Report of an approach for valuing recreation wellbeing effects of Lake Puruvesi

Annika Tienhaara, Eija Pouta and Tuija Lankia
Natural Resources Institute Finland (LUKE)

Cover photo: Lake Puruvesi. Eija Pouta.

The project has received funding from the LIFE Programme of the European Union. The material reflects the views by the authors, and the European Commission or the EASME is not responsible for any use that may be made of the information it contains.

Summary

This report is a part of Freshabit LIFE IP (LIFE14/IPE/FI/023) -project, where several measures will be implemented to improve the water quality of Lake Puruvesi. The aim of this report is to value recreation benefits of Lake Puruvesi and to examine how water quality affects these benefits. The data used in this report was collected using an internet based survey that was targeted for people visiting Lake Puruvesi. Using travel cost and contingent behavior methods, the number of visits and consumer surplus estimates for four different water quality scenarios were estimated. The results indicate a strong association between the water quality and the recreation benefits. The aggregated consumer surplus for best water quality (Scenario A) was approximately 5.5-6.7 million euros, whereas the consumer surplus for worst water quality (Scenario D) was only 2.8 million euros. The aggregated consumer surplus estimates were, however, very dependent on the number of visits, i.e. the information that was rather uncertain.

1. Introduction

Recreation is one of the key ecosystem services that can be enhanced by management of lake ecosystems. Improving the quality of environment and the services for recreation also affects wellbeing effects from recreation. Measuring the changes in recreation behavior and benefits due to development projects provides information for justifying the management actions and for prioritizing various management alternatives. This report examines the effects of water quality changes on recreation behavior and the value of recreation benefits.

In Finland, there are almost 190 000 lakes larger than 500 square meters, and nearly ten percent of the country is covered by water. Thus, it is evident that water recreation is an important leisure time activity in Finland. For example, about two-thirds of the Finnish population annually swims in natural water systems, 44% go fishing and almost half uses water bodies for boating (Sievänen & Neuvonen 2011). The water recreation of Finns is further strengthened by the leisure home culture (Sievänen, Pouta & Neuvonen 2007). Finland has a population of 5 million and there are approximately 500 000 leisure homes, often situated by a lake. Since water recreation is a significant leisure activity in Finland, it undoubtedly has effects on people's wellbeing. Thus, it is important to know how the benefits from recreation would be affected by potential changes in water quality (Vesterinen et al. 2010; Lankia, Neuvonen & Pouta 2017).

The value of water recreation has been estimated from national samples (Lankia et al. 2017, Vesterinen et al. 2010). These studies, using the travel cost method and also contingent behavior questions, have estimated the value of one water recreation visit or day, and also assessed how this value would change if water quality changed. The value estimates for water recreation are in the range of 6–20 euros per visit. In Lankia et al. (2017) a water quality improvement increased the recreation benefits by 53–80 percent, while deterioration in quality decreased the benefits by approximately 80 percent. As the approach in these studies used a national sample and did not specify water body, it is unclear how the results can be applied for an individual lake. Previous studies have also shown the importance of different water quality attributes such as water clarity, absence of blue-green algae blooms and low tendency for sliming (for review Ahtiainen, Pouta & Artell 2015). However, importance of these water quality attributes is always case specific.

In this report, we are interested in Lake Puruvesi (shown in Figure 1), which is one of the Freshabit LIFE IP (LIFE14/IPE/FI/023) -project target areas. Case of Lake Puruvesi is special, as it is currently on excellent state, but facing eutrophication that is already observed in measurements and also visible on beach and bay areas. As the water quality is changing and there are spatial differences in the quality, people's perception on the water quality and its changes may differ from the objectively measured quality. This implies special challenges for the study. Regardless of the special conditions of Lake Puruvesi, this study aims to develop an approach that would be applicable to other sites of lake restoration in Freshabit LIFE IP and other projects. Freshabit LIFE IP includes management actions concerning several lake areas. In all these areas, there is need for information concerning the benefits of water quality improvements and also for the approaches that can be used in individual sites. Thus this report facilitates lake management decisions on new areas in the future.

