Fisheries Research 221 (2020) 105377

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Understanding angler profiles in cases of heterogeneous count data – A travel cost model

H. Pokki[a,*], J.B. Jacobsen[b], S.B. Olsen[c], A. Romakkaniemi[d]

[a] *Natural Resources Institute Finland (Luke), Latokartanonkaari 9, FI-00790 Helsinki, Finland*
[b] *University of Copenhagen, Department of Food and Resource Economics & Centre for Macroecology, Evolution and Climate, Rolighedsvej 23, 1958 Frb. C, Copenhagen, Denmark*
[c] *University of Copenhagen, Department of Food and Resource Economics, Rolighedsvej 23, 1958 Frb. C, Copenhagen, Denmark*
[d] *Natural Resources Institute Finland (Luke), Paavo Havaksentie 3, FI-90570 Oulu, Finland*

ARTICLE INFO

Handled by A.E. Punt

Keywords:
Environmental valuation
Salmon
Travel cost
Recreational fisheries

ABSTRACT

Fishery managers need to understand how anglers will react to changes in the various social and ecological dimensions of the angling experience to develop optimal policies and management strategies. This knowledge requires a solid understanding of the anglers' underlying preferences for angling attributes and how these preferences translate into angling trips. We use a travel cost method employing a stepwise estimation procedure to investigate how anglers' preferences for site attributes affect the length of a trip, and we estimate welfare measures associated with recreational angling in the Tornionjoki River in Finland. We identify three distinct types of anglers, who differ substantially in their underlying preferences and angling trip patterns. For short visits (< 3 days), anglers with a stronger selective angler profile tend to visit more often than other anglers. For longer visits, anglers with a stronger nature lover profile visit more frequently than others. Furthermore, anglers who catch more fish tend to make shorter visits and visit less frequently than others. These findings may help decision-makers to identify optimal fishery policies for cases such as the Tornionjoki River.

1. Introduction

Understanding anglers' motivations for going on angling trips while also recognizing the behavioural patterns of different angler types is vital for optimal recreational fishery management. Previous research on angling motivation has shown that anglers seek multiple benefits from angling, some of which are catch-related and others not (Arlinghaus, 2006; Arlinghaus and Mehner, 2004; Beardmore et al., 2011a; Hendee, 1974; Driver and Knopf, 1976; Fedler and Ditton, 1994). Bryan (1977) introduced the idea of recreation specialization where anglers can be arranged in a behavioural range from general to specific, based on their fishing behaviour, equipment used and desired settings. According to this angler specialization framework, more specialized anglers with activity-specific motivation tend to be interested in the angling-related elements in the recreational experience of angling per se, such as target species, size of fish, quantity of fish, disposition of the catch (e.g., releasing vs. harvesting), and fishing technique. In contrast, anglers with activity-general motivation are motivated by aspects that are not catch related; for example, they have strong preferences for experiencing the natural surroundings. Such preferences could, in principle, be satisfied by undertaking other types of outdoor activities (Fedler and Ditton, 1994; Fisher, 1997).

According to Arlinghaus et al. (2014), most anglers appear to prefer angling sites offering the possibility to catch many or large fish in solitary surroundings. This supposition is supported by other authors, although in some angler segments, catching fish is a more important motivation for the angling trip than in other segments (Bryan, 1977; Beardmore et al., 2011a, 2015; Bonnichsen et al., 2016). Angler specialization can certainly be one factor explaining varying angler motivation for fishing (Ditton et al., 1992) as well as an indication of supportive actions on catch-and-release policies to maintain healthy fish populations (Bryan, 1977; Fisher, 1997), although supportive actions depend on the culture and norms of the angling community. In addition to catch orientation, differences in angler type may also relate to other behavioural differences, e.g., in the distance travelled to fishing sites and the response to different stock management options such as stocking and harvest regulations, including minimum length and daily bag limits (Arlinghaus et al., 2014; Beardmore et al., 2011a; Bonnichsen et al., 2016).

Indeed, much effort has been made in angling research to

---

[*] Corresponding author.
E-mail address: heidi.pokki@luke.fi (H. Pokki).

https://doi.org/10.1016/j.fishres.2019.105377
Received 23 April 2019; Received in revised form 11 September 2019; Accepted 12 September 2019

understand the heterogeneity of angler preferences and elaborate frameworks for angler typologies to predict behavioural patterns of anglers (Beardmore et al., 2011b, 2013; Bryan, 1977; Cooke et al., 2016; Ditton et al., 1992). The optimal management policy may depend on the angler types present at a given site (Johnston et al., 2010). Therefore, it is necessary to properly explain angler types and preferences because this will enable the prediction of anglers' behavioural responses to alternative management policies being considered.

Atlantic salmon in the Baltic Sea catchment are an important natural resource for both commercial and recreational fisheries. The Tornionjoki River on the border between Sweden and Finland is one of the largest spawning rivers of Atlantic salmon in the world, and currently more than one third of all salmon in the Baltic Sea region are Tornionjoki salmon (ICES, 2017). Salmon spawning runs into the river have been rapidly increasing for the last two decades, reflecting the recovery of the stock from the past overfishing at sea (Romakkaniemi et al., 2003; ICES, 2017). Abundant spawning runs have increased the attractiveness of the river to salmon anglers; currently approximately 10,000 anglers from Finland alone visit the river annually, and the importance of angling for the regional economy has been acknowledged both in Sweden (Jordbruksverket, 2017) and in Finland (Pohja-Mykrä et al., 2018). The decreasing commercial salmon catch at sea and the reviving salmon stock brings the potential to boost the angling tourism in the Tornionjoki River area.

Recreational angling has great potential to increase due to the increase in demand, even to the point where it can be argued to not be sustainable (Lewin et al., 2006; Post et al., 2002). The issue of sustainability may be especially challenging when a population of a recreationally highly valued species has low productivity (Cox and Walters, 2002). Although the Tornionjoki River has had abundant spawning runs recently, most Atlantic salmon populations are suffering from reduced productivity, which is commonly linked to climate-driven adverse changes in the ecosystems (Beaugrand and Reid, 2012; Mills et al., 2013; Friedland et al., 2017). Indeed, angling of Atlantic salmon has been strongly restricted in many regions to avoid the reduction of spawning stocks to below set targets (Crozier et al., 2003).

As climate change is expected to continue and to cause more severe impacts on the aquatic ecosystems, changes in the regulation of recreational angling may be expected even among rivers with current abundant salmon populations, such as the River Tornionjoki. Knowledge of how recreational anglers will react to different measures is needed to design such regulations to be efficient and fair. This need requires knowledge of angler preferences. Due to the larger heterogeneity of recreational fisheries compared to commercial fisheries, fishery managers may consider a wider range of alternative management actions to reconcile the biological requirements and the socio-economic perspective to maximize recreational value and the regional economic benefits of the fisheries. The economic value of commercial fishing in the Baltic is well known and reported based on the EU legislation (STECF, 2018). However, there are fewer published estimates available on the economic impacts of recreational angling in the Nordic countries (e.g., Pokki et al., 2018; Toivonen et al., 2004; Navrud, 2001; Bonnichsen et al., 2016). Moreover, the literature addressing salmon angling in Northern Europe remains very sparse on thorough investigations of the potential importance of anglers' preferences and how these might be linked to anglers' considerations concerning how often, for how long, and where to go on angling trips.

Using a Travel Cost Method (TCM) on survey responses, this paper investigates the heterogeneity in angler preferences for fishing site attributes while explaining how these preferences affect the welfare measures of angling in the Tornionjoki River. A stepwise estimation procedure is applied, in which a factor analysis is first conducted based on questions on preferences for site attributes to identify groupings in the sample; then the factor loadings are used in the travel cost model as explanatory variables. The paper answers the following questions: What is the recreational use value of salmon angling in Tornionjoki River? What are the common factors reflecting appreciation of the Tornionjoki River as a fishing-site by anglers? How do these common factors affect the behaviour of anglers, e.g., time spent on site per trip and the number of trips taken per season? Which other factors explain the angling behaviour, and how does the consumer surplus of short angling trips differ from those of longer angling trips? To our knowledge, this study is the first empirical application simultaneously considering the heterogeneity of angler preferences regarding site attributes and on-site time while estimating the recreational use value of salmon angling using the TCM. Policy-wise, the results will help fishery managers assess how alternative management strategies will likely affect the behaviour of specific groups of anglers as well as the overall social welfare associated with angling.

