Water recreation benefits from reduced eutrophication in Finnish surface waters

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Abstract— **Eutrophication has been commonly acknowledged as a typical problem of the Baltic Sea, but it is also emerging in Finnish inland waters. As municipal sources of nutrients have been addressed by enhancing waste water treatment, the pressure has focused to agriculture along with the adoption of the EU- Water Framework Directive, which aims to improve surface water quality to "good ecological status" by 2015. The implementation of the directive will likely affect water recreation behavior and benefits. In this study we modeled water recreation participation and water quality econometrically using a hurdle model for three activities: swimming, fishing and boating. In addition, we estimated the consumer surplus for a water recreation day using a travel cost approach. We found that close-to-home water quality affects swimming and fishing behavior positively, and that for a 1-meter improvement in water clarity, consumer surplus for swimmers would increase at a range between 32 to 97 million Euros, and for fishers by 43 to 130 million Euros. In comparison with previously estimated costs of decreasing agricultural nutrient flow to the Gulf of Finland, we found that net benefits may be positive.**

Keywords— **Water recreation, non-market valuation, eutrophication**

I. INTRODUCTION

The EU-water framework directive (WFD) (2000) aims to harmonize water protection in EU countries, so that all aquatic ecosystems meet "good ecological status" by 2015. Eutrophication has been acknowledged as a typical problem of the Baltic Sea, but it is also emerging in Finnish inland waters. As municipal sources of nutrients causing eutrophication have been addressed enhancing waste water treatment, the pressure has focused to agriculture. The trend of centralizing animal farming threatens to increase eutrophication especially in the basins of Southern and Western Finland and has a profound effect to the quality of Finnish surface waters [1].

The recreational benefits from the implementation of WFD will undoubtedly be considerable. Studies have shown that recreation is the most important reason for conserving water bodies [2] and that over 60 % of the total benefits of water protection come from recreation [3].

We study recreational benefits from water protection in Finland, where the abundance of water recreation opportunities has an effect on the applicability of different recreation demand models. Modelling water recreation demand in a water rich country requires the focus to be more in understanding the prerequisites of everyday close-to-home recreation activities than in site choice of remote destinations. To our knowledge only one study has previously analyzed water recreation in relation with general water quality in home region [4].

Changes of water quality in every-day living environment may affect water recreation in two ways: the likelihood of non-users to engage in water recreation and current users to increase their use day frequency. We tackle the association between recreation participation and water quality econometrically using a hurdle model for three water activities: swimming, fishing and boating. In addition, we estimate the consumer surplus for a day spent in water recreation. We also discuss the monetized recreational benefits in relation to costs of water quality improving policies.

II. METHODS AND DATA

We estimated recreational benefits from water quality changes in two stages as shown in figure 1. At the first stage we modelled water recreation behaviour separately for each activity using a hurdle model, with logit and negative binomial specifications for participation and trip frequency estimation, respectively. At the second stage we constructed a travel cost model to obtain an estimate for the value of a water recreation day.