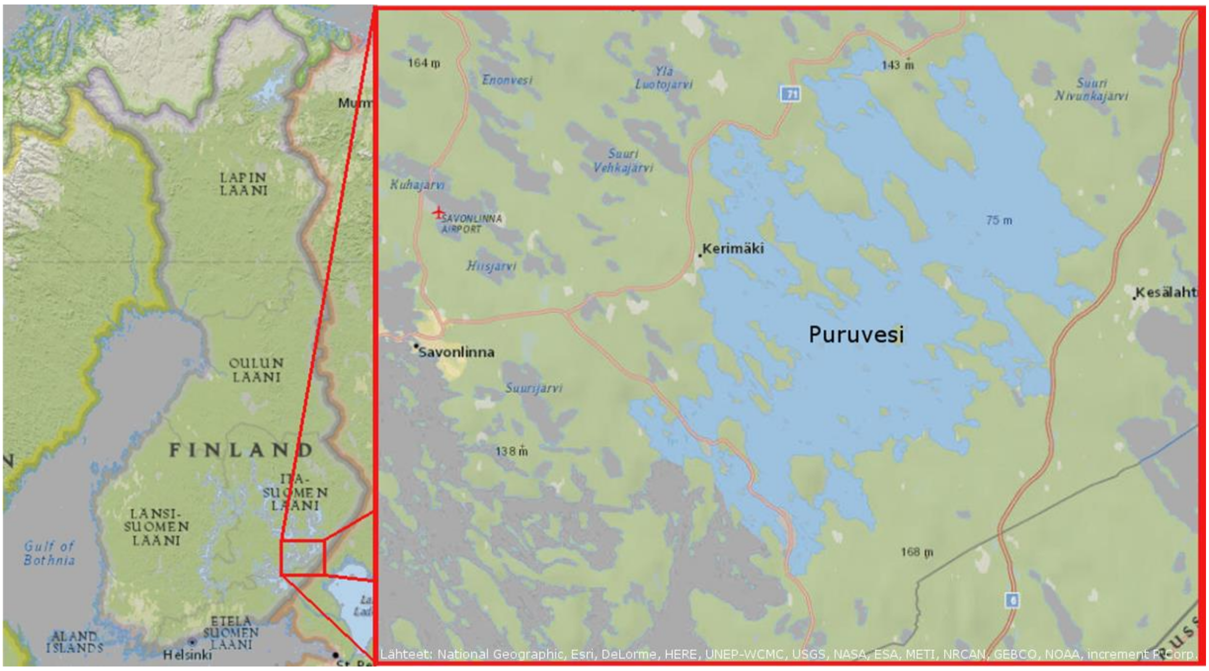

Figure 1. Map of Lake Puruvesi.

In this report, we evaluate the benefits of recreation and water conservation on Lake Puruvesi before management actions. We use the approach of combined travel cost and contingent behavior method that allows taking into account also water quality levels that are not currently present. The estimated demand functions based on this approach reveal the effect of water quality on water recreation, and allow us to calculate the welfare effects of water quality changes at the lake scale. Estimating the recreation benefits makes it is possible to compare them to the costs of management activities. In addition, we discuss the possibilities of transferring benefit estimates from one lake to another in Finland.

Figure 2. Suuri-Hytermä island in Lake Puruvesi. Erkki Oksanen

2. Methods and data

2.1 Study area

Lake Puruvesi is part of the Vuoksi water system and of the Lake Saimaa. Lake Puruvesi is located in Eastern Finland between South-Savo and North-Karelian regions and surrounded by Savonlinna and Kitee municipalities. The morphology of the lake is very complex with several large basins and over 850 islands. In total, 77 % of the lake area belongs to the N2000 site representing an oligotrophic lake. The catchment area in relation to the lake surface area (416 km^2) and volume (mean depth ~9m) is small.

The lake is known for its pure water and has unique, excellent underwater visibility that reaches up to 12 meters. Part of the water originates from groundwater entering the lake from below. The oxygen situation of the lake is good and water does not contain humus either. According to the general usability classification the water quality is on average excellent.