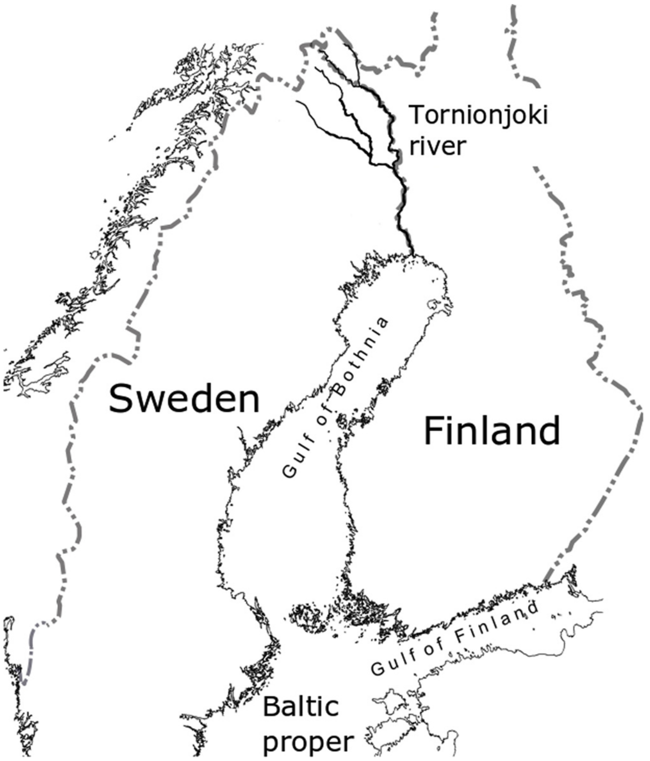

Fig. 1. Tornionjoki River is situated on the border between northern Finland and Sweden.

2. Study area

The Tornionjoki River flows on the border between northern Finland and Sweden (Fig. 1). The catchment area covers approximately 40,010 km^2 of sparsely populated terrain within boreal and subarctic zones. Salmon occupies approximately 1000 river kilometres in the catchment. In the last five years, 50,000–100,000 salmon spawners have been counted to annually ascend the middle and upper parts of the catchment. The recent annual angling catch in the river has ranged from 10,000–20,000 salmon (ICES, 2017).

The river is a remote location for Europeans and most Finnish citizens, being between the 65° 50′ and 69° 00′ latitudes. For instance, the one-way travel distance from the Helsinki metropolitan area is approximately 1,000 km, and the provincial capital, Rovaniemi (population 58,000), is 100 km away. People from both the small population living on the river valley and those living elsewhere in Finland angle along the river during the three summer months (fishing season covers June, July and August), when salmon ascend the river for spawning. However, the large majority of anglers visiting the river live in southern or middle Finland (Romakkaniemi et al., 2010). According to the fishing permit register, 10,817 Finnish anglers bought a special fishing permit allowing salmon fishing in Tornionjoki in 2016. This permit covers the Finnish waters entirely as well as the majority of Swedish waters of the Finnish-Swedish border river. The number of fishing permits sold is not regulated. Furthermore, there are no limits to the total catch. However, there is a bag limit of one retained salmon per day per angler.

3. Methodology

The estimation of the demand for angling trips to Tornionjoki River is conducted using a stepwise procedure. First, exploratory factor analysis is performed to identify latent variables or angler profiles potentially affecting the length of the visit and the number of trips taken to the site. Responses to questions on the appreciation of different site attributes of Tornionjoki River as a fishing site are used as indicators of the latent factors (angler profiles) affecting the decision-making process. The identified factors are subsequently utilized in the next steps where the on-site time and trip demand models are estimated.

3.1. Exploratory factor analysis

Heterogeneity in underlying preferences for fishing site attributes can be either observable (such as trip duration of targeted fish species) or unobservable (Dabrowksa et al., 2017) in anglers' fishing site choices. Factor analysis can be used to reveal different angler subgroups, which each have their specific set of preferences for site attributes. In a factor analysis, the underlying unobservable factors affecting the decision-making process are explored by modelling them as latent variables (Costello and Osborne, 2005; Cudeck, 2000; O'Rourke and Hatcher, 2013; Yong and Pearce, 2013). These latent variables are in turn identified by a set of indicators based on responses to questions on the appreciation of different attributes. This approach serves two purposes: 1) it allows for using several indicators which may each explain part of the heterogeneity but being potentially highly correlated, and 2) it can avoid potential endogeneity originating from the answers to the indicators being correlated with the answers to the main choice (number of visits per season), and thereby potentially affecting the error term. When the factor scores of the latent factors are incorporated in the trip demand model functions, the effect of these factors on the average time spent on site and the trip frequency can be examined.

In factor analysis, it is assumed that there are m underlying factors whereby each observed variable is a linear function of these factors together with a residual variate. In the model, p denotes the number of variables ($X_1, X_2, \ldots, X_p$), and m denotes the number of underlying factors ($F_1, F_2, \ldots, F_m$). X_j is the variable represented in latent factors. The mathematical model estimated intends to reproduce the maximum correlations using the following equation:

$$X_j = a_{j1}F_1 + a_{j2}F_2 + \ldots + a_{jm}F_m + e_j,$$

where $j = 1, 2, \ldots, p$ and the factor loadings are $a_{j1}, a_{j2}, \ldots, a_{jm}$, and the unique factor is denoted by e_j (Yong and Pearce, 2013). The factor loadings provide an idea about how much the variable has contributed to the factor; the larger the factor loading is, the more the variable has contributed to that factor (Harman, 1976).

When applying factor analysis in practice, there are several options for extraction methods, such as unweighted least squares, generalized least squares, maximum likelihood, principal axis factoring, alpha factoring, and image factoring (Costello and Osborne, 2005). In this study, the principal factor method in SAS is used for the initial extraction of the factors. Each factor explains a maximum amount of the variance that has not previously been explained by the previously extracted factors, and each factor is uncorrelated with all of the previously extracted factors (O'Rourke and Hatcher, 2013). After extraction, the number of factors to retain for rotation needs to be chosen. The default is to retain all factors with eigenvalues greater than 1.0 in many software packages (Costello and Osborne, 2005), where the eigenvalue represents the amount of variance that is represented by a given factor (O'Rourke and Hatcher, 2013). However, this amount might not be optimal in the common factor analysis. Thus, the scree test (Cattell, 1966) was employed in this paper, where the eigenvalues are plotted to find the meaningful factors retained for rotation.

To make the factor pattern more interpretable, normally linear transformation on the factor solution, called rotation, is performed employing either the varimax or promax method (for the description of these rotation methods, see e.g. Tabachnick and Fidell (2007)). Next, the rotation solution and the rotated factor patterns are interpreted to find meaningful common factors. The meaning of the factors can be interpreted by examining the factor pattern matrix and variables loaded on specific factors and related factor loadings. (O'Rourke and Hatcher, 2013)

3.2. Demand modelling

Hotelling (1949) was the first to introduce the idea of the TCM in which a demand curve for visits to a recreational site can be constructed from visitor data using the costs associated with reaching the site. The consumer surplus of a recreational trip can be calculated once the demand curve for visits has been constructed. TCM is one of the most well established revealed preferences valuation techniques used for determining the value of nature-based recreational activities, and it has been widely used in the recreational fisheries valuation literature (e.g., Ezzy et al., 2012; Fleming and Cook, 2008; Pokki et al., 2018).

The applicability of TCM for valuing recreational demand has at times been questioned. One important criticism concerns the potential endogeneity of explanatory variables used in the trip demand model (Berman and Kim, 1999; Freeman, 1995; Landry and McConnell, 2007; Larson, 1993; McConnell, 1992; Randall, 1994). Basically the endogeneity problem means that one or more of the explanatory variables are correlated with the error term (Landry and McConnell, 2007; Randall, 1994) while exogenous variables are not correlated with the error term. Endogeneity of explanatory variables of a recreational demand model brings along the risk of biased parameter estimates and thus biased welfare estimates (Moeltner and von Haefen, 2011). Often the endogeneity problem in recreation demand models comes from the omitted variables that are not observed, but are correlated with the observed explanatory variables (Melstrom and Lupi, 2012). Endogeneity problems can also arise when both the dependent variable and explanatory variable affect each other simultaneously.

Smith and Kopp (1980) suggested that recreational trips may not be homogenous; recreationists travelling long distances to the recreational site might spend more time on-site per trip than those living closer by. Furthermore, the non-homogenous on-site time has important implications for the consumer surplus estimates in a TCM. A fundamental assumption in TCM is that travel costs reflect the demand for recreational trips and that higher travel costs generally lead to fewer trips being made (Bockstael, 1995). However, when only a few angling trips to a particular fishing site are made per season and they last for several days and on-site time is endogenous, the travel costs might not be the main determinant. Instead, on-site time could be the more important determinant for defining the demand of trips (McConnell, 1992).

If the length of stay at a site hardly varies among visitors, on-site time can be regarded as an exogenous variable in the trip demand model. If the length of stay varies considerably among visitors and varying the on-site time affects the price of a trip, the on-site time should instead be regarded as endogenous (McConnell, 1992). There have been several efforts to address the endogeneity of on-site time (Berman and Kim, 1999; Landry and McConnell, 2007; Larson, 1993; McConnell, 1992; English et al., 2019). Reducing heterogeneity and the potential endogeneity of on-site time in estimation can be accomplished by dividing the data into more homogenous groups based on on-site time and estimating a separate travel cost model for each group (Acharya et al., 2003; Bell and Leeworthy, 1990). This can be done to the degree that on-site time can be varied, i.e. short visits may substitute longer visits which may however bias results (English et al., 2019).

