of suitable water areas or other

resources. We address the association between recreation participation and water quality econometrically using hurdle models for three water activities: swimming, fishing and boating. In addition, we estimate the consumer surplus of a water recreation day. This approach enables us to estimate the marginal social net benefits of an exogenous increase in water quality.

We also discuss the relationship between the estimated recreational benefits of water quality improvements and the corresponding costs. Providing guidance for policy making is a challenge as the costs of water quality improvements are associated with physical measures, such as the abatement of nutrient emissions, whereas benefits are often expressed in terms of water quality indicators. We illustrate the linkage between physical measures, ecological impacts and the monetary values of damages and benefits. Finally, we point out that a warmer climate may increase demand for water recreation while having adverse effects on water quality due to, for example, the increased frequency of algal blooms. Climate change effects thus pose further challenges and possibilities for multidisciplinary research in water quality.

## **2. Water resources, recreation participation and water quality indicators**

Finland, with a population of about five million, has one lake for every 26 people. There are 187 888 lakes larger than 500 square meters, and water areas cover about 10 percent of the total area of the country. In addition to lakes, the Baltic Sea and its extensive archipelago are actively used for water recreation. The Finnish national outdoor recreation demand and supply inventory confirms the importance of water resources in Finnish outdoor recreation. Over two-thirds of the population swim in natural waters every year, swimming being the second most popular outdoor recreation activity after walking. Participation rates in fishing and boating are slightly above and below 50 percent, respectively (Pouta and Sievänen 2001). Given the Finnish climate,

with only four summer months on average, such a level of water recreation activity is almost surprising.

The main water recreation activities in Finland are swimming, fishing and boating. The water quality in a citizen's home municipality is particularly important for these activities as the majority of one-day or shorter visits (68 percent in boating, 79 percent in fishing, 86 percent in swimming) take place close to home (Pouta and Sievänen 2001). The natural resources for these activities are readily available as the median distance from an individual's home to the nearest area suitable for swimming, fishing, or boating is only two kilometers.

In the setting described, it is appealing to focus on the question how the availability and quality of recreation resources in individuals' living environment affect their participation in recreation activities. The environmental quality of a person's home region and its effect on his or her recreation behavior has been the topic of a number of recreation demand studies (Ribaud and Piper 1991, Boxall and McFarlane 1995, Neuvonen et al. 2007). The high provision of recreational opportunities in people's living environment has generally been found to promote active living that includes participation in recreation (Henderson and Bialeschki 2005). The environmental quality of the recreational setting is positively associated with the level of recreational activity and the health of community members (Kaczynski and Henderson 2007).

The water environment is part of a high-quality environment that increases physical activity and enhances human health (Bauman et al. 1999, Giles-Corti and Donovan 2002, Humpel et al. 2004). Water areas in the nearby living environment and their quality have been found to be a significant factor in hedonic property price studies (e.g. Leggett and Bockstael 2000, Michael et al. 2000, Tyrväinen 1997) and in landscape preference studies (e.g. Dramstad 2006). However, these approaches have not focused on how water quality affects recreation on a general scale. To the authors' knowledge, the only study analyzing the correlation between water quality and water

recreation participation in an individual's home region is that conducted by Ribaudo and Piper (1991), which focused on fishing.

To analyze the effect of water quality improvement on recreation behavior, it is important to select a water quality indicator that is meaningful for both active and potential recreationists. The WFD states that water bodies are to be in good ecological status, a description that covers indicators such as fish, water plants, zoobenthos and plankton species. In the WFD, current ecological status is compared to natural status. Ecological status may not be a quality indicator easily observable by the public that would have an effect on recreation behavior. Site selection studies have used a multitude of different water quality variables from the amount of suspended solids (Egan et al. 2004, Parsons et al. 2003) and harmful bacteria in water (Parsons et al. 2003) to subjective measures of water quality (Whitehead et al. 2000, Whitehead 2005). Since we are interested in the most voluminous water recreation activities (swimming, fishing and boating), we use water clarity as an indicator to capture the effect of water quality on recreation activities. As argued by Sandström (1996) and Soutukorva (2005), among others, water clarity is an easily observed indicator of quality for users and is correlated with nutrient levels and thus eutrophication. While swimmers and boaters should find water clarity a good indicator of water quality, some fishers may prefer species that dwell in murky but otherwise clean waters. This implies that not all fishers will necessarily benefit from less eutrophic waters. However, since many of the nationally valued fish species in Finland, such as brown trout and vendace, require clear, high-quality waters, using water clarity as an indicator of water quality is defensible also in the case of fishing. Water clarity may not be the best quality indicator for humic inland lakes, which may have good ecological status despite relatively poor clarity. While the ecological status of lakes is likely closely linked to the quality perceived by recreationists, we still lack a conception of water quality that would be usable in valuation studies. Moreover, understanding the linkage between water quality

as perceived by the public and measures affecting the physical attributes of water quality is crucial for policy making. We will elaborate on this issue when discussing our data on water quality.