Unfortunately, recent observations have shown that eutrophication and spread of vegetation has increased around the shallow basins. Rocks can be slimy, and in some locations there exists thick eutrophic bottom sediment. Also blue-green algal blooming has occurred few years. The main reason for eutrophication is forestry, including forest cuttings and drainage of peatlands. Fields cover less than 10% of the catchment land area, but partly affect the eutrophication. Only noteworthy point source of nutrients is Kerimäki population centre.

The use of Lake Puruvesi for recreation is abundant, as it is popular location for summer cottages and also due to Punkaharju's status as a major tourism destination. The lake is actively used for fishing and other outdoor activities by local people, although there have been signs of declining water quality. In addition, many private enterprises in the region are dependent on outdoor water recreation activities.

In the Freshabit LIFE IP -project, several measures will be implemented to improve the water quality of Puruvesi. The controlling of loading targets both agricultural and forestry loads. The measures include 12 hectares new floodplains and 55 action locations with e.g. sedimentation pits, peak runoff control and wetland bay management. Also removal of fish is carried out by removing dense fish stocks in selected target areas. Recreation facilities will be developed by providing new trails, information boards, tables and benches. This report provides information on the recreation benefits for different water qualities before the improvement measures are implemented.

2.2 Travel cost and contingent behavior methods

Since recreation in natural waters is a non-market good that does not have a market price, the value of recreation has to be estimated with non-market valuation methods. Commonly, the benefits of outdoor recreation are evaluated with the travel cost method, in which the demand for and the value of a recreation site is estimated on the basis of the costs associated with travelling to the site and the number of visits made. Travel expenses are used as an approximation for the price of recreation, and as the travel costs and the trip frequency varies across individuals a demand curve for recreation can be estimated. The estimated curve can then be used to calculate the value of a recreation visit (e.g. Haab & McConnell, 2002; Ward & Beal, 2000.)

However, the travel cost model focusing on a single recreation site does not permit evaluating the welfare effects of changes in environmental quality. Valuation of changes in environmental quality is not possible because in a single site model the analysis is limited to a single site and single period, when there seldom is notable variation in the environmental quality. Therefore, to study the effects of water quality changes on the recreation benefits of Lake Puruvesi, we applied combined travel cost – contingent behavior approach (TC-CB) (e.g. Hanley, Bell, and Alvarez-Farizo, 2003). The contingent behavior method is a stated preferences valuation method in which respondents are asked how many times they would visit the recreation site in the future under different hypothetical environmental quality scenarios. Thus, supplementing travel cost data with contingent behavior data allows estimation of a recreation demand curve that takes also environmental quality into account. Consequently, also the effects of the environmental quality changes on the value of recreation can be estimated.

The TC-CB data has two important features that need to be taken into account in the econometric analysis. First, since the number of recreation visits takes only non-negative integer values, a count data model is preferable over a linear model (Hellerstein 1991). Second, the combined travel cost-contingent behavior data is in panel data format containing multiple observations from each respondent. Hence, the TC-CB model has to be estimated with a panel data model that takes the possible correlation across an individual's multiple observations into account.

Consequently, we estimated the travel cost model with negative binomial model and the combined travel cost – contingent behavior models with the random effects Poisson model. A common approach in count data modelling is to assume that the number of trips follows a Poisson distribution if the conditional mean is equal to the variance (Haab and McConnell 2002). However, in our data as well as commonly in previous literature, the variance was found to be larger than the mean. Therefore, in the travel cost model, we applied a negative binomial model. It is commonly used in the application of the travel cost method, because it extends the Poisson model to allow the variance to be larger than the mean.

The combined TC-CB model was estimated with random effects Poisson model (e.g. Hanley et al. 2003, Bhat et al. 2003, Whitehead et al. 2010 and Simões, Varata, and Cruz 2013). In the random effects Poisson model, a gamma distributed random individual specific term is added to the mean function to take into account the unobservable individual characteristics and overdispersion (Cameron and Trivedi 1998, Whitehead et al. 2010).