On-site time in TCM models can be interpreted as both a source of utility and as a cost (Bockstael, 1995; McConnell, 1992). McConnell (1992) addresses the endogeneity of on-site time by including the on-site time as an argument in the recreationist's utility function and determining the on-site time and number of angling trips simultaneously. A consumer chooses the number of trips to the recreational site (x) and consumes a composite bundle of goods (*z*) to maximize utility (*U*), while each trip to the site lasts *t* hours. The on-site time *t* is included as an argument in the recreationist's utility function:

$$U = U(x, t, z), \partial U/\partial x \geq 0 \text{and} \partial U/\partial t \geq 0 \tag{1}$$

The income (Y) and time (*T*) constraints for recreationists are:

$$Y = c_x x + c_t tx + c_z z \tag{2}$$

$$T = (t_x + t)x + t_z z \tag{3}$$

where c_x is the travel cost of a recreational trip, c_t is the on-site cost per unit of on-site time, c_z is a composite price for the Hicksian composite consumption bundle, *T* is the total time available for consumption activities, t_x is the travel time, *t* is the on-site time, and t_z is the time spent consuming the Hicksian bundle (z) [1] .

In this case, the combined budget constraint for the time and income constraints can then be written (Bockstael et al., 1987; McConnell, 1992):

$$Y + wT = y = x(p_x + p_t t) + pz, \tag{4}$$

where *y* is the full income, including wage and non-wage income, $p_x = c_x + wt_x$ is travel expenses c_x plus opportunity cost of travel time per trip wt_x, $p_t = w + c_t$ is opportunity cost of time plus on-site expenses per unit of on-site time, and $p = c_z + wt_z$ is consumption expenses plus opportunity cost of time for each unit of the Hicksian bundle consumed.

The potential endogeneity of on-site time is investigated by estimating the demand for on-site time per trip:

$$t = f(p_x, p_t, p, y). \tag{5}$$

On-site time *t* is regarded as endogenous, when the coefficients of (5) differ significantly from zero, and the on-site time per trip is explained by the travel costs per trip and the on-site costs. Consequently, the measure for cost of time spent on-site (p_t) is added to the traditional TCM model. The trip generating function for recreational trips becomes:

$$x = f(p_x, p_t, p, y). \tag{6}$$

One may conclude that on-site time is predetermined when the coefficients of Eq. (5) do not differ significantly from zero. In this case, the on-site costs (including on-site time cost) per trip ($p_t t$) are directly incorporated with other travel costs into a composite full-cost variable, and the on-site time per trip (*t*) is included as an additional explanatory variable in the trip generating function (McConnell, 1992):

$$x = f(p_x + p_t t, p, y, t) \tag{7}$$

The decision of a potential visitor on taking a recreational trip can be modelled using a binomial distribution (Cameron and Trivedi, 1998; Hellerstein and Mendelsohn, 1993). The dependent variable in the travel cost model is normally the number of trips taken to the recreation site over a season, taking only non-negative integer values. Often the sample is collected on site, i.e., intercept sampling, including only participants in the sample. Consequently, all respondents have taken at least one trip to the site, and the sample is truncated at zero visits. Poisson, truncated Poisson or negative binomial probability distributions are typically used in the recreational valuation literature when truncation and non-negative integer values are present in the data (Cameron and Trivedi, 1998; Creel and Loomis, 1990; Grogger and Carson, 1991; Hellerstein, 1991; Hellerstein and Mendelsohn, 1993; Shaw, 1988). If there is overdispersion or underdispersion in the trip data (i.e., variance differs from the mean), the truncated Poisson generates inconsistent and biased estimates, and the truncated negative binomial model should be used instead (Grogger and Carson, 1991). The potential overdispersion (or underdispersion) in the Poisson model can be investigated by testing for significance of the overdispersion parameter in the variance function of an appropriate negative binomial model (Cameron and Trivedi, 1998).

It is also crucial to incorporate the cost of travel time into the travel cost variable to obtain unbiased estimates (Cesario and Knetsch, 1970). No common agreement has been established thus far on the treatment of the cost of travel time, although several approaches have been taken (e.g., Bockstael et al., 1987; McKean et al., 2003; Ovaskainen et al., 2012). The fraction-of-wage-rate approach introduced by Cesario (1976) is commonly used, most often employing one-third of the wage rate as the opportunity cost of time (Hellerstein and Mendelsohn, 1993; Englin and Shonkwiler, 1995; Englin and Cameron, 1996).

3.3. *Calculating welfare measures*

To obtain welfare estimates, the estimated travel cost coefficients from the trip demand models may be utilized to calculate the average recreational value or consumer surplus of an angling trip with the following formula:

$$CS = -1/\beta_{TC} \tag{8}$$

where β_{TC} is the parameter estimate for the travel cost variable (Creel and Loomis, 1990). The approximate standard error for the consumer surplus per trip is calculated using the following second-order Taylor series approximation for the variance of consumer surplus (Englin and Shonkwiler, 1995):

$$Var\left(\frac{1}{\beta_{TC}}\right) = \frac{S^2}{\beta_{TC}^4} + 2\left(\frac{S^4}{\beta_{TC}^6}\right) \tag{9}$$

where *S* denotes the standard error of β_{TC}.

4. Survey and data

Data collection was conducted using a mail survey targeting both local and visiting anglers of the Tornionjoki River after the 2016 fishing season. A sample of 1500 anglers (13.9% of total fishing permits sold) was selected for a mail survey from the register of fishing permits. Anglers were unconventionally sampled from the target population based on the first letter of their surname, i.e., by selecting anglers from alphabetically sorted surnames, until the required sample size is achieved. This process was done because the survey is repeated annually; sampling from different sets of surnames precludes sampling any angler repeatedly in consecutive years, and doing so is assumed to improve the response rate. Due to the sampling method, we need to assume that the surnames do not follow a specific spatial pattern and that no other sociodemographic characteristics related to surnames could affect the results. The questionnaires were sent in November 2016, and two reminders were also sent: the first one in December 2016 and the second one in January 2017. After these three rounds, the response rate in the survey was 55.2%.

The survey was not intended only for valuation purposes but also for compiling annual catch statistics. Thus, the questionnaire contained questions concerning angler's fishing effort and catches and the individual angler's costs associated with travelling to the river, accommodation, fishing permits, and services in the area. These data form the

---

[1] Hicksian demand denotes the consumer demand for a bundle of goods (Hicksian consumption bundle) that minimizes consumer expenditures and provides a fixed level of utility (Freeman et al., 2014).

Table 1
Site attributes for choosing the Tornionjoki River as a fishing location.

How important (on a scale 1-5) did you consider the following statements for choosing Tornionjoki River area as your fishing destination in 2016?
Catch certainty of salmon
Catch certainty of other fish species
Nature experience (other than catch)
River location
Wilderness nature of the river area
Free flowing river
Easy access to the river
Versatile fishing destination
River located on a vacation route
River located close to home or summer cottage or relatives
Previous fishing experience in Tornionjoki River
Fishing permit system
The range of special fishing spots
Suitable for fly fishing
Suitable for boat fishing
Other factor, specify

basis for the TCM analysis in the following. The anglers were also asked about the reasons for choosing the Tornionjoki River as their fishing destination. Table 1 displays the 16 statements or site attributes offered. The attributes for the study were selected mainly based on previous studies on preferences for fishing site attributes in another Finnish salmon river, River Simojoki. For each of these attributes, respondents were requested to rate the level of importance on a 5-point Likert scale where 1 was important and 5 was unimportant.

Nearly all (99.2%) the respondents had been angling in the Tornionjoki River at least once during the season, and 772 anglers reported the number of trips taken to the Tornionjoki River in 2016. Three respondents reported zero visits and were excluded from the sample to target only visitors. Accordingly, the trip demand functions were estimated using either zero-truncated Poisson or Negative Binomial models. Examining the data as a whole, anglers made 1 to 90 trips to the Tornionjoki River (Fig. 2) and 4 trips on average. Most respondents (54%) visited Tornionjoki only once in 2016.

Only the aggregate number of angling days and trips over the season was available from the survey. Hence, the average number of fishing days spent on an angling trip was used in the analysis, assuming each trip was identical, i.e., the average seasonal on-site time over the number of trips made. Anglers stayed, on average, 4 days on an angling trip (Fig. 3). Most of the visits were short; a quarter of the respondents stayed one day per visit, and 26% stayed 2–3 days. The majority (60%) of the respondents were angling tourists having no base (relatives or summer cottage) in the Tornionjoki valley, while 17% were locals. Nearly all (96%) the respondents were male. Anglers reported only the aggregate number of catch and angling days over the season in the questionnaire. Thus, the average number of salmon caught per fishing day (Catch of salmon per day) was used in the analysis, and it was calculated based on the reported aggregate number of salmon caught and aggregate number of fishing days over the season. The distribution of the average number of salmon catch per fishing day is presented in Fig. 4. The definitions and the descriptive statistics of the variables used in the on-site time demand and trip demand models are presented in Tables 2 and 3.