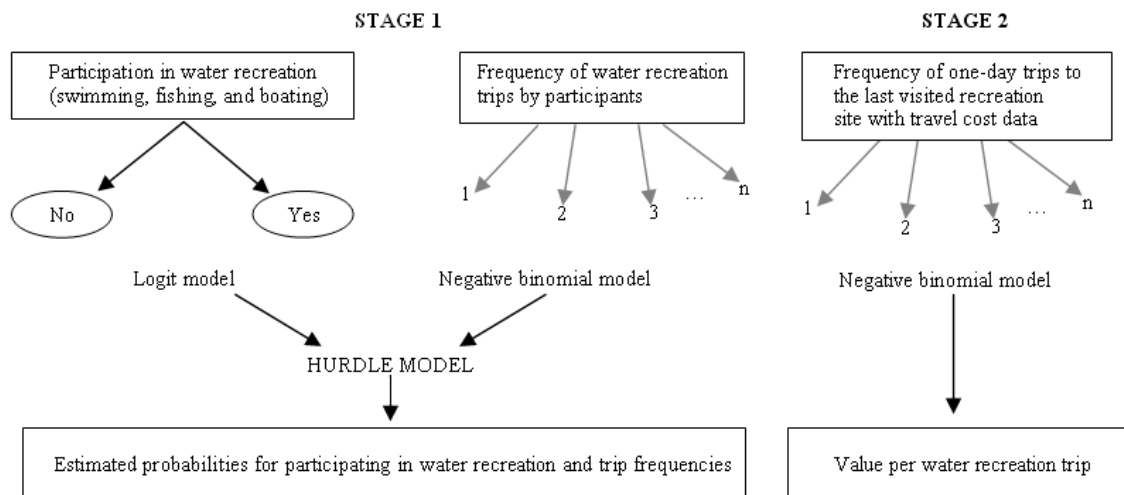
## **Methods**

### *Participation models*

Our assessment of the effects of water quality in individuals' home regions provides an additional insight by decomposing water recreation participation into two components: the overall rate of participation within a time period and, for those who participate, the frequency of participation measured by the number of recreation trips in that period. In order to participate, both environmental conditions, such as water quality, and personal conditions, for example, activity skills and equipment, have to be met. Therefore, a basic investment, or threshold, exists for swimming, fishing and boating participation, and different factors may affect the overall decision to participate and the decision on participation frequency (cmp. Huhtala and Pouta 2006). Previous studies of outdoor recreation have shown that gender, age, social status, income and education are the variables having the most explanatory power with regard to differences in recreation behavior. These variables may affect participation rate and the frequency of participation separately or jointly.

Both changes in participation rate and participation times can be seen to contribute to the overall welfare impact of a change in water quality. As the significance of both components contributing to the ultimate impact is an empirical question, we investigated the impact through participation and frequency models. We estimated benefits from water quality changes in two stages, as shown in Figure 1, modeling water recreation behavior separately for each activity using a hurdle model, with logit and negative binomial specifications for participation and trip frequency estimation, respectively. Using a hurdle model enabled us to estimate the proportion of potential

water recreation participants if water quality improved, and thus to avoid making the assumption that both processes – participation and the frequency of trips – produced zero-trips from the same data generation process. According to Cameron and Trivedi (1998), a simpler two-stage model would lead to model misspecification.



**Figure 1. Stages of water recreation behavior and benefit estimation**

Hurdle models estimate simultaneously a binary choice model and a count data model, in the present case the decision to participate in water recreation activity, and the number of recreation trips, respectively. These two processes are estimated by assuming a logistic binary process model and a count data model with a negative binomial distribution to correct for possible overdispersion, i.e., variance higher than the mean in the dependent variable.

Let us assume that participation in an activity is a binary process where  $s_i = 0$  indicates that respondent  $i$  does not participate and  $s_i = 1$  that he or she is a participant. Those two probabilities are

$$\Pr_{Logit}(s_i = 0) = (1 + \mu_i)^{-1} = \frac{1}{1 + \exp(\beta_0 + \beta q + \boldsymbol{\theta} \mathbf{x})} \quad (1)$$

$$\Pr_{Logit}(s_i = 1) = 1 - \Pr_{Logit}(s_i = 0) = 1 - (1 + \mu_i)^{-1} = \frac{\exp(\beta_0 + \beta q + \boldsymbol{\theta} \mathbf{x})}{1 + \exp(\beta_0 + \beta q + \boldsymbol{\theta} \mathbf{x})},$$

where  $\mu_i = \exp(\beta_0 + \beta q + \boldsymbol{\theta} \mathbf{x})$  is the mean parameter for non-participation (Cameron and Trivedi 1998). The probability of non-participation depends on the vector of individual characteristics,  $\mathbf{x}$ ; their respective coefficients in vector  $\boldsymbol{\theta}$ ; water quality,  $q$ , and its coefficient  $\beta$ ; and the constant  $\beta_0$ .

Following Cameron and Trivedi (1998), the estimated negative binomial probability of an individual  $i$  making  $j$  recreation trips is formally given by

$$\Pr_{Negbin}(s_i = j | j > 0) = \frac{\Gamma(s_i + \alpha^{-1})}{\Gamma(\alpha^{-1})\Gamma(s_i + 1)} \left( \frac{1}{(1 + \alpha \mu_{2i})^{\alpha^{-1}} - 1} \right)^{-\alpha^{-1}} \left( \frac{\mu_{2i}}{\mu_{2i} + \alpha^{-1}} \right)^{s_i}, \quad (2)$$

where  $\mu_{2i} = \exp(\xi_0 + \eta q + \boldsymbol{\omega} \mathbf{x})^1$  is the mean of non-zero recreation trips to be estimated,  $\alpha$  is the dispersion parameter and  $\Gamma$  is the gamma function. The probability of making  $j$  trips is estimated in the hurdle model as

$$\Pr(s_i = j) = \left[ \frac{1 - \Pr_{Logit}(s_i = 0)}{1 - \Pr_{Negbin}(s_i = 0)} \right] \Pr_{Negbin}(s_i = j | j > 0), \quad (3)$$

where the bracketed term on the right-hand side represents the correction for the possible misspecification of assuming the same data generation process for non-participation,  $j = 0$ , for both potential and non-participants. Let us define the indicator

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<sup>1</sup> As in the logit model,  $\xi_0$  represents the intercept,  $\eta$  is the parameter associated with water quality  $q$ , and  $\boldsymbol{\omega}$  is the vector of parameters associated with the vector of individual characteristics,  $\mathbf{x}$ . Note that the same set of individual characteristics in both parts of the hurdle model can be used.

function  $1_s = 1$  when  $s_i > 0$  and  $1_s = 0$  when  $s_i = 0$ . The joint likelihood  $LL_{Hurdle}$  is estimated by maximizing separately the log likelihoods of both equations  $LL_{Logit}$  and  $LL_{Negbin}$ ,

$$LL_{Hurdle} = LL_{Logit} + LL_{Negbin}$$

$$LL_{Logit} = \sum_{i=1}^n 1_s(s_i = 0) \ln[\Pr_{Logit}(s_i = 0)] + \sum_{i=1}^n 1_s(s_i = 1) \ln[1 - \Pr_{Logit}(s_i = 0)] \quad (4)$$

$$LL_{Negbin} = \sum_{i=1}^n 1_s(s_i > 0) \ln[\Pr_{Negbin}(s_i = j | j > 0)].$$

After modeling the participation with the hurdle model, we estimated the value of a water recreation trip applying the travel cost method. We constructed a travel cost model including all three recreational activities and estimated the model with zero-truncated negative binomial regression. Contrary to traditional travel cost models focusing on a specific site, we modeled the demand for recreation trips to a representative site (Creel and Loomis 1990, Zawacki et al. 2000, Pouta and Ovaskainen 2006), which is a combination of destinations defined by our sample rather than any single area. We estimated the annual frequency of one-day trips from home to the last visited water recreation site. The data collection method limited the trips to those that were identical to the most recent trip, with the same primary and secondary activities. Accordingly, people whose primary and secondary activities on their most recent trip were boating and swimming, respectively, would indicate the number of boating plus swimming trips to the same site in the past twelve months. The travel cost models used the same explanatory variables as the count data part of the hurdle models, as well as additional travel cost measures and indicators for the most important recreational activities during the trip.