The estimated demand curve for trips to Puruvesi allows us to estimate the value of a recreation visit i.e. consumer surplus per trip. The consumer surplus is the difference between the maximum amount an individual is willing to pay for a visit and the amount she actually pays for it. Both the travel cost method estimated with the negative binomial model and the combined TC-CB model estimated with the random effects Poisson model provided us a semi-log specification of the demand curve, which allows us to calculate the consumer surplus per visit simply by the formula $CS/Y = -1/\beta_{TC}$ (Haab & McConnell 2002). β_{TC} is the estimated coefficient of the travel cost variable and Y is the expected number of trips to Puruvesi.

The effects of water quality in the value of recreation visit can be examined by calculating the consumer surplus for recreation under different water quality scenarios. This can be done with the formula $CS/Y = -1/(\beta_{TC}+\beta_{TC*WaterQualityScenario})$, by adding interaction variable between water quality scenario and travel cost to the equation. In all models, travel cost variable was defined by using round-trip distance to visitation site, estimated driving costs, i.e. 0.16 euros per km (Ovaskainen et al. 2012), as well as travel time. For those who walked or cycled to Puruvesi, travel cost variable only included the opportunity cost of travel time.

2.3 Survey

The survey was targeted to people who had visited Puruvesi and used area for recreation during the last 12 months. The survey began with questions concerning respondents' relationship with Puruvesi, recreation activities, evaluation of overall water quality and the importance of different water quality attributes. These are reported in Tienhaara & Pouta (2017).

The survey then focused on trips to Puruvesi. The respondents identified the location of the site they had last visited and reported the number of trips taken to this site during the previous 12 months. The distance from home or leisure home together with the travel time to the site were used as the basis for the travel cost variable.

The survey then proceeded to questions concerning site characteristics of the last visited site on Puruvesi. These questions included respondents' perceptions of the water quality. To obtain water quality variables as usable as possible, it was important to select water quality attributes that are understandable and easily observed by individuals. The selected water quality indicators included water clarity, blue-green algae blooms, the amount of slime on piers and rocks, vegetation (reed) on the beach and the muddiness of the beach. These indicators can be measured objectively and are therefore applicable in management design. Especially water clarity is an important determinant of water recreation (Egan et al. 2009). Water clarity can be improved by using management activities that decrease nutrient loads, as it has been shown to correlate with nutrient levels (Sandström 1996, Soutukorva 2005).

After the questions concerning their past recreation behavior, the respondents were presented with four contingent behavior questions asking how their visits to Lake Puruvesi would change under different hypothetical water quality scenarios. Before the hypothetical scenarios were presented, the following information was given:

Many things affect the water quality of Lake Puruvesi. The water quality is maintained/improved in the Puruvesi area by many management activities, for example by building wetlands to prevent nutrient flow to waterbodies. Despite these activities, the water quality may deteriorate locally, if the conditions change in the area, for example due to the changes in forestry and agriculture.

The respondents were then asked to state how many times they would visit their last visitation site in Puruvesi under differing water quality scenarios. Table 1 shows four different water quality scenarios that were presented to the respondents. The first contingent behavior question asked how many times respondents would visit the site in the next twelve months if the water quality of the water system was the best possible (Scenario A). The following contingent behavior questions presented rest of the scenarios ending in the worst water quality in Scenario D.

Table 1. Different water quality scenarios.

	Scenario A	Scenario B	Scenario C	Scenario D
Water clarity	Over 8 meters	6 meters	4 meters	2 meters
Blue-green algae blooms	None	1-4 days	5-10 days	More than 10 days
Sliming	None	Slight	Some	Abundant
Amount of reed on the beach	None	Individual canes	Patchy	Abundant
Muddiness of the beach	No mud	Under 2 cm	3-10 cm	Over 10 cm

The current measured water quality of Lake Puruvesi is on average between Scenarios A and B. Overall, the water quality of Lake Puruvesi is excellent, especially in the middle of the lake, but the quality is inferior near the shoreline. For travel cost and contingent behavior models, we formed dummy variables for each water quality scenario, so that the effects of water quality on recreation visits and their value could be estimated.

2.4 Data

The data were collected during 2016 using an Internet based survey that allowed incorporation of spatial information. The respondents consisted of those who had responded to visitor survey in Puruvesi implemented by Metsähallitus (State Forest Enterprise) in the summer 2016. In addition, the survey was sent to the members of Pro Puruvesi association. The purpose of the selected data collection methods was to reach as many respondents as possible who had visited Puruvesi during the last 12 months.