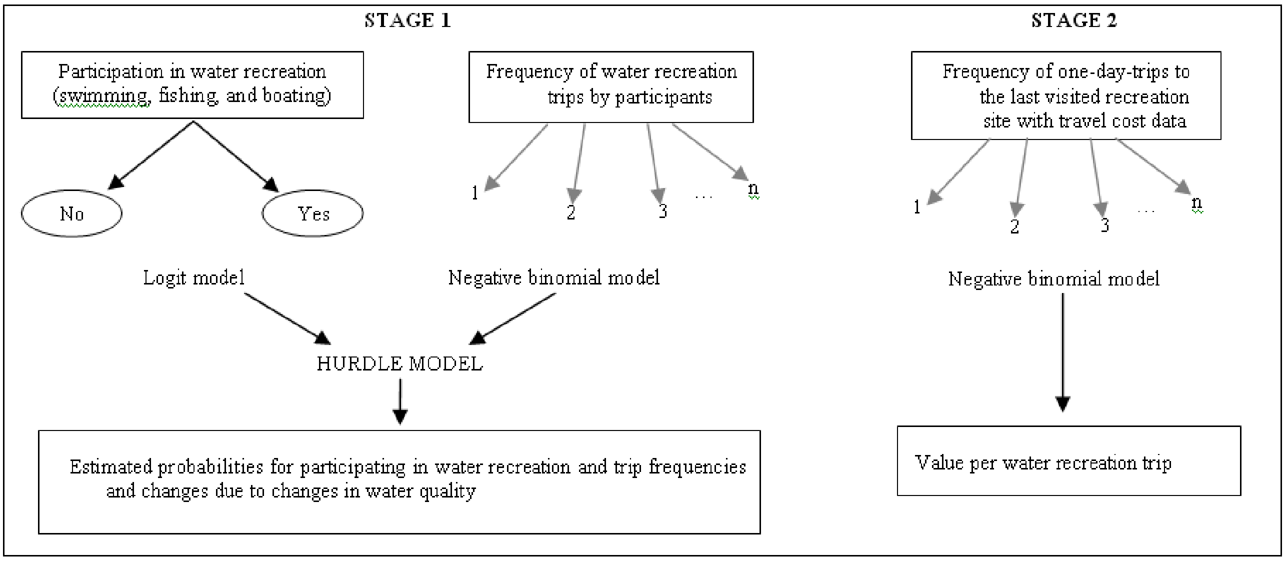

Fig. 1. Stages of water recreation behavior and benefit estimation.

We combined two national scale databases for the analysis. Water recreation behaviour data was acquired from the Survey for the Finnish national outdoor recreation demand inventory collected between 1998 and 2000. Information of annual water recreation participation was available for 5414 respondents, while the travel cost sample for day trips had 167 swimmers, 175 fishers and 89 boaters. Water quality data was taken from Finnish Environmental Institute's "State of Finland's Surface Waters" database for the summer seasons of 1998, 1999 and 2000. The water quality database covered over 3 000 lakes and 1 400 measuring points at sea. We chose water clarity to represent water quality, as it is easily observable by the public and is affected by eutrophication. Since we were interested of the effect of close-to-home water quality, the estimations employ average water clarity data from respondents' home municipalities.

III. RESULTS

The hurdle model estimation results for participation and trip frequencies are shown in table 1. The estimated participation model results for swimming, fishing and boating are reported in the first column for each activity, while participation frequency estimations are shown in the second set of columns respectively. The results imply that water clarity in respondents' home municipalities did not restrict the participation in swimming or boating. On the other hand, water clarity had a significant positive effect on fishing participation probability, and swimming and fishing trip frequencies. We also found that hot days in the respondents' home region increased participation across the activities, and in the case of swimming, had a significant effect on trip frequency. This suggests that climate change may induce growth in water recreation activities.

The estimated benefits of a water recreation day from the travel cost model and the aggregated annual benefits are shown in table 2. The per-trip-values were estimated using all three water recreation activities due to data limitations, hence the values are same for each activity. However, the travel cost estimation did not show significant difference between per-trip-values from each activity.

Figure 2 displays the estimated adjustment in annual aggregate water recreation days with changing levels of water clarity. Using our results for benefits per water recreation visit, and the change in recreation frequency, we estimated that a one-meter improvement in average close-to-home water clarity would increase swimming and fishing benefits, respectively, at ranges of 32 to 97 and 43 to 130 million Euros per year.