We applied the participation models to illustrate the effects of a hypothetical improvement or decrease in water clarity on participation rate and

frequency. The hypothetical policy effect chosen was a one-meter increase and decrease in water clarity. To value the increase in water recreation trips we use the welfare estimates from travel cost model.

## **Data**

We combined two national scale databases for the analysis. The primary data source described national outdoor recreation demand over a three-year span; this was supplemented by a national database on surface water quality. The combined dataset and its components are presented in the following subsections.

### ***Outdoor recreation inventory***

Data on water recreation behavior were acquired from the survey for the Finnish national outdoor recreation demand and supply inventory, conducted by Statistics Finland between August 1998 and May 2000 (Virtanen et al. 2001). For the survey, a random sample of Finns age 15 to 74 was drawn from the Census of Finland. The data were gathered in two phases through telephone interviews and a mail-in questionnaire. The total sample size in the first phase was 12 649 people, and interview data were gathered from 84 percent of those sampled. In this first phase, data related to participation in recreation activities and to socio-economic variables were collected from a total of 10,651 respondents. The mail-in questionnaire, which focused on particular themes of outdoor recreation, was sent to those respondents who during the telephone interview indicated that they were willing to answer the questionnaire. After one postcard reminder and one follow-up had been sent to non-respondents, 65 percent of the mail survey sample eventually completed the questionnaire. In the following analysis, we combined telephone interview data on participation and some socioeconomic variables with mail survey data containing background variables such as income, education and family composition. We then extracted data for the three most voluminous water recreation activities: swimming, fishing, and boating. In addition to

participation, respondents reported the annual frequency of recreational trips<sup>2</sup> per activity. The trip frequency and travel costs of one-day trips to the last visited recreation site were also available.

Information on participation in water recreation and on annual trip frequency during the twelve-month period prior to the survey was available for 5414 respondents<sup>3</sup>. Travel cost data were available from 167 swimmers<sup>4</sup>, 175 fishers and 89 boaters. The travel cost data were from the most recent outdoor recreation activity, and thus the sample size for travel costs was smaller than that for general water recreation behavior. The travel cost data included the purpose of the trip, the number of annual visits to the same site for the same purpose<sup>5</sup>, travel distance and time, mode of travel, and estimated costs per person.

In Finland it is not self-evident that an individual's home region or municipality can be defined as his or her dominant recreational setting. Recreation at a summer cottage or other type of vacation residence (owned or rented long term) is common, with 45 percent of Finns having access to such resources on a regular basis (Sievänen et al. 2007). Roughly one-third of summer cottages are located in the cottage owners' municipality of residence<sup>6</sup>. Summer cottage access affects participation in many recreational activities (Pouta et al. 2006, Sievänen et al. 2007) and water quality near summer cottage can be assumed to affect water recreation participation. However, according to data from the national inventory of recreation demand (Virtanen et al. 2001), only around 18 percent of one-day water recreation trips originated from respondents' summer cottages. Based on this finding, we may quite safely assume that

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<sup>2</sup> A trip was defined as one lasting longer than 15 minutes and occurring outside the respondent's home. If the respondent made trips lasting longer than one day, each consecutive day was also counted as a trip in calculating the annual trip frequency. Thus, a three-day trip constituted three trips in the database.

<sup>3</sup> Of these 5414 respondents 5, 8 and 115 respondents were removed from the swimming, fishing and boating traveling frequency data, respectively. The screening removed outliers and inconsistent survey responses. Respondents with annual traveling frequencies of more than one per day were considered outliers. The significantly larger rejection of boater responses is due to reported non-participation or missing data on participation.

<sup>4</sup> In the travel cost analysis, recreational swimming includes snorkeling, surfing and water skiing. All winter activities, such as winter swimming and fishing, were rejected, as were trips from other places than home.

<sup>5</sup> Limited to one trip per day per year.

<sup>6</sup> Personal communication with Statistics Finland (building and residence statistics).

the environmental quality of an individual's home region has a dominating effect on his or her water recreation behavior.