The questionnaire was tested with pilot study and then finalized based on the answers obtained from the pilot. Overall, the survey was sent to 868 recipients and 327 respondents replied to the survey. Out of these respondents, 251 completed the whole questionnaire, with the response rate being 29%. Table 2 presents the descriptive statistics of the respondents.

Table 2. Descriptive statistics for the sample.

	Mean/ % of the respondents	**Std.dev.**	**Min**	**Max**
Gender (male)	64%	0.481	0	1
Age (years)	57.5	12.3	18	81
High education	51%	0.50	0	1
Household size (persons)	2.40	1.04	1	6
Individual gross income (€/month)	3197	1264	500	5500
Living by Lake Puruvesi	22%	0.414	0	1
Leisure home by Lake Puruvesi	69%	0.462	0	1
Access to a boat	83%	0.377	0	1
Distance to Lake Puruvesi (km)	158.6	175.62	0.01	1000
Travel cost, €	30.11	37.06	0	180
Cycling or walking	12.5%	0.331	0	1
Member of Pro Puruvesi association	76%	0.427	0	1
Number of recreation activities	5.01	1.78	0	8
Overall perceived water quality	2.56	0.662	1	5
Importance of water quality	1.57	0.438	1	5

The sample contained slightly more men than women. The mean age of respondents was 57.5 years and 51% had higher education. Average household size was two persons and mean individual gross income was approximately 3200 euros per month. The respondents had a strong connection to Lake Puruvesi as 22% of the respondents lived at the waterfront and almost 70% had a leisure home by Lake Puruvesi. The majority of the respondents (83%) had an access to boat. The mean one-way distance travelled to Lake Puruvesi was approximately 158 kilometers, varying from 10 meters to 1000 kilometers. However, for half of the sample, the distance was only 45 kilometers or less. Travel costs ranged from 0 to 180 euros, while the mean was 30 euros.

Out of the respondents, 12.5% cycled or walked to their last visitation site and 76% were members of Pro Puruvesi association. The respondents were on average engaged in five different recreation activities during the last twelve months, including for example boating, fishing and swimming. The perception on the water quality of Lake Puruvesi in general was 2.65 (scale from 1 – excellent to 5 – poor), and the mean importance of water quality attributes was 1.57 on a scale ranging from 1 to 5 (very important – not at all important).

3. Results

Table 3 presents the results of recreation demand models for Lake Puruvesi. Travel cost model only considers actual trips taken to Lake Puruvesi (Model 1). Combined travel cost and contingent behavior models include both actual and hypothetical visits (Models 2 and 3).

Table 3. Travel cost model (Model 1) and combined travel cost-contingent behavior models (Models 2 and 3).

	Model 1	**Model 2**	**Model 3**
Variables	*TC-model*	*TC-CB 2-model*	*TC-CB 3-model*
Constant	-0.128	0.678	0.440
Travel cost	-0.128***	-0.012***	-0.008***
Water quality B	0.116	-0.101**	
Water quality C	0.121	-0.302***	
Water quality D	-0.332*	-0.679***	
Travel cost – water quality B interaction			-0.002***
Travel cost – water quality C interaction			-0.004***
Travel cost – water quality D interaction			-0.012***
Travel cost – cycling or walking interaction	-4.540***	-4.088***	-4.092***
Cycling or walking	2.493***	2.409***	2.392***
Summer cottage	1.644***	1.459***	1.455***
Fishing	0.808***	0.795***	0.791***
Income	0.000*	0.000*	0.000*
Age	0.023***	0.015**	0.016**
CB question (1=yes, 0=no)		-0.164**	-0.135**
Alpha	1.123	1.105	1.097
Number of observations	189	945	945
Number of respondents	189	189	189
Log-likelihood	-812.07	-7253.78	-8237.95
Restricted log-likelihood (constant only)	-946.43	-12 402.24	-12 402.24
McFadden's Pseudo R^2	0.094	0.41	0.34