5. Model specification

The dependent variable in the demand model for on-site time is the average number of days spent per angling trip to the Tornionjoki River during the 2016 fishing season. The average length of an angling trip is approximately three times longer in the group of long visits than the group of short visits (Table 3). The dependent variable in the trip demand models is the number of angling trips taken to the Tornionjoki River during the 2016 fishing season. The season average number of trips for short visits is 6.55 with a standard deviation of 10.66 and 2.01 for long visits with a standard deviation of 3.55. The variance (square of standard deviation) is 17 times the mean for short visits, which suggests that overdispersion is likely present. Explanatory variables selected for the trip demand model for short trips using the model specification in Eq. (6) are round-trip travel cost (including cost of travel time), on-site costs (including cost of on-site time), number of salmon caught per fishing day (also including the released catch), local resident, and selective angler factor. For the trip demand model of long trips using the model specification in Eq. (6), explanatory variables selected are round-trip travel cost (including cost of travel time), on-site costs (including cost of on-site time), age, number of salmon catch per fishing day (also including the released catch), income, family accompaniment, angling in Sweden, and nature lover factor.

The travel costs used in the analysis are combined travel costs, including both the driving cost and the cost of travel time. The round-trip

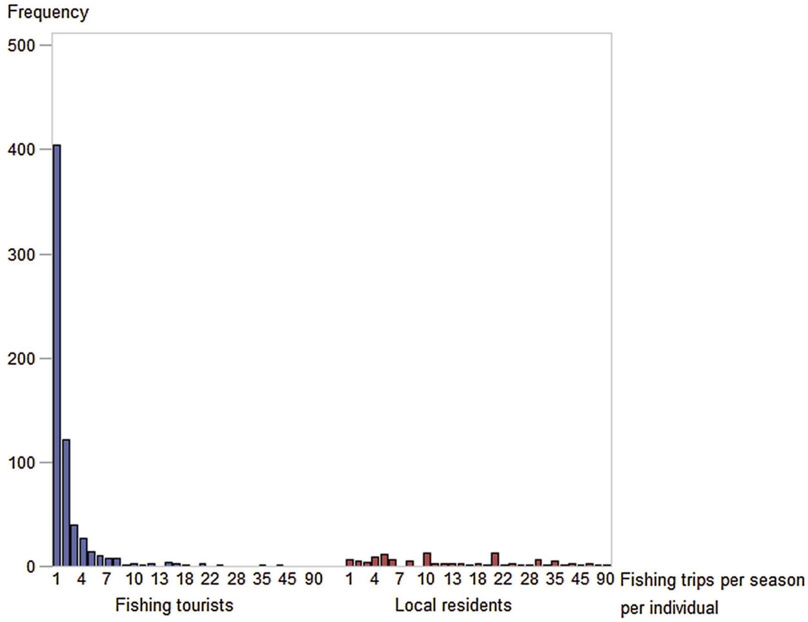

Fig. 2. Number of angling trips to the Tornionjoki River taken by local residents and angling tourists per individual during the 2016 fishing season.

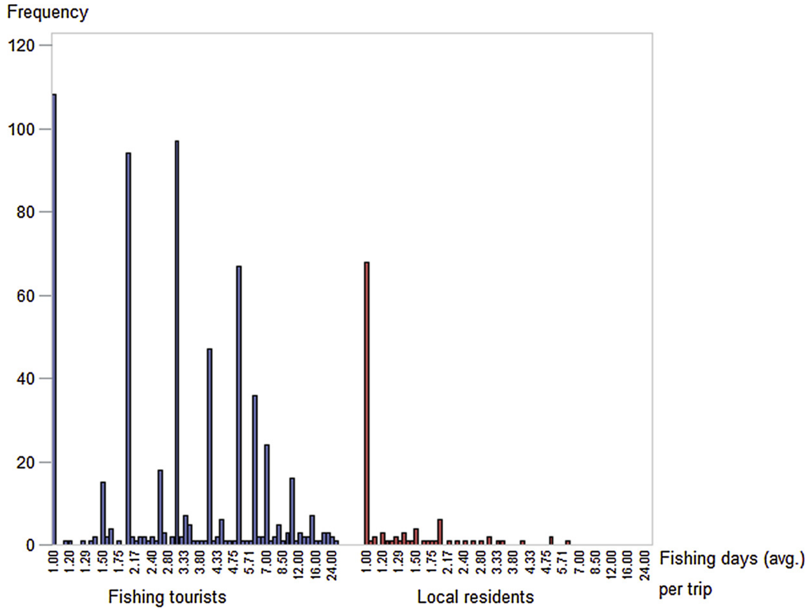

Fig. 3. The average number of fishing days spent on an angling trip to the Tornionjoki River for local residents and angling tourists during the 2016 fishing season.

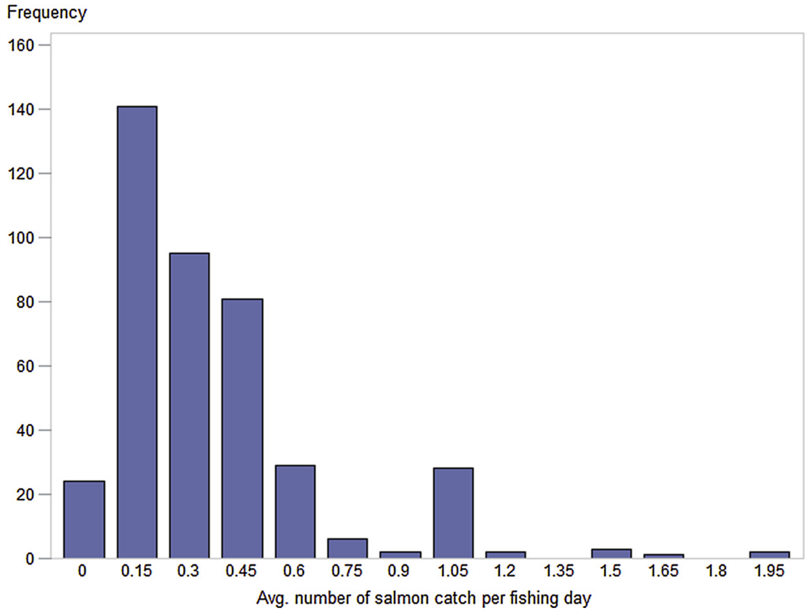

Fig. 4. The average number of salmon catch per fishing day in Tornionjoki River during the 2016 fishing season.

travel cost is the self-reported amount of money spent on travelling for a round trip to the River Tornionjoki. No self-reported cost of travel or on-site time was available. Therefore, a fraction of the wage rate approach is employed, which is also commonly used in the recreation valuation literature (Englin and Shonkwiler, 1995; Englin and Cameron, 1996; Hellerstein and Mendelsohn, 1993). The cost of travel time is defined as 0.3 times the respondent's hourly wage rate times the stated round-trip travel time in hours. Comparably, on-site costs used in the analysis consist of the on-site expenditures plus the cost of on-site time. Again, the cost of on-site time is defined as 0.3 times the respondent's average wage rate per day. Other on-site expenditures per fishing day include the self-reported costs of travel inside the Tornionjoki River area, accommodation, fishing permits, fishing equipment, and vessel (equipment, fuel, and vessel rent). Respondents travelling with their family reported the money spent on angling trips including the costs of the whole family.

The number of salmon caught per fishing day is included as an explanatory variable in the trip demand model as catch rates often appear to affect the visiting behaviour of individuals (Freeman, 1995). Generally, catch and catch-related aspects are major elements of motivation for taking an angling trip (Arlinghaus, 2006); however, the importance of catch varies across angler segments (Beardmore et al., 2015; Bryan, 1977; Bonnichsen et al., 2016). Anglers seek multiple benefits from angling; some of these are catch-related, while others are not (Driver and Knopf, 1976; Fedler and Ditton, 1994; Hendee, 1974). Past research on angler satisfaction has shown that the sense of having a sufficient catch expressed by either the catch rate or the size of fish is the commonly found factor for a satisfactory angling experience by anglers (Arlinghaus and Mehner, 2005; Arlinghaus et al., 2008). However, even with low catch opportunities due to overfishing or other reasons, anglers may still want to continue fishing (Arlinghaus et al., 2007).

The salmon catch per day variable includes the number of both the harvested and released salmon. In cases with high angling efforts,

Table 2
Definitions of the variables used in the econometric models.