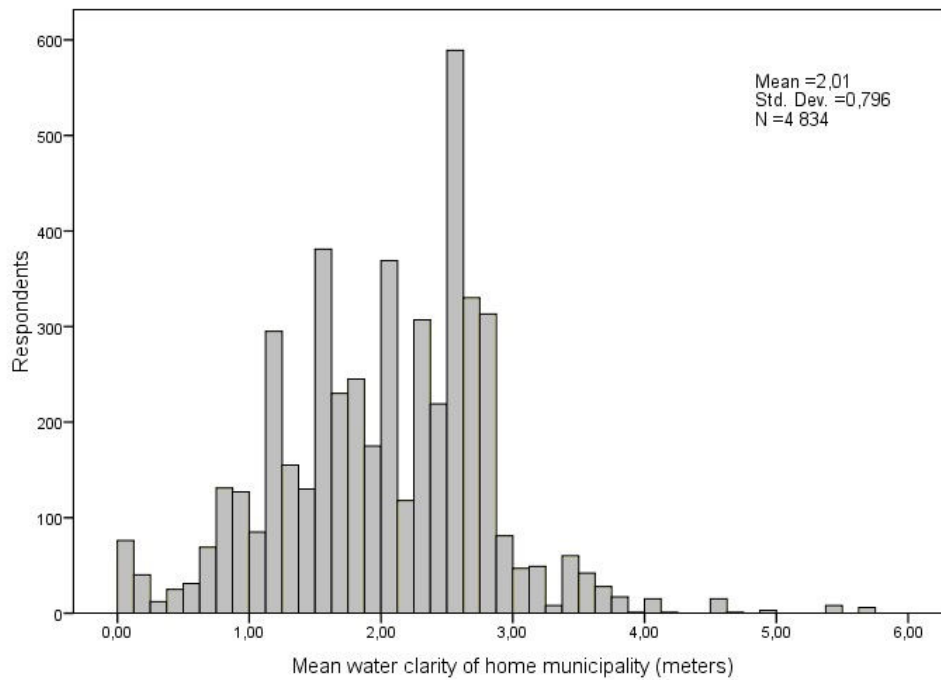
### *Water quality measurement data*

Water quality data were taken from the Finnish Environmental Institute's State of Finland's Surface Waters (PIVET) database for the summer seasons of 1998, 1999 and 2000. We defined the summer season as beginning in June and ending in September. The PIVET database has multiple water quality indicators for lakes, rivers and the coast, with measures for water clarity<sup>7</sup>, chlorophyll, turbidity, color, total phosphorus and nitrogen, and coliform bacteria levels. The water quality database covers over 3 000 lakes and 1 400 measuring points at sea, with data on some 24 000 and 14 000 water samples, respectively.

Although national resources for water recreation are exceptionally abundant and the quality of water is generally quite good, there are also lakes and regions where good water quality is either threatened or has been lost as indicated by Figure 2. The figure shows a histogram of near-home water clarity for the representative sample of Finns used in this study. The proportion of the sample living in a municipality where water clarity is less than one meter on average is likely to suffer from compromised water quality. Eutrophication is the principal problem that degrades water quality. As municipal sources of eutrophivating nutrients have been tackled through enhancements in waste water treatment, the pressure to implement abatement measures has shifted to agriculture. The trend towards centralizing animal farming threatens to increase nutrient runoff and Eutrophication, particularly in the basins of southern and western Finland, and will have a profound effect on the quality of Finnish surface waters (Uusitalo et al. 2007).

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<sup>7</sup> Measured with a secchi disc, an 8-inch round disc with alternating black and white quadrants. The water clarity measure is the depth, in meters, at which the secchi disc disappears from sight.



**Figure 2. Distribution of mean water clarity in the home municipality of the sampled respondents between 1998 and 2000**

As we are interested in the effect of water clarity in individuals' home municipality, water quality data were combined with recreation behavior data based on respondents' home municipality. Water clarity on the municipality level was the mean for the study period and the measurement points in each municipality<sup>8</sup>. Since water clarity data were not available for rivers, we excluded rivers from the analysis, and thus our results can only be generalized to water recreation on the coast of Finland and on inland lakes.

### *Variables for model specifications*

We expected water recreation to be weather dependent, and thus included in the analysis the regional<sup>9</sup> frequency of days warmer than 25 degrees Celsius during the twelve months prior to the survey response date. A day when the temperature is over 25 degrees centigrade is called "hellepäivä" in Finnish (lit. "hot day") and is considered

<sup>8</sup> This increases the weight of points with frequent measurements. Measurement points are, however, chosen by the Environmental Institute to represent areas of interest or frequent changes in water quality, and thus may in fact properly weight areas with much use.

<sup>9</sup> The information on the number of hot days was obtained from the Finnish Meteorological Institute data of 20 weather stations. These were linked to the survey responses based on the home municipality of each respondent and the province where each station was located.

hot weather in the Finnish summer. We expected hot days to increase participation and participation frequency in swimming and boating. The effect on fishing was thought to be less certain since preferences for weather depend on which species of fish is sought.

Respondent characteristics used in the estimation included age, gender, education, work participation, family composition and the average per adult income in the household. The effect of summer cottages was captured by including the variable “summer cottage access”. We also included the distance to the nearest water recreation site as reported by the respondent<sup>10</sup>. We corrected for possible bias in the reported water recreation frequency by adding a time lag indicator for responses outside the summer season.

In the travel cost models we used two alternate measures, reported and calculated travel costs. The reported travel costs were estimated by the survey respondents as round-trip travel costs per person, while the calculated round-trip travel costs for car travelers were estimated as 0.33 euros per kilometer<sup>11</sup>. Opportunity costs of time were also incorporated in the estimations, with travel time costs estimated at one-third of the wage rate<sup>12</sup>. Additionally, we constructed dummy variables for respondents who had reported that water recreation was a secondary activity at the site, and for those whose main and secondary visiting purposes both involved water recreation.

The descriptive statistics of all variables are listed in Table 1.

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<sup>10</sup> The distances to recreation sites were limited to 100 kilometers for swimming and 200 kilometers for fishing and boating. This procedure removed less than 0.5 percent of the sample.

<sup>11</sup> The cost is based on the official kilometer allowance of 1.99 Finnish Marks for the year 1999 granted by Finnish Tax Administration. Of the non-car travelers, five swimmers and one fisher used public transport, while the majority walked or biked.

<sup>12</sup> The wage rate was determined by dividing the household income by the number of adults in the household.

**Table 1. Sample description**

<b>Variable</b>	<b>Mean</b>	<b>Std. dev.</b>	<b>N</b>
Swimming participation	0.735	0.442	5414
Fishing participation	0.489	0.500	5414
Boating participation	0.494	0.500	5414
Swimming frequency	28.402	34.242	3921
Fishing frequency	31.443	40.663	2624
Boating frequency	25.274	32.351	2664
Mean water clarity in home municipality (meters)	2.011	0.796	4834
Number of hot days (>25° Celsius) in home region	13.036	10.714	5414
Distance to nearest swimming site, kilometers	3.251	5.165	4996
Distance to nearest fishing site, kilometers	5.351	14.040	4677
Distance to nearest boating site, kilometers	6,125	15.924	4685
Age	41.423	15.648	5414
Gender (female = 1)	0.558	0.497	5535
Monthly income (1000 €)	1.292	0.680	4828
Number of adults in household	2.149	0.990	5432
Number of children in household (under 18)	0.625	1.048	5432
Academic education (over high school education = 1)	0.268	0.443	5535
Unemployed	0.077	0.267	5535
Retired	0.147	0.354	5535
Homemaker	0.045	0.208	5535
Access to summer house	0.443	0.497	5276
Access to car	0.880	0.325	5276
Access to boat	0.461	0.499	5535
Months since summer (June to September)	3.017	2.771	5535
<b>Travel cost variables, Swimming:</b>			
Annual swimming trips to the site	32.606	68.156	142
Reported travel costs per person	1.213	5.013	148
Calculated travel costs per person	1.854	8.614	167
Opportunity cost of time per person	1.838	4.620	144
<b>Fishing:</b>			
Annual fishing trips to the site	29.732	58.015	153
Reported travel costs per person	3.051	5.217	157
Calculated travel costs per person	5.642	12.146	171
Opportunity cost of time per person	3.071	5.201	153
<b>Boating:</b>			
Annual boating trips to the site	32.055	56.574	73
Reported travel costs per person	2.251	4.302	75
Calculated travel costs per person	1.436	5.105	87
Opportunity cost of time per person	2.690	5.537	70