In Model 1, the travel cost variable was negative and statistically significant, as expected. This means that increase in travel cost leads to lower visitation frequency. The water quality in Model 1 was respondents perceived water quality at their last visit site on Lake Puruvesi. It did not have great impact on current recreation visits. This may be due to the fact that the current water quality of Lake Puruvesi is rather good and the water quality does not vary a lot. However, having the best water quality (level A) as a reference level, the water quality level D was weakly significant, implying that the worst water quality decreased the number of visits. The dummy variable for those who cycled or walked to the site was positive and significant indicating that these respondents were likely to visit more often. All of the models also included socio-demographic explanatory variables. These had similar effects on all three models. Those respondents who have summer cottage near Lake Puruvesi as well as those who go fishing were likely to visit more often. Also age and income had a significant positive effect, increasing the number of visits to Lake Puruvesi.

Model 2 shows that water quality affected recreation visits as expected. Water quality dummy variables for levels B, C and D were negative and significant, and coefficients decreased with lower levels of water quality. This implies that the respondents are less likely to visit Lake Puruvesi if the water quality gets worse, and vice versa, better water quality increases the number of visits. The CB dummy was significant, implying that respondents' behavior in actual and hypothetical setting differed. This could, however, be caused by the fact that all water quality levels described in the contingent behavior section are not currently present in Lake Puruvesi.

While Model 2 included dummy variables for water quality, revealing the effects of water quality on the number of visits, interaction variables between water quality and travel cost in Model 3 reflect how the sensitivity to the travel cost variable changes with different water quality scenarios, also implying changes in consumer surplus. All interaction variables were statistically significant and behaved as hypothesized. A decrease in water quality caused respondents to be more sensitive to travel costs. This leads to reduction in consumer surplus along decreasing water quality. Demographic variables had similar effect as in Models 1 and 2.

The average number of current visits per year was 350 for those who cycled or walked to Puruvesi. It should be noted that most of these respondents live by Lake Puruvesi. For others, the average number of current visits was 29 visits per year. Based on the models, it was possible to obtain visit estimates for all water quality scenarios. These are presented in Table 4. Visit estimates under different water quality levels ranged between 379 and 192 for cyclists and walkers, whereas the range was between 34 and 17 visits per year for others. Hence, the number of visits clearly decreases as the water quality deteriorates.

Table 4. Visit and consumer surplus estimates for current water quality and different water quality levels based on TC and combined TC–CB models.

	Visits, per year Cycling/walking	Visits, per year Other	Consumer surplus, € Cycling/walking	Consumer surplus, € Other
Current	350	29	0.22	78.31
Average			0.24	84.37 *TC-CB 2
Level A	379	34	0.24	120.93 *TC-CB 3
Level B	343	31	0.24	94.95 *
Level C	280	25	0.24	78.33*
Level D	192	17	0.24	48.62 *

Note: Water quality levels presented in Table 1.

Table 4 also presents the recreation values per person per visit in terms of consumer surplus. The estimated consumer surplus under the current water quality (based on Model 1) was 78.31 euros per visit. For those who cycled or walked to Puruvesi, the estimated consumer surplus was 0.22 euros per visit. The consumer surplus for average water quality (based on Model 2) was 84.37 euros per visit, while it was 0.24 euros for cyclists and walkers. The recreation values for different water quality levels described in scenarios A, B, C and D were derived based on corresponding interaction variables (Model 3). The consumer surplus per visit was 120.93 euros for water quality A, 94.95 euros for water quality B, 78.33 euros for water quality C and 48.62 euros for water quality D. For those who cycled or walked to Puruvesi, the corresponding consumer surplus estimates for water quality levels were very close to one another all rounding to 0.24 euros.

To calculate the aggregated recreation benefit estimates, information on the total number of recreation visits to Puruvesi is required. We used an estimate based on Visitor survey in the Punkaharju and Puruvesi area 2016–2017 (Karppinen 2017). Total number of visits to the area was 137 300 per year, and approximately 40% out of these visits were directed to Puruvesi (54 600 visits/year). To include residents in the Puruvesi area more comprehensively, we calculated separate estimate for the nearby visits, taking in to account the size of the lake, the length of the shoreline, the population density, average number of nearby visits from data and the participation rate of outdoor recreation (Sievänen & Neuvonen 2011). Estimated number of nearby visits was 427 500 per year.