Variable	Variable definition
Dependent variables	
Angling trips per season	Number of angling trips to the Tornionjoki River during the 2016 fishing season
Fishing days per trip	Average number of days spent angling per angling trip in the Tornionjoki River during the 2016 fishing season
Explanatory variables	
Round-trip travel cost*)	Round-trip travel cost per trip in euros, combined travel costs (driving cost plus cost of travel time)
On-site total cost)**	Respondent's cost of on-site time in euros per day plus other on-site costs per fishing day in euros
Catch of salmon per day	Average number of salmon caught (including released fish) by the respondent per fishing day in the Tornionjoki River in 2016
Age	Age of the respondent
Income	Respondent's monthly income in a scale 0-5 (0 = 500 euros, 1 = 1500 euros,…, 5 = 5500 euros or above)
Local resident, dummy	1, if the respondent was a resident of Tornionjoki valley in 2016, 0 otherwise
Family accompanied, dummy	1, if the respondent had his family with him on the angling trip, 0 otherwise
Angling in Sweden, dummy	1, if the respondent had also been angling in Sweden in 2016, 0 otherwise
Selective angler factor	Estimated factor score of the respondent on the selective angler factor
Nature lover factor	Estimated factor score of the respondent on the nature lover factor

*) Travel time cost: 0.3*round trip travel time (hours)*the respondent's average hourly wage.
**) On-site time cost: 0.3*the respondent's average daily wage.

Table 3
Descriptive statistics of the variables used in the econometric models.

	Short visits (n = 170)		Long visits (n = 149)	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Dependent variables				
Angling trips	6.55	10.66	2.01	3.55
Fishing days	1.49	0.54	5.62	3.67
Explanatory variables				
Round-trip travel cost*), combined	102.84	104.89	229.11	141.19
On-site total cost)**	146.67	217.29	120.36	78.88
Catch of salmon per day	0.41	0.33	0.32	0.25
Age			50.25	15.55
Income			2.80	1.25
Local resident, dummy	0.24	0.43		
Family accompanied, dummy			0.36	0.48
Angling in Sweden, dummy			0.05	0.21
Selective angler factor	0.03	0.79		
Nature lover factor			−0.03	0.84

*) Travel time cost: 0.3*round trip travel time (hours)*the respondent's average hourly wage.
**) On-site time cost: 0.3*the respondent's average daily wage.

catch-and-release is often applied to reduce the impact of angling on fish populations (Policansky, 2002). Several studies have shown that catch-and-release behaviour is linked to the angler specialization; that is, more specialized anglers are more likely to practice catch-and-release and support catch-and-release regulations (Arlinghaus et al., 2007), although this catch-and-release behaviour is highly dependent on the angling culture and norm and in our case, the personal preference for catch and release is not observed because of the bag-limit of one salmon retained. A dummy variable for local residents is included in the trip demand model for short visits, as locals tend to make more frequent but shorter visits than angling tourists (Figs. 2 and 3). Including angler profile factor scores in the trip demand models allows viewing whether anglers with a certain profile tend to visit more frequently than others.

Although the costs of visits to substitute sites is excluded from the model, angling in other salmon rivers in Finland and abroad during the 2016 fishing season were tested in the trip demand models. However, none were statistically significant. Finally, angling in Sweden (during the 2016 fishing season) is included in the trip demand model for long visits to investigate whether angling in Sweden should be considered a substitute or a complement. If angling in Sweden returns a statistically significant positive coefficient, angling in Sweden and angling in the Tornionjoki River can be considered complements. In the case of a negative statistically significant coefficient, they can be regarded as substitutes.

6. Results

6.1. Step 1: identifying common factors

Using the principal factor method[2], the explanatory factor analysis reveals three meaningful factors, which are retained for rotation. The following interpretation for rotated factor pattern is used; if the factor loading is 0.45 or greater for a given factor and less for the others, an item is said to load on this factor. Based on this interpretation, five items load on the first factor labelled 'Nature lover factor'. These five items are: nature experience, wilderness nature of the river area, free flowing river, river location and versatile fishing destination. Four items load on the second factor labelled 'Easy fishing factor'. These items are: suitable for boat fishing, fishing permit system, previous angling experience in the River Tornionjoki, and easy access to the river. Finally, the following four items are found to load on the third factor labelled 'Selective angler factor': the range of special fishing spots, suitable for fly fishing, catch certainty of other species, and river located on a vacation route.

In this context, selectivity implies using a specific fishing technique (fly fishing) in specific fishing spots, targeting specific species (other than salmon). However, the questionnaire did not include questions on the preferred target species. Bryan (1977) described the specialists (or highly specialized anglers), among other things, to use advanced equipment and techniques; to be highly committed to the activity; to have strong sense of group identification with other members of the leisure social world. These are all characteristics of fly-fishermen in Finland. Moreover, Bryan (1977) has considered specialization as a process where the end product of progression in specialization is an elite fly-fisher. According to Bryan (1977), when anglers become more specialized, they favour fishing under specific conditions (such as fishing on limestone springs with fellow specialists) and a management philosophy that is encouraging preservation of natural setting instead of stockings. Acknowledging the framework for specialization presented by Bryan (1977), the selective anglers in our study could be regarded as highly specialized, while anglers with an easy fishing profile are far less-specialized as they have strong preference for the ease of access (by means of location, fishing permit system, boat fishing). Nature lovers in our study seem to appreciate other aspects over the catch, and they appreciate strongly the experience of natural surroundings.

Beardmore et al. (2013) have found that centrality to lifestyle

---

[2] The promax rotation was used.

Table 4
Factor loadings from the rotated factor pattern matrix for each questionnaire item.

Factor pattern 1: Nature lovers	2: Easy fishing	3: Selective anglers	Site attributes for fishing in river Tornionjoki
0.69	−0.14	−0.05	Nature experience (other than catch)
0.56	−0.07	0.17	Wilderness nature of the river area
0.50	0.26	−0.16	Free flowing river
0.48	0.18	0.03	River location
0.47	0.18	0.23	Versatile fishing destination
0.04	**0.60**	−0.13	Suitable for boat fishing
−0.09	**0.58**	0.12	Fishing permit system
0.07	**0.49**	0.16	Previous fishing experience in River Tornionjoki
0.40	**0.47**	−0.08	Easy access to the river
−0.17	0.24	**0.57**	The range of special fishing spots
0.01	−0.01	**0.50**	Suitable for fly fishing
0.19	−0.23	**0.49**	Catch certainty of other species
0.04	−0.06	**0.48**	River located on a vacation route

captures best the variation in fishing preferences and that centrality to lifestyle can be an adequate measure for predicting general fishing preferences and fishing behaviour. Beardmore et al. (2013) found three classes of anglers that differ in terms of their degree of specialization, measured by centrality to lifestyle. Their findings can be related to our analysis on angler profiles: The class 1 anglers are to some extent comparable to our easy fishing anglers; they showed greater centrality to lifestyle and were more interested in catching anything (size of fish or species not very relevant). Class 2 anglers were the least specialized anglers (or least committed), which indicated less attachment to fishing and were more drawn to other leisure activities than fishing. This resembles our nature lovers. Moreover, the Class 3 anglers were willing to travel more and described as species-specialized anglers, comparable to our selective anglers. Despite all these comparisons, one should avoid making too far-reaching conclusions on angler specialization in Finland because we did not follow any specific specialization framework presented in the earlier recreation specialization literature. Questionnaire items on the site attributes for angling in the Tornionjoki River and corresponding loadings are presented in Table 4.

6.2. Step 2: modelling on-site time demand

In the second step, the obtained factor scores are entered as explanatory variables in the TCM. The potential endogeneity of on-site time is addressed by dividing the data into two more homogenous groups, trips less than 3 days (short visits) and trips of 3 days or longer (long visits), and estimating the demand function for on-site time per angling trip using ordinary least squares regression (Table 5). In accordance with McConnell's (1992) approach (for similar applications, see also Acharya et al. (2003); and Pokki et al. (2018)), the potential endogeneity of on-site time is investigated in both groups separately by testing the null hypothesis that the parameters of the on-site time demand function (Eq. 5) would not be jointly significantly different from zero.

As expected, the results for the on-site time model for short visits indicate that higher travel costs tend to increase the length of stay. However, on-site costs have no significant bearing on the on-site time per trip for those on short visits. Higher salmon catch rates imply shorter stays per trip, while local anglers tend to spend less time on site per trip than tourist anglers do. The latter corresponds to the fact that on average locals make more frequent but shorter visits (Figs. 2 and 3); they have lower travel costs, and the on-site costs can be minimized by returning home for the night. All the remaining explanatory variables have no statistically significant impact on on-site time for the short visits, while the F-test statistic indicates that the model is jointly statistically significant.

Table 5
Estimated OLS demand functions for on-site time per angling trip (standard errors in parentheses).