## Results

### *Recreation participation and water quality*

The hurdle model estimation results for participation in each activity and participation times are shown in table 2. The decision to participate in swimming, fishing or boating, a logit binary choice, is reported in the first column for each activity. According to the results, water quality, defined as water clarity in the respondent's home municipality, did not restrict participation in swimming or boating. In the case of fishing, water clarity had a significant positive effect on participation probability. For participation in the three activities, the distance to the nearest recreation site was not a consideration precluding participation in fishing or boating. The probability of participation in swimming, on the other hand, was negatively associated with increased distance to a usable recreation site (p-value 0.09). The probability of water recreation participation increased with the number of hot summer days, confirming our expectations. The results suggest that, at least for swimming and boating, hot days are a strong inducement to participate in water recreation, whereas water clarity has no direct effect on the pivotal decision.

The results also reveal an association between socioeconomic variables and water recreation participation. They show that fishing and boating were predominantly male activities, while swimming was enjoyed equally by both genders. The elderly were not as likely to participate in swimming and boating as younger people; the difference between the two groups was not significant in the case of fishing. Surprisingly, swimming was more popular with increasing income. Compared to other socioeconomic groups, students tended to participate more in swimming, but less in boating. Homemakers participated less in all activities across the board. The results did not show any significant effect for unemployed or retired people, suggesting that participation in all three activities was similar across the sample regardless of employment status. On balance, time constraints may not be important factors in the

**Table 2. Results of the hurdle model for water recreation activities**

	Swimming		Fishing		Boating	
	Logit	Negbin	Logit	Negbin	Logit	Negbin
Independent variables	coefficient (t-ratio)					
Water clarity in home municipality	-.006 (-.110)	.059 <sup>b</sup> (2.321)	.107 <sup>b</sup> (2.335)	.097 <sup>a</sup> (3.287)	0.070 (1.462)	.020 (0.763)
Distance to nearest recreation site	-.015 <sup>c</sup> (-1.681)	-.014 <sup>a</sup> (-5.640)	.004 (1.578)	.002 <sup>c</sup> (1.692)	-.001 (-.336)	.001 (.400)
Number of hot days	.041 <sup>a</sup> (10.198)	.016 <sup>a</sup> (9.062)	.006 <sup>c</sup> (1.722)	-.002 (-.719)	.012 <sup>a</sup> (3.405)	.002 (1.217)
Gender (female = 1)	.085 (1.026)	.086 <sup>b</sup> (2.304)	-1.077 <sup>a</sup> (-14.522)	-.015 <sup>a</sup> (11.475)	-.528 <sup>a</sup> (-6.862)	-.333 <sup>a</sup> (-6.902)
Age	-.025 <sup>a</sup> (-6.005)	.010 <sup>a</sup> (5.415)	-.001 (-.357)	.010 <sup>a</sup> (3.383)	-.015 <sup>a</sup> (-4.042)	.006 <sup>b</sup> (2.371)
Income (1000€)	.206 <sup>a</sup> (2.737)	.027 (.864)	.005 (.082)	-.173 <sup>a</sup> (-3.352)	.075 (1.097)	-.060 (-1.449)
Academic education	.130 (1.381)	-.031 (-.731)	-.238 <sup>a</sup> (-2.856)	-.205 <sup>a</sup> (-3.362)	.048 (.567)	-.141 <sup>b</sup> (-2.544)
Student	.315 <sup>c</sup> (1.832)	.208 <sup>a</sup> (3.260)	.043 (.318)	-.008 (-.079)	-.235 <sup>c</sup> (-1.677)	.116 (1.342)
Unemployed	.073 (.478)	.065 (1.022)	.061 (0.444)	.483 <sup>a</sup> (4.865)	0.032 (.218)	.219 <sup>b</sup> (2.415)
Retired	-.019 (-.130)	-.023 (-.306)	.168 (1.162)	.140 (1.365)	-.055 (-.368)	.210 <sup>b</sup> (2.209)
Homemaker	-.414 <sup>b</sup> (-2.210)	-.327 <sup>a</sup> (-3.613)	-.510 <sup>a</sup> (-2.900)	-.218 (-1.270)	-.351 <sup>c</sup> (-1.892)	-.101 (-0.815)
Number of children	.041 (0.921)	.008 (.459)	.054 (1.483)	-.083 <sup>a</sup> (-3.140)	.027 (.692)	-.003 (-.155)
Number of adults	-.018 (-.377)	.042 <sup>c</sup> (1.793)	.013 (.361)	-.001 (-.043)	-.073 (-1.640)	.006 (.207)
Access to summer house	.381 <sup>a</sup> (4.541)	.268 <sup>a</sup> (6.999)	.613 <sup>a</sup> (8.223)	.358 <sup>a</sup> (6.606)	.221 <sup>a</sup> (2.668)	.251 <sup>a</sup> (5.216)
Access to car	.346 <sup>a</sup> (2.853)	.128 <sup>b</sup> (2.158)	.438 <sup>a</sup> (3.761)	.305 <sup>a</sup> (3.425)	-.036 (-.301)	.096 (1.236)
Access to boat					1.550 <sup>a</sup> (18.664)	.711 <sup>a</sup> (14.501)
Months since summer season		.004 (.661)		.015 (1.547)		-.007 (-.772)
Intercept	.985 <sup>a</sup> (3.596)	2.172 <sup>a</sup> (18.503)	-.205 (-.875)	2.772 <sup>a</sup> (14.781)	.008 (.035)	2.316 <sup>a</sup> (15.467)
N	3749		3536		3560	
LL (hurdle model)	-14271		-10462		-10096	
LL (restricted model)	-64722		-65417		-48667	
$\chi^2$ (hurdle model)	100901		109910		77142	
Pseudo R <sup>2</sup>	.78		.84		.79	
Alpha	1.053 <sup>a</sup> (29.621)		1.328 <sup>a</sup> (21.741)		1.086 <sup>a</sup> (22.885)	

<sup>a</sup> p-value < .01; <sup>b</sup> p-value < .05; <sup>c</sup> p-value < .10

decision to participate in water recreation. We also found that family composition had no effect on participation probability. Having access to a summer house, and a car or a boat at one's disposal, all had highly significant positive coefficients. Drawing these results together, it can be said that the distribution of water recreation participants was

fairly even across the focal population, which indicates that these activities are uniformly popular in Finland.