In calculating the aggregate welfare effects, we used two different methods (Table 5). Method 1 used the relative change in the number of estimated visits under different water qualities compared to current visits (350 visits per year for cyclists and walkers or 29 visits per year for others) and the consumer surplus estimate for average water quality based on Model 2. On the basis of Method 1, the aggregate consumer surplus was 5.5 million euros for water quality A and 2.8 million euros for water quality D. As a comparison, aggregated consumer surplus for current visits was 4.37 million euros. In method 2, we multiplied the consumer surplus estimates for different water quality levels (based on Model 3) with the total number of visits both for those who cycled or walked and others. Altogether, the aggregated consumer surplus was 6.7 million euros per year for water quality A, whereas it decreased to 2.8 million euros for water quality D. This method produced slightly higher aggregate consumer surplus estimates compared to Method 1.

Table 5. Aggregated recreation benefit estimates (€ million/year).

	Method 1			**Method 2**		
Water quality	**Cycling /walking**	**Other**	**All**	**Cycling /walking**	**Other**	**All**
Level A	0.111	5.401	**5.512**	0.103	6.603	**6.706**
Level B	0.101	4.924	**5.025**	0.103	5.184	**5.287**
Level C	0.082	3.971	**4.053**	0.103	4.277	**4.380**
Level D	0.056	2.700	**2.756**	0.103	2.655	**2.758**

4. Conclusions

This report presented how changes in the water quality can affect the benefits obtained from recreation visits to Lake Puruvesi. Aggregated consumer surplus for current visits was 4.37 million euros. This would increase to 5.5- 6.7 million euros per year, if the water quality was excellent, i.e. water clarity of Lake Puruvesi was over eight meters and no sliming, algae blooms, reeds or muddiness existed. However, if the water quality was poor, i.e. water clarity was 2 meters, blue-green algae blooms occurred more than 10 days a year, there was abundant sliming and reeds on the beach as well as over 10 cm muddiness of the beach, the aggregated annual consumer surplus would be 2.8 million euros per year. Hence, moving from excellent to poor water quality would cut the benefits from recreation in half.

However, there are some challenges in the travel cost method that has to be taken into account, especially when applying this method to other lakes and areas. Firstly, it is good to acknowledge that the travel cost method is rather sensitive to how travel costs are defined and how the cost of travel time is incorporated (Ovaskainen et al. 2012). Secondly, getting representative sample from recreation users is fairly difficult. In our case, we were able to utilize visitor survey made by Metsähallitus (State Forest Enterprise) as well as active stakeholders (members in Pro Puruvesi association). However, for other, especially smaller lakes these kinds of means to help data collection may not be available.

In addition, it is impossible to know the exact number of visits, so it has to be estimated. We used two different visit estimates in this report, 427 500 for nearby visits (those who cycled or walked to the site) and 54 600 for others. Nonetheless, these are only approximations and there are a lot of uncertainties relating to number of visits made to Puruvesi. This also applies to other lakes, where this method could be used. Still, separating nearby visits made by bike or foot, developed more applicable method to other sites, as the nearby visits could be estimated based on the size of the lake and the population density, whereas the information on the number of other visits could be based, for example, on tourism enterprise survey.

Overall, the welfare estimates obtained from this survey were quite different compared to those from the national sample. For the cyclists and walkers, the consumer surplus per visit under excellent water quality was only 0.24 euros, whereas for example in Lankia et al.

(2017) consumer surplus was 7 euros. This might be due to the fact that many of the respondents live by the lake leading to short distance to recreation site and consequently also low travel costs. In turn, in the national sample, the preferred recreation site might not be the nearest one, thus raising the travel costs and consumer surplus.

In contrast, when travelling by car is considered, the welfare estimates were higher than the ones in national sample, 121 euros in our sample compared to 22 euros in national sample. This can be related to the special characteristics of Lake Puruvesi that attract visitors also further away. In the case of Lake Puruvesi, the aggregated consumer surplus of those who came from longer distance outweighed the benefits from nearby visits. The importance of these two groups is, however, very site specific.