Table 1. Hurdle model estimation results for water recreation activities

	Swimming		Fishing		Boating	
	Logit	Negbin	Logit	Negbin	Logit	Negbin
Independent variables	coefficient-value (*** p-value < 1 %; ** p-value < 5 %; * p-value 10 %)					
Intercept	.985***	2.172***	−.205	2.772***	.008	2.316***
Gender (female = 1)	.085	.086**	−1.077***	−.015***	−.528***	−.333***
Age	−.025***	.010***	−.001	.010***	−.015***	.006**
Household income (1000€)	.206***	.027	.005	−.173***	.075	−.060
Academic education	.130	−.031	−.238***	−.205	.048	−.141**
Student	.315*	.208***	.043	−.008	−.235*	.116
Unemployed	.073	.065	.061	.483***	.032	.219***
Retired	−.019	−.023	.168	.140	−.055	.210**
Home employed	−.414**	−.327***	−.510***	−.218	−.351*	−.101
Number of children	.041	.008	.054	−.083***	.027	−.003
Number of adults	−.018	.042*	.013	−.001	−.073	.006
Number of hot days (> 25 ºC)	.041***	.016***	.006*	−.002	.012***	.002
Distance to nearest recreation site	−.015*	−.014***	.004	.002*	−.001	.001
Access to a summer house	.381***	.268***	.613***	.358***	.221***	.251***
Access to a car	.346***	.128**	.438***	.305***	−.036	.096
Access to a boat					1.550***	.711***
Water clarity in home municipality	−.006	.059**	.107***	.097***	.070	.020
Months since summer season when responding		.004		.015		−.007
N	3749		3536		3560	
LL (hurdle model)	-14271		-10462		-10096	
χ^2 (hurdle model)	100901		109910		77142	
Pseudo R^2	.78		.84		.79	

Table 2. Per visit and national aggregate benefit estimations of water recreation

Activity	Estimated value per trip, € (1998)	Participants (millions)	Participation frequency (days)	Annual total benefits, millions of € (1998)
Swimming	6.30 to 19.20	3.046	26.52	507 to 1 548
Fishing	6.30 to 19.20	2.076	20.78	271 to 827
Boating	6.30 to 19.20	2.022	18.31	232 to 710

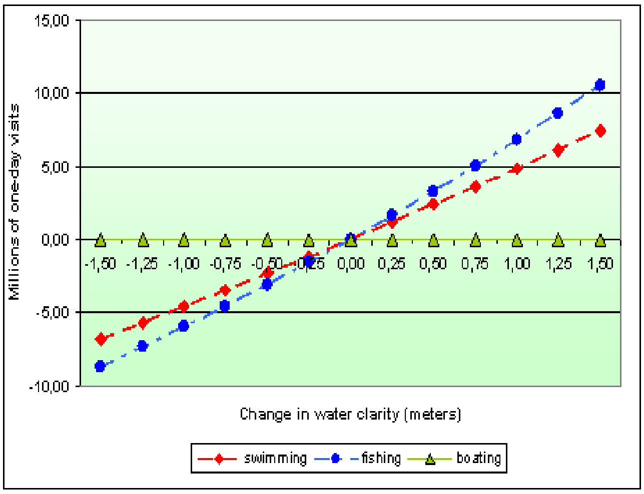

Fig. 2. Estimated change in water recreation activity with changing water clarity

IV. CONCLUSIONS

After modelling water recreation behaviour, we found that close-to-home water clarity, as a proxy for quality, had a positive effect on swimming and fishing trip frequencies. Additionally, we found that better water quality could increase participation in fishing. We estimated that a one-meter water clarity improvement in Finnish surface waters, would, increase annual swimming benefits by 32 to 97 million Euros, and fishing benefits by 43 to 130 million Euros.

Helin et al. [5] estimated that a 50 % reduction in nitrogen flow from Finnish agriculture to the Gulf of Finland would cost 34.9 to 47.6 million Euros per year, while Söderqvist and Scharin [6] found that in Stockholm archipelago a one-meter clarity improvement from 1.5 meter depth to 2.5 meter depth would require approximately 30 % reduction of nitrogen, and an improvement from 2.5 meters would require a 21 % reduction. A comparison of these figures indicates possible positive net benefits from agricultural nutrient reductions.

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