The annual water recreation frequencies are presented in the second column for each activity (Table 2). Water clarity in the home municipality had positive effects on fishing and swimming frequencies. Distance to the nearest recreation site only affected swimming frequency with high significance. Distance to the nearest fishing site had a barely significant positive coefficient, and may relate to active fishers looking for high-quality sites farther away from home. The interaction between distance and water clarity for fishers is interesting, because it may indicate that they are willing to travel longer distances to reach clearer waters.

Only swimming frequency was affected very significantly by the number of hot days. Swimming trips require less advance planning compared to fishing and boating, and therefore it seems logical that weather conditions such as the number of hot days have a stronger positive effect on swimming frequency than on the frequency of the other activities.

Regarding socioeconomic variables, the recreation frequency estimates results showed trends similar to those for participation, but with some interesting differences. Women, for example, were estimated to swim more often than men, although the coefficient value was not very high. Higher age increased the frequency of participation among participants. Available time was associated with many socioeconomic factors that further determined participation frequency. Non-working groups, apart from those who were homemakers, tended to make more water recreation visits. Students were active swimmers, while unemployed people were estimated to fish and boat more often. In the case of fishing, an academic education and income had both negative and highly significant coefficients, suggesting that a lack of time decreased the number of fishing trips made. Fishing and boating are both naturally more time-intensive hobbies than swimming, and thus it is not surprising that they were more

sensitive to respondents' time-related answers. As in the case of decisions to participate in the activities, access to a summer house, car and boat had very significant positive effects on participation frequency.

### ***Benefit estimates***

The next step in evaluating water quality changes was to estimate a travel cost model for valuing water recreation activity days. Due to the small number of observations for the most recent trip for each water recreation activity, we pooled the three activities and estimated a value for a generic visit. Table 3 shows the estimation results. The table presents four models for different travel cost estimates. As the significant alpha coefficients reveal, the negative binomial model was suitable to correct for data overdispersion. As the demand theory assumes, an increase in travel costs decreases the rate of visits to a site. The only other significant variable across all four models was being a student. Students returned to the site of their previous visit less frequently than others, a finding perhaps attributable to their having a wider selection of destination sites, as they may have two home municipalities. The data leave this question open. Number of children had a negative effect on visiting frequency to the last visited water recreation site in three of the four models. In the model of calculated travel costs, it was estimated that respondents for whom water recreation was a secondary activity took more trips to the last visited site.

The results of the travel cost model were used to estimate the per-trip benefits of visits. The model based on respondents' reported travel costs yielded the smallest willingness to pay estimates per trip per person, these ranging from approximately 6.30 to 8.30 euros; calculated travel costs for people travelling by car provided higher willingness to pay estimates, in the range of 18.90 to 19.00 euros per visit per person. In both instances, the higher figures result from taking the opportunity cost of time into account.

**Table 3. Negative binomial travel cost model for water recreation using four travel cost measures**

Model	Calculated travel costs	Reported travel costs	Calculated travel costs + time costs	Reported travel costs + time costs
Independent variables	coefficient (t-ratio)			
Travel cost	-.053 <sup>a</sup> (-4.555)	-.159 <sup>a</sup> (-4.139)	-.053 <sup>a</sup> (-5.518)	-.121 <sup>a</sup> (-6.110)
Water recreation secondary activity at site	.586 <sup>c</sup> (1.759)	.349 (1.025)	.540 (1.608)	.324 (.990)
Water recreation primary and secondary activity at site	.404 (-.498)	.087 (.105)	-.555 (-.710)	.080 (.106)
Boated	.248 (.495)	.365 (.630)	.278 (.568)	.448 (.841)
Fished	.031 (.071)	.145 (.336)	.070 (.161)	.353 (.854)
Water clarity in home municipality	-.187 (-1.109)	-.017 (-.090)	-.165 (-1.017)	-.020 (-.118)
Number of hot days	-.006 (-.341)	-.001 (-.061)	-.007 (-.436)	-.006 (-.350)
Gender (female = 1)	-.154 (-.429)	.046 (.121)	-.160 (-.453)	.083 (.248)
Age	-.001 (-.058)	-.004 (-.271)	-.005 (-.401)	-.006 (-.459)
Income (1000€)	.031 (.107)	.096 (.320)	.118 (.414)	.098 (.353)
Academic education	.042 (.098)	.329 (.852)	-.040 (-.097)	.173 (.464)
Student	-1.296 <sup>b</sup> (-2.242)	-1.609 <sup>a</sup> (-2.953)	-1.403 <sup>b</sup> (-2.496)	-1.379 <sup>b</sup> (-2.476)
Unemployed	.353 (.698)	-.172 (-.313)	.396 (.815)	-.267 (-.548)
Retired	.709 (1.261)	.665 (1.143)	.814 (1.378)	.644 (1.196)
Homemaker	1.104 (1.557)	1.082 (1.500)	1.117 (1.587)	1.755 <sup>b</sup> (2.159)
Number of children	-.198 (-1.505)	-.239 <sup>c</sup> (-1.694)	-.219 <sup>c</sup> (-1.738)	-.220 <sup>c</sup> (-1.795)
Number of adults	.098 (.483)	.347 <sup>a</sup> (2.614)	.193 (.905)	.024 (.114)
Access to summer house	-.104 (-.297)	.018 (.048)	-.085 (-.249)	.004 (.010)
Access to car	-.534 (-1.058)	-.638 (-1.251)	-.552 (-1.039)	-.745 (-1.413)
Access to boat	.047 (.138)	.044 (.130)	-.057 (-.171)	-.060 (-.180)
Months since summer season	-.046 (-.895)	-.044 (-.797)	-.050 (-.982)	-.079 (-1.531)
Intercept	3.691 <sup>a</sup> (3.614)	2.860 <sup>a</sup> (3.131)	3.801 <sup>a</sup> (3.870)	4.062 <sup>a</sup> (4.008)
N	263	242	255	234
LL (negbin model)	-1065	-959	-1034	-927
LL (restricted model)	-6782	-5781	-6152	-5124
$\chi^2$ (negbin model)	11435	9643	10236	8394
Pseudo R <sup>2</sup>	.84	.83	.83	.82
Alpha	3.530 <sup>a</sup> (4.130)	3.459 <sup>a</sup> (3.843)	3.083 <sup>a</sup> (4.522)	2.742 <sup>a</sup> (4.527)
Consumer surplus €	18.90	6.30	18.98	8.28