Even though the welfare estimates per visit differed from the estimates in the national sample, when aggregated benefit estimates are divided by the total number of visits, the mean value per trip ranges between 5 for worst water quality (level D) and 13 euros for best water quality (level A). This is in line with the previous national estimates, which ranged from 6 to 20 euros.

This study demonstrated an approach that can be used for estimating the recreation benefits of water management on local level. However, more empirical case studies are needed to get information on how the lake characteristics affect consumer surplus, especially as Lake Puruvesi is known for its' exceptionally clear waters.

References

Ahtiainen, H., Pouta, E & Artell, J. 2015. Modelling asymmetric preferences for water quality in choice experiments with individual-specific status quo alternatives. *Water Resources and Economics,* 12: 1–13.

Bhat, M.G. 2003. Application of Non-Market Valuation to the Florida Keys Marine Reserve Management. Journal of Environmental Management 67 (4), 315-325.

Cameron, C. A. & Trivedi, P, K, 1998. Regression analysis of count data. Econometric Society Monographs No 30. Cambridge University Press.

Egan, K.J., Herriges, J.A., Kling, C.L. & Downing, J.A. 2009. Valuing water quality as a function of water quality measures. American Journal of Agricultural Economics 91 (1), 106-123.

Haab, T.C. & McConnell, K.E. 2002. Valuing Environmental and Natural Resources. Edward Elgar, Cheltenham.

Hanley, N., Bell, D. & Alvarez-Farizo, B. 2003. Valuing the Benefits of Coastal Water Quality Improvements Using Contingent and Real Behavior. Environmental and Resource Economics 24 (3), 273-285.

Hellerstein, D.M. 1991. Using count data models in travel cost analysis with aggregate data. American Journal of Agricultural Economics 73 (3), 660-666.

Karppinen, P. 2017. Punkaharjun ja Puruveden alueen kävijätutkimus 2016-2017. Metsähallituksen luonnonsuojelujulkaisuja. Sarja B 233.

Lankia, T., Neuvonen, M. & Pouta, E. 2017. Effects of water quality changes on recreation benefits in Finland: Combined travel cost and contingent behavior model. Water Resources Economics. https://doi.org/10.1016/j.wre.2017.10.002.

Ovaskainen, V., Neuvonen, M. & Pouta, E. 2012. Modelling recreation demand with respondent-reported driving cost and stated cost of travel time: A Finnish case. Journal of Forest Economics 18 (4), 303-317.

Sandström, M. 1996. Recreational benefits from improved water quality: A random utility model of Swedish seaside recreation. Stockholm School of Economics. Working Paper Series in Economics and Finance, 121.

Sievänen, T. & Neuvonen, M. (eds.) 2011. Luonnon virkistyskäyttö 2010. Working Papers of the Finnish Forest Research Institute 212.

Sievänen, T., Pouta, E. & Neuvonen, M. 2007. Recreational home users - potential clients for countryside tourism? Scandinavian Journal of Hospitality and Tourism 7 (3), 223-242.

Soutukorva, Å. 2005. The value of improved water quality. A random utility model of recreation in the Stockholm archipelago. The Beijer International Institute of Ecological Economics, The Royal Swedish Academy of Sciences.

Tienhaara, A. & Pouta, E. 2017. Recreation benefits of Lake Puruvesi under various development alternatives. Luonnonvarakeskus. Available online: http://www.metsa.fi/documents/10739/9170275/Recreation_benefits_Lake_Puruvesi.pdf/a867ea40-5487-44b4-add8-dbbfe0e8eb16

Vesterinen, J., Pouta, E., Huhtala, A. & Neuvonen, M. 2010. Impacts of change in water quality on recreation behavior and benefits in Finland. Journal of Environmental Management 91 (4), 984-994.

Ward, F.A. & Beal, D. 2000. Valuing nature with travel cost models. Edward Elgar, Cheltenham.

Whitehead, J.C., Phaneuf, D.J., Dumas, C.F., Herstine, J., Hill, J. & Buerger, B. 2010. Convergent validity of revealed and stated recreation behavior with quality change: A comparison of multiple and singe site demands. Environmental and Resource Economics 45, 92-112.

NATURAL RESOURCES
INSTITUTE FINLAND