	On-site time model:		On-site time model:	
Variables	Short visits		Long visits	
Constant	1.8290[a]	(0.0936)	8.2243[a]	(1.2721)
Round-trip travel cost	0.0015[a]	(0.0005)	0.0072[a]	(0.0024)
On-site total cost	−0.0001	(0.0003)	−0.0089[b]	(0.0037)
Catch of salmon per day	−0.4642[a]	(0.1377)	−4.1606[a]	(1.1361)
Age			−0.0132	(0.0204)
Income			−0.4600	(0.2849)
Local resident, dummy	−0.4110[a]	(0.1027)		
Family accompanied, dummy			1.2179[c]	(0.6350)
Angling in Sweden, dummy			0.1199	(1.1755)
Selective angler factor	−0.0048	(0.0500)		
Nature lover factor			−0.4261	(0.3486)
n	169		149	
R^2	0.1990		0.2034	
F-value	8.1525		4.4685	

Based on OLS regression.
[a] Coefficient significant at $P \leq 0.01$.
[b] Coefficient significant at $0.01 < P \leq 0.05$.
[c] Coefficient significant at $0.05 < P \leq 0.10$.

The cost coefficients of the on-site time demand model for the long visit group are both statistically significant; the coefficient for travel costs is positive, and the coefficient for on-site costs is negative. Thus, the fishing days spent per trip (on-site time) increase with higher travel costs and decreases with higher on-site costs per fishing day. These results support findings in previous travel cost studies, where long travel and high travel expenses often entail longer stays on a recreation site (Bell and Leeworthy, 1990; Smith and Kopp, 1980). Additionally, the number of fishing days per trip is explained by the salmon catch and the family accompaniment dummy. A higher salmon catch per day means fewer days spent on-site per angling trip. When an angling trip is undertaken together with the family, the on-site time per trip tends to be higher than for anglers visiting without family. Intuitively, travelling with family requires more planning ahead, and for families, the on-site time might be more fixed prior to the trip than for those travelling without family. Moreover, families visiting the site might also pursue other welfare generating activities in addition to angling.

All the remaining explanatory variables of the on-site time model for long visits have no statistically significant coefficients. The F-test value of 4.47 indicates that the coefficients are jointly significant. Despite efforts to reduce the potential severity of endogeneity by dividing the data into more homogenous segments (Acharya et al., 2003; Bell and Leeworthy, 1990), it is clear from the results above that the endogeneity of on-site time persists in both groups[3] .

6.3. Step 3: modelling demand for angling trips

The demand for angling trips to Tornionjoki River is estimated separately for short and long visits. Due to the endogeneity of on-site time, the trip demand model for both groups is specified in accordance with Eq. (6). The overdispersion test statistic reported in Table 6 suggests that the trip data for short visits are overdispersed. Moreover, the variance of the number of angling trips per season (the square of the

---

[3] For comparison, the on-site time demand model was estimated on the whole data. Results showed more significant coefficients for the explanatory variables in the model, indicating stronger endogeneity of on-site time with a single trip demand model estimation.

Table 6
Estimated demand function for angling trips per season, endogenous on-site time (standard errors in parentheses).

Variables	Trip demand model: Short visits (TNEGBIN)		Trip demand model: Long visits (TPOISSON)	
Constant	2.4696[a]	(0.1723)	0.1065	(0.3741)
Round-trip travel cost	−0.0083[a]	(0.0012)	−0.0063[a]	(0.0009)
On-site total cost	−0.0010	(0.0008)	−0.0016	(0.0012)
Catch of salmon per day	−0.8369[a]	(0.2690)	−1.1650[a]	(0.4265)
Age			0.0131[b]	(0.0059)
Income			0.3505[a]	(0.0766)
Local resident, dummy	0.8806[a]	(0.1735)		
Family accompanied, dummy			0.5756[a]	(0.1736)
Angling in Sweden, dummy			0.8574[a]	(0.3230)
Selective angler factor	0.2085[c]	(0.1080)		
Nature lover factor			0.2773[b]	(0.1217)
n	170		149	
Pseudo-R2	0.2456		0.2877	
Log L	−425.34		−185.16	
Restricted Log L	−563.79		−259.96	
Overdisp. Test $(g=\mu)$	4.597		0.106	
Point estimate (CS), € per trip	121.21		159.49	
Standard error (CS), € per trip	17.38		24.44	
Standard error (CS), %	14.34		15.33	

[a] Coefficient significant at $P \le 0.01$.
[b] Coefficient significant at $0.01 < P \le 0.05$.
[c] Coefficient significant at $0.05 < P \le 0.10$.

standard deviation in Table 3) is substantially higher than the mean. Therefore, a truncated Negative Binomial model for short visits is estimated. The overdispersion test for long visits, in turn, shows a statistically nonsignificant coefficient for the overdispersion parameter; thus, a truncated Poisson model for long visits is estimated for this part of the data.

The pseudo- R^2 is 0.29 in the demand model for long visits and 0.25 for short visits, indicating that both models fit the data well[4] . In both trip demand models estimated, the travel cost coefficient is statistically significant and has the expected negative sign. The other cost coefficient representing the opportunity cost of on-site time (fishing days per trip) is not significant in any of the models. Additionally, all other explanatory variables are statistically significant in both models.

The number of salmon caught, an essential variable from the stock management point of view, has a negative coefficient in both models, indicating a higher salmon catch decreases the frequency of visits. The dummy variable denoting local residents has a positive coefficient in the model for short visits, implying local residents visit more often than those living outside Tornionjoki River area. Additionally, the selective angler factor variable in the trip demand model for short visits has a positive coefficient. Hence, visitors with strong selective angler profile take more frequent short visits than other anglers.

Conversely, the nature lover factor score has a positive coefficient, indicating that anglers with a strong nature lover profile are more frequent visitors in regard to long visits. Factor analysis proved that anglers with a nature lover profile provide high ratings on appreciation of nature experience other than angling, wilderness nature of the river and the opportunity to fish in a free flowing river.

Older anglers on long visits, as well as those accompanied by their families, tend to visit more frequently than others. Furthermore, the positive coefficient of angling in Sweden implies that angling in Tornionjoki River and angling in Sweden can be considered complements; anglers who additionally visited Sweden in the 2016 fishing season are also more frequent visitors in River Tornionjoki. The estimated consumer surplus for short visits is 121 euros per trip and for long visits 159 euros per trip (Table 6). Both have approximately similar precision indicated by the relative standard errors.

7. Discussion and conclusion

This paper has examined the connection between angler preferences for site attributes and angling behaviour in case of recreational salmon angling. This connection is an important aspect to understand when regulating angling activities in a manner that balances between exploitation and conservation of fish stocks. Endogeneity of explanatory variables such as on-site time and underlying angler preferences produce biased consumer surplus estimates in travel cost models, if the endogeneity is not properly considered. In this paper, we add to the previous studies on heterogeneous angler preferences by addressing the potential endogeneity in a travel cost model setting, which is the novelty of the paper. Three distinct angler profiles based on angler preferences for fishing site attributes were identified and labelled ‘nature lovers’, ‘easy fishing anglers’, and ‘selective anglers’. These angler profiles support the previous research findings on angler types, where anglers with a nature orientation have been distinguished from more catch-oriented anglers, while the importance of catch varies depending on the angler type and degree of specialization (Beardmore et al., 2011a; Bryan, 1977). On-site time was found to be endogenous both for short and long visits. Thus, to avoid biased consumer surplus estimates, the trip demand functions were estimated without on-site time; instead including the opportunity cost of on-site time as demonstrated by McConnell (1992).

The results suggest that, for short visits, anglers with a stronger selective angler profile exhibit a tendency to visit Tornionjoki River more often than other anglers. Moreover, anglers with a strong nature lover profile appear to make more frequent long visits than other anglers. Nature lovers are likely making more multipurpose trips than other anglers, also engaging in other outdoor activities during the trip. The estimated consumer surplus per trip was 121 euros for short visits and 159 euros for long visits. The estimates are notably smaller compared to a recent TCM study on salmon angling in River Teno, where the consumer surplus per visit was approximately double that in Tornionjoki River when the opportunity cost of travel time was considered (Pokki et al., 2018). Evidently, the lower estimates are primarily explained by the lower travel expenses to Tornionjoki River and that locals were also included in the sample.

Generally, when the recreational site is remote and rare, but long lasting trips are taken during a season, the on-site costs might become important when defining the demand for recreational trips. However, the results from both trip demand models showed that the on-site costs do not explain the number of trips taken per season, not even for long visits. This finding could be an indication of the inelasticity of demand of angling trips in relation to changes in price of a fishing day in River Tornionjoki. An inelastic demand could be explained by the fact that the Tornionjoki River is more accessible for anglers from southern Finland compared to another major salmon angling river, River Teno, causing substitutions to be few. If this interpretation holds, increasing the prices of on-site angling services (or fishing permits) would not affect the number of fishing trips to the Tornionjoki River much; however, it would benefit the tourism-based business of the Tornionjoki valley.