<sup>a</sup> p-value < .01; <sup>b</sup> p-value < .05; <sup>c</sup> p-value < .10

The hurdle models (Table 2) were used to calculate the current rate and frequency of water recreation participation for the whole population (Table 4). The probability of participation was estimated at roughly 78 percent for swimming, 53 percent for fishing and 52 percent for boating. The models produce slightly higher participation rates than the sample does (Table 2). The estimated number of activity

days per participant varied from about 27 days for swimming to 21 for fishing and 18 for boating. The fishing and boating models underestimate sample means somewhat; the estimated values are closer to the median number of trips, which are 20, 17, and 14 days for swimming, fishing and boating, respectively. The figures for activity days per individual (including non-participants) capture the effect of both the rate and frequency of participation. The table reports also the total benefits for each activity. It must be noted that adding annual benefits together would most likely not provide correct benefit estimate for water recreation as whole, because the recreation types are interrelated; moreover, there may be synergies and substitute effects that do not show when estimating activities separately. Our data do not allow for a proper study of substitution effects between the activities.

**Table 4. Estimated participation rates, days and benefits per activity at present and under two policy alternatives, water clarity +1 m and water clarity -1 m**

	Swimming			Fishing			Boating		
	Present	Water clarity increase + 1 m	Water clarity decrease - 1 m	Present	Water clarity increase + 1 m	Water clarity decrease - 1 m	Present	Water clarity increase + 1 m	Water clarity decrease - 1 m
Population, million	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Proportion of participants %	78.10	78.10 <sup>a</sup>	78.10 <sup>a</sup>	53.24	55.91	50.56	51.85	51.85 <sup>a</sup>	51.85 <sup>a</sup>
Number of participants	3.046	3.046 <sup>a</sup>	3.046 <sup>a</sup>	2.076	2.180	1.972	2.022	2.022 <sup>a</sup>	2.022 <sup>a</sup>
Activity days/participant	26.52	28.12	25.01	20.78	22.90	18.85	18.31	18.31 <sup>a</sup>	18.31 <sup>a</sup>
Total number of activity days, million	80.78	85.65	76.28	43.14	49.93	37.17	37.06	37.06	37.06
Consumer surplus per day, low estimate	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30
Consumer surplus per day, high estimate	18.98	18.98	18.98	18.98	18.98	18.98	18.98	18.98	18.98
Total benefits, low estimate, million €	508.5	539.2	479.6	271.6	314.3	234.0	233.1	233.1	233.1
Total benefits, high estimate, million €	1 532.8	1 625.2	1 445.7	818.6	947.4	705.3	702.8	702.8	702.8
Change in total benefits %		6.03	-5.68		15.73	-13.84		0	0
Change in total benefits, million €		30.6 to 92.4	-28.9 to -87.1		42.7 to 128.8	-37.6 to -113.3		0	0

<sup>a</sup> Estimated coefficient not significant.

### *Policy effects*

Table 4 shows the sensitivity of participation and total benefits to water quality change from the national status quo to a one-meter improvement/degradation in water clarity. An improvement would increase the probability of fishing by 2.7 percent, and add 2.1 days of fishing annually on average. Swimming participation levels and boating behavior as a whole were not estimated as being affected by water clarity. Improved water quality was, however, predicted to increase the average number of swimming trips per person by 1.6 days annually. The policy alternatives affected swimming and fishing days in particular, whereas boating days were not sensitive to policy changes. Figure 3 shows the estimated change in water recreation visits due to altered water clarity. The data presented take into account the estimated water clarity coefficients only where they were significant in the estimations.

Table 4 also shows how changes in water clarity would affect water recreation benefits. A one-meter reduction in average water clarity would lead to a loss of swimming benefits on the order of 28 to 87 million euros annually. The decrease in fishing benefits would be larger, since our results indicate that also the number of participants would change. The fishing benefits lost would range between 38 and 113 million euros per year. Since boating was not affected by water clarity in our estimations, no monetary loss can be estimated. However, this does not mean that boaters' consumer surplus would not diminish. If water clarity were to improve by one meter on average, swimmers' consumer surplus would increase by 31 to 92 million euros per year, while fishers would enjoy an even larger enhancement in benefits, from 43 to 129 million euros annually.