Anglers with higher catch rates tend to spend less time on site per trip. Moreover, higher catch rates appear to decrease the on-site time less for a long visit than for a short visit. As locals make short visits more often than the fishing tourists, locals appear to adjust their on-site time depending on the catch outcome more than the fishing tourists,

---

[4] The McFadden pseudo-R^2 values tend to be considerably lower than R^2 values and thus the ‘good fit’ should be evaluated differently than in ordinary regression analysis. I. e. values from 0.2 to 0.4 indicate an excellent model fit (McFadden, 1979, p. 35).

who have more fixed on-site time. Those anglers who have easier access to the river (local residents) or who can more easily adjust the length of their fishing trip (e.g., anglers without accompanying family) are intuitively the most capable of adjusting their fishing efforts to obtain the desired catch. Moreover, 'nature lovers' are likely, on average, less responsive to catch in their behaviour than anglers in the other two groups.

Higher salmon catch was found to decrease the frequency of visits (within a season) equally for short and long visits. Catch is an important element for a satisfactory angling experience (Arlinghaus, 2006; Arlinghaus et al., 2008). However, anglers' reactions may vary once a fish is caught; they may become even more eager to continue angling, or they may feel that the experience of catching a fish was sufficient to finish angling for the day. Because of the current regulation of only bagging one fish per day, stopping once a fish is caught may appear more attractive than having to return it and hope for a larger one, risking returning with none. Our result shows that the Tornionjoki anglers appear to follow a strategy of returning home once a certain quantity of catch is attained. Our finding is similar to the notion of the previous research on angler satisfaction related to catch; the marginal return of angler utility decreases with the increasing catch rates (Arlinghaus et al., 2014). Arlinghaus et al. (2014) treated average number of fish caught logarithmically in their model to capture diminishing marginal utility at higher (catch rate) values. Hence, logarithmic and quadratic specifications for average salmon catch per day were also estimated, but they did not improve our model fit or change the main conclusions. Some bias could potentially arise in our trip demand models from the fact that catch rate was measured as an average salmon catch per fishing day over the fishing season. Thus, anglers' trips are assumed identical over the season in regard the catch rate. Whether anglers overall find catch rates in Tornionjoki River satisfactory may not be revealed by our analysis, because we did not examine how varying catch rates between different years affect the total number of anglers annually visiting the river or the total number of angling trips.

The above described behaviour of individual Tornionjoki anglers has potentially adverse implications to sustainable resource use, when anglers' fishing effort and total catch are not regulated. If anglers are seeking for a fixed catch within a season, in years when salmon spawning runs are small and stock size is reduced, there is the potential for anglers to exert depensatory mortality upon the stock. This finding is an opposite behaviour to what would be desirable for sustainable fishing because, in years with small salmon spawning runs, the fishing effort should instead be smaller than in years with abundant spawning runs.

In case of abundant fish stocks, increasing catch rates even more through stocking or fishing restrictions might not be optimal. Moreover, certain angler groups such as nature lovers might be indifferent in regard to catch opportunities. Arlinghaus et al. (2014) suggest that recreational fishery managers concentrate not only on the catch rates but also on the size of fish, especially maintaining trophy fish when they want to maximize the utility gained by the anglers. However, if fishery managers want to reduce the effects of the catch-related behaviour among anglers, regulations setting limits on the catches and/or effort would be required. Whether the limits would be set to the whole fishing of a season or to an individual angler's fishing during the season would have different consequences as elaborated in the following.

As the marginal return of angler utility decreases in addition to the increasing catch rates, the highest overall recreational benefit to the society would be achieved by limiting an individual angler's fishing instead of setting total seasonal limits. Thus, a larger population of anglers would have an opportunity to fish than in the case of seasonal restrictions to the total catch and/or effort (which would likely lead to the first come, first serve type of rivalry for fishing permits). Moreover, the consumer surplus estimates for short and long visits reveal only a small gain in welfare with a longer fishing trip (due to the longer travel cost). Thus, increasing the number of short visits would increase the society level welfare more than increasing the number of long visits would increase that welfare. Limits set to individual anglers would not control the total catch, which is the ultimate measure of the effect on the salmon stock. However, total catches need to be controlled mainly in years when spawning runs are weak; one may assume that catch-oriented anglers make their decisions regarding their fishing trips based on the combination of fishing opportunities and catching opportunities. Weak spawning runs together with short permissible fishing periods may effectively restrict the total seasonal angling effort and the consequent catch because more anglers may decide to forgo fishing trips to the river.

Acknowledgements

Danish National Research Foundation (grant no. DNRF96) supported the research by Jette Jacobsen at the Centre for Macroecology, Evolution and Climate. The authors are indebted to the technical staff of the Natural Resources Institute Finland, especially to Ville Vähä, who was responsible for the field data collection and to Erja Mikkola for editing the references.

References

Acharya, R.N., Upton Hatch, L., Clonts, H.A., 2003. The role of on-site time in recreational demand for wilderness. J. Agric. Appl. Econ. 35, 159–169.

Arlinghaus, R., Mehner, T., 2004. A management-orientated comparative analysis of urban and rural anglers living in a metropolis (Berlin, Germany). Environ. Manage. 33, 331–344.

Arlinghaus, R., Mehner, T., 2005. Determinants of management preferences of recreational anglers in Germany: habitat management versus fish stocking. Limnologica 35, 2–17.

Arlinghaus, R., 2006. On the apparently striking disconnect between motivation and satisfaction in recreational fishing: the case of catch orientation of German anglers. N. Am. J. Fish. Manage 26, 592–605.

Arlinghaus, R., Cooke, S.J., Lyman, J., Policansky, D., Schwab, A., Suski, C.D., Sutton, S.G., Thorstad, E.B., 2007. Understanding the complexity of catch-and-release in recreational fishing: an integrative synthesis of global knowledge from historical, ethical, social, and biological perspectives. Rev. Fish. Sci. Aquac. 15, 75–167.

Arlinghaus, R., Bork, M., Fladung, E., 2008. Understanding the heterogeneity of recreational anglers across an urban–rural gradient in a metropolitan area (Berlin, Germany), with implications for fisheries management. Fish. Res. 92, 53–62.

Arlinghaus, R., Beardmore, B., Riepe, C., Meyerhoff, J., Pagel, T., 2014. Species-specific preferences of German recreational anglers for freshwater fishing experiences, with emphasis on the intrinsic utilities of fish stocking and wild fishes. J. Fish Biol. 85 (6), 1843–1867.

Beardmore, B., Haider, W., Hunt, L.M., Arlinghaus, R., 2011a. The importance of trip context for determining primary angler motivations: are more specialized anglers more catch-oriented than previously believed? N. Am. J. Fish. Manage. 31 (5), 861–879.

Beardmore, B., Dorow, M., Haider, W., Arlinghaus, R., 2011b. The elasticity of fishing effort response and harvest outcomes to altered regulatory policies in eel (Anguilla anguilla) recreational angling. Fish. Res. 110, 136–147.

Beardmore, B., Haider, W., Hunt, L.M., Arlinghaus, R., 2013. Evaluating the ability of specialization indicators to explain fishing preferences. Leisure Sci. 35 (3), 273–292.

Beardmore, B., Hunt, L.M., Haider, W., Dorow, M., Arlinghaus, R., 2015. Effectively managing angler satisfaction in recreational fisheries requires understanding the fish species and the anglers. Can. J. Fish. Aquat. Sci. 72, 500–513.

Beaugrand, G., Reid, P.C., 2012. Relationships between North Atlantic salmon, plankton, and hydroclimate change in the Northeast Atlantic. ICES J. Mar. Sci. 69, 1549–1562.

Bell, F.W., Leeworthy, V.R., 1990. Recreational demand by tourists for saltwater beach days. J. Environ. Econ. Manage. 18, 189–205.

Berman, M.D., Kim, H.J., 1999. Endogenous onsite time in the recreation demand model. Land Econ. 75, 603–619.

Bockstael, N., 1995. Travel cost models. In: Bromley, Daniel W. (Ed.), Handbook of Environmental Economics. MA: Basil Blackwell Ltd, Cambridge.

Bockstael, N.E., Strand, I.E., Hanemann, W.M., 1987. Time and the recreational demand model. Am. J. Agric. Econ. 69 (2), 293–302.

Bonnichsen, O., Jensen, C.L., Olsen, S.B., 2016. An Empirical Investigation of German Tourist Anglers' Preferences for Angling in Denmark. Department of Food and Resource Economics, University of Copenhagen IFRO Working Paper, Nr. 2016/10.

Bryan, H., 1977. Leisure value systems and recreational specialization: the case of trout fishermen. J. Leisure Res. 9, 174–187.

Cameron, A.C., Trivedi, P.K., 1998. Regression Analysis of Count Data. Econometric Soc. Monograph, no. 30. Cambridge University Press.

Cattell, R.B., 1966. The scree test for the number of factors. Multivariate Behav. Res. 1, 245–276.

Cesario, F.J., Knetsch, J.L., 1970. Time bias in recreation benefit estimates. Water Resour.

Res. 6 (3), 700–704.

Cesario, F.J., 1976. Value of time in recreation benefit studies. Land Econ. 52 (1), 32–41.

Cooke, S.J., Arlinghaus, R., Johnson, B.M., Cowx, I.G., 2016. Recreational fisheries in inland waters. In: Craig, J.F. (Ed.), Freshwater Fisheries Ecology, 1st ed. Wiley, pp. 449–465 Ch. 4.4.

Costello, A.B., Osborne, J.W., 2005. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. Pract. Assess. Res. Eval. 10 (7).

Cox, S.P., Walters, C., 2002. Modeling exploitation in recreational fisheries and implications for effort management on British Columbia rainbow trout lakes. N. Am. J. Fish. Manage. 22, 21–34.

Creel, M.D., Loomis, J.B., 1990. Theoretical and empirical advantages of truncated count data estimators for analysis of deer hunting in California. Am. J. Agric. Econ. 72, 434–441.

Crozier, W.W., Schön, P.-J., Chaput, G., Potter, E.C.E., O´Maoiléidigh, N., MacLean, J.C., 2003. Managing Atlantic salmon in the mixed stock environment: challenges and considerations. ICES J. Mar. Sci. 61, 1344–1358.

Cudeck, R., 2000. Exploratory factor analysis. In: Tinsley, H.E.A., Brown, S.D. (Eds.), Handbook of Applied Multivariate Statistics and Mathematical Modeling. Academic Press, San Diego Ch. 10.

Dabrowksa, K., Hunt, L.M., Haider, W., 2017. Understanding how angler characteristics and context influence angler preferences for fishing sites. N. Am. J. Fish. Manage. 37, 1350–1361.

Ditton, R.B., Loomis, D.K., Choi, S., 1992. Recreation specialization: re-conceptualization from a social worlds perspective. J. Leisure Res. 24, 33–51.

Driver, B.L., Knopf, R.C., 1976. Temporary escape: one product of sport fisheries management. Fisheries 1 (21), 24–29.

Englin, J.E., Shonkwiler, J.S., 1995. Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation. Rev. Econ. Stat. 77, 104–112.

Englin, J., Cameron, T.A., 1996. Augmenting travel cost models with contingent behavior data. Environ. Resour. Econ. Rev. 7 (2), 133–147.

English, E., McConnell, K., von Haefen, R.H., Lupi, F., 2019. Should single day and multiple day trips be pooled when estimating travel cost models. The 24th Annual Conference of the European Association of Environmental and Resource Economists, Manchester 26th – 29th June 2019.

Ezzy, E., Scarborough, H., Wallis, A., 2012. Recreational value of southern bluefin tuna fishing. Economic papers: J. Appl. Econ. Policy 31 (2), 150–159.

Fedler, A.J., Ditton, R.B., 1994. Understanding angler motivations in fisheries management. Fisheries 19, 6–13.

Fisher, M.R., 1997. Segmentation of the angler population by catch preference, participation, and experience: a management-oriented application of recreation specialization. N. Am. J. Fish. Manage. 17, 1–10.

Fleming, C.M., Cook, A., 2008. The recreational value of Lake McKenzie, Fraser Island. Tourism Manage. 29 (6), 1197–1205.

Freeman III, A.M., 1995. The Benefits of water quality improvements for marine recreation: a review of empirical evidence. Marine Resour. Econ. 10, 385–406.

Freeman III, A.M., Herriges, J., Kling, C., 2014. The Measurement of Environmental and Resource Values (Resources for the Future, New York).

Friedland, K.D., Dannewitz, J., Romakkaniemi, A., Palm, S., Pulkkinen, H., Pakarinen, T., Oeberst, R., 2017. Post-smolt survival of Baltic salmon in context to changing environmental conditions and predators. ICES J. Mar. Sci. 74, 1344–1355.

Grogger, J.T., Carson, R.T., 1991. Models for truncated counts. J. Appl. Econ. Chichester Engl. (Chichester Engl) 6 (3), 225–238.

Harman, H.H., 1976. Modern Factor Analysis (3rd Ed. Revised). University of Chicago Press, Chicago, IL.

Hellerstein, D., 1991. Using count data models in travel cost analysis with aggregate data. Am. J. Agric. Econ. 73 (3), 860–866.

Hellerstein, D., Mendelsohn, R., 1993. A theoretical foundation for count data models. Am. J. Agric. Econ. 75 (3), 604–611.

Hendee, J.C., 1974. A multiple-satisfaction approach to game management. Wildl. Soc. Bull. 2, 104–113.

Hotelling, H., 1949. Letter to National Park Service, in: an Economic Study of the Monetary Evaluation of Recreation in the National Parks. U.S. Department of the Interior, National Park Service and Recreational Planning Division, Washington, DC.

ICES, 2017. Report of the Baltic Salmon and Trout Assessment Working Group (WGBAST), 27 March–4 April 2017. ICES CM, Gdańsk, Poland 2017/ACOM:10. 298 pp.

Johnston, F.D., Arlinghaus, R., Dieckmann, U., 2010. Diversity and complexity of angler behaviour drive socially optimal input and output regulations in a bioeconomic recreational-fisheries model. Can. J. Fish. Aquat. Sci. 67, 1507–1531.

Jordbruksverket, 2017. Sportfiske och fisketurism för landsbygdens utveckling – om intäktspotential, framgångsfaktorer och förvaltning av gemensamma naturresurser. Rapport 2017, 18 (In Swedish with English summary.).

Landry, C.E., McConnell, K.E., 2007. Hedonic onsite cost model of recreation demand. Land Econ. 83 (2), 253–267.

Larson, D.M., 1993. Joint recreation choices and implied values of time. Land Econ. 69 (3), 270–286.

Lewin, W.-C., Arlinghaus, R., Mehner, T., 2006. Documented and potential biological impacts of recreational fishing: insights for management and conservation. Rev. Fish. Sci. 14 (4), 305–367.

McConnell, K.E., 1992. On-site time in the demand for recreation. Am. J. Agric. Econ. 74 (4), 918–925.

McFadden, D., 1979. Quantitative methods for analyzing travel behavior of individuals: some recent developments. In: Hensher, D., Stopher, P. (Eds.), Cowles Foundation Discussion Paper No. 474, Nov. 1977. Published in Behavioral Travel Modeling. Croom-Heim., London.

McKean, J.R., Johnson, D., Taylor, R.G., 2003. Measuring demand for flat water recreation using a two-stage/disequilibrium travel cost model with adjustment for overdispersion and self-selection. Water Resour. Res. 39 (4), 1107.

Melstrom, R., Lupi, F., 2012. Using a Control Function to Resolve the Travel Cost Endogeneity Problem in Recreation Demand Models. MPRA Paper No. 48036, posted 5. July 2013. https://mpra.ub.uni-muenchen.de/48036/1/MPRA_paper_48036.pdf.

Mills, K.E., Pershing, A.J., Sheehan, T.F., Mountain, D., 2013. Climate and ecosystem linkages explain widespread declines in North American Atlantic salmon populations. Glob. Change Biol. Bioenergy 19, 3046–3061.

Moeltner, K., von Haefen, R., 2011. Microeconometric strategies for dealing with unobservables and endogenous variables in recreation demand models. American Review of Resource Economics 3, 375 -296.

Navrud, S., 2001. Economic valuation of inland recreational fisheries: empirical studies and their policy use in Norway. Fish. Manage. Ecol 8 (4), 369–382.

O'Rourke, N., Hatcher, L., 2013. A Step-by-step Approach to Using SAS for Factor Analysis, 2nd ed. SAS Press.

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

Pohja-Mykrä, M., Matilainen, A., Kujala, S., Hakala, O., Harvio, V., Törmä, H., Kurki, S., 2018. Erätalouteen liittyvän yritystoiminnan nykytila ja kehittämisedellytykset (Current status and development prospects of business models related to the wilderness economy). Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 40/2018 (In Finnish with English summary.).

Pokki, H., Artell, J., Mikkola, J., Orell, P., Ovaskainen, V., 2018. Valuing recreational salmon fishing at a remote site in Finland: a travel cost analysis. Fish. Res. 208, 145–156.

Policansky, D., 2002. Catch-and-release recreational fishing: a historical perspective. In: Pitcher, T.J., Hollingworth, C.E. (Eds.), Recreational Fisheries: Ecological, Economic and Social Evaluation. Blackwell Science, Oxford, pp. 74–93.

Post, J.R., Sullivan, M., Cox, S., Lester, N.P., Walters, C.J., Parkinson, E.A., Paul, A.J., Jackson, L., Shuter, B.J., 2002. Canada's recreational fisheries: The invisible collapse? Fisheries 27, 6–17.

Randall, A., 1994. A difficulty with the travel cost method. Land Econ. 70, 88–96.

Romakkaniemi, A., Perä, I., Karlsson, L., Jutila, E., Carlsson, U., Pakarinen, T., 2003. Development of wild Atlantic salmon stocks in the rivers of the northern Baltic Sea in response to management measures. ICES J. Mar. Sci. 60, 329–342.

Romakkaniemi, A., Leskinen, J., Hollmen, A., Länsman, M., Kuusela, J., Juntunen, K., Jokikokko, E., Erkinaro, J., Mäki-Petäys, A