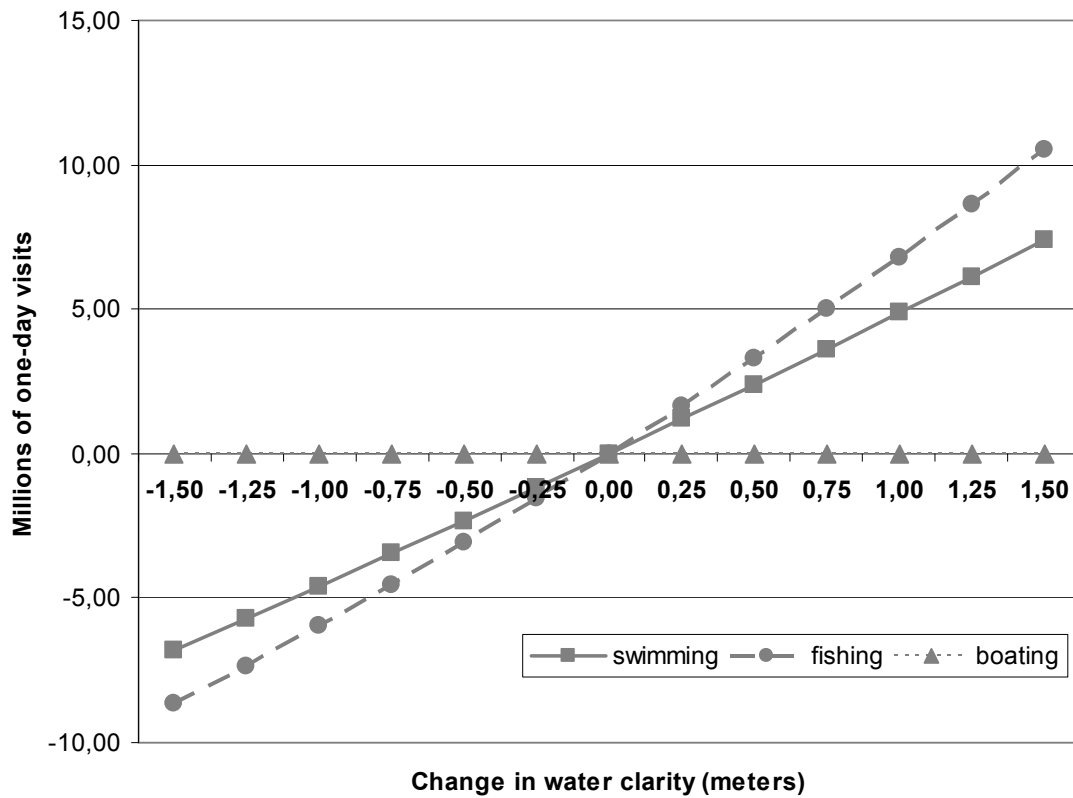


Figure 3. Estimated change in water recreation activity for changes in aggregate local water clarity

### *Comparison with costs*

For policy purposes it is imperative to understand both the costs and benefits of improving water quality. Our study examined water clarity as an indicator of water quality, with eutrophication problems in mind. Even for a rough comparison of the benefits and costs of reducing eutrophication, we would need to know how nutrient levels interact with both sea and inland water clarity, and what the associated annual costs of reducing nutrients are.

As policy measures regarding water quality and previous evaluations of policy costs are associated with nutrient discharge instead of water clarity, we constructed simple regressions for converting nutrient reductions into water clarity improvements in both the sea and lakes. We set water clarity<sup>13</sup> dependent on temperature, depth of measurement point and inverse measures of both total nitrogen

<sup>13</sup> The water clarity regressions used national scale data from six years: the period from 1998 to 2002, and the year 2004.

and phosphorus measures. Both clarity models had significant signs for nutrient levels, and the  $R^2$  figures of .72 and .44 for the lake and sea models, respectively, suggest that we were better able to estimate water clarity for lakes. The results for the two models are shown in Table 5.

**Table 5. Nutrient level effects on water clarity, OLS regression results**

Independent variables	Water clarity	
	Lake	Sea
	coefficient (t-ratio)	
Total phosphorus (inverse)	13.513 <sup>a</sup> (86.077)	9.346 <sup>a</sup> (25.811)
Total nitrogen (inverse)	357.723 <sup>a</sup> (50.564)	428.609 <sup>a</sup> (27.795)
Water temperature	.011 <sup>a</sup> (6.702)	.000 (.116)
Depth of measurement point	.018 <sup>a</sup> (41.702)	.034 <sup>a</sup> (49.781)
Intercept	-.022 (-.659)	.117 <sup>c</sup> (1.673)
N	16 308	8 210
$R^2$	.72	.44
Std. error of the estimate	.704	.895

<sup>a</sup> p-value < .01; <sup>b</sup> p-value < .05; <sup>c</sup> p-value < .10

Using the regression results from Table 5, we estimate that a uniform reduction of 38 and 37 percent in nutrient levels in lakes and on the Finnish coast, respectively, would be required to achieve a one-meter improvement in average water clarity. Söderqvist and Scharin (2000) found that in the Stockholm archipelago a one-meter improvement in clarity from 1.5 to 2.5 meters, would require approximately a 30 percent reduction in nitrogen, while a similar improvement from a better initial water clarity of 2.5 meters would require a smaller, 21 percent reduction.

Helin et al. (2006) estimated that a 50 percent reduction in nitrogen flow from Finnish agriculture to the Gulf of Finland would cost 34.9 to 47.6 million euros annually, depending on policy regime. Although inland water eutrophication is more often phosphorus-limited, our simple water clarity models suggest that reductions in nitrogen flows to the sea also have an effect on inland waters, providing additional benefits. Comparing these results with the recreational benefits we have derived, which likely represent a lower bound estimate since non-use values are excluded, it seems that

the benefits of water clarity improvements are at least at the level of the associated costs.

## **Conclusion**

Using a hurdle model for water recreation participation and trip frequency, we found that water clarity in the home municipality affects recreation behavior in Finland. The annual number of swimming trips was estimated to increase by 1.6 on average per participant for a one-meter increase in water clarity, while the number of fishers would increase by 2.7 percent and the number of fishing trips per person by 2.1 per year. As in Sandström's (1996) study on the Swedish coast, we found boating unresponsive to changes in water clarity. Boaters may not, however, be completely oblivious to water clarity since the spatial scale for their activity may well be wider than their home municipality.

Hot summer days affected participation and swimming frequency positively, making climate change effects on recreation an important aspect of future studies. A warmer climate may increase the number of participants and water recreation trips taken, but may also have an adverse effect on water quality in the form of increased algal blooming, among other problems. Ecological scenarios of this interaction would allow it to be combined with analyses such as that presented here in the future.

Estimating travel costs to a representative site we found the average water recreation visit to have a value in the range of 6.30 to 19.00 euros. Policies leading to better water clarity and quality would thus provide swimmers with a consumer surplus in the range of 31 to 92 million euros annually for a one-meter improvement in clarity. Benefits to fishers were estimated to be slightly higher, although the participant base is

smaller, i.e., 43 to 129 million euros annually for a corresponding change in water clarity.

Close-to-home water quality changes have large enough effects on recreation behavior to merit consideration in formulating policies designed to improve water quality in general. When weighing the costs and benefits of improving coastal water quality, inland water quality changes due to nutrient flow reductions should also be taken into account, lest the attainable benefits be underestimated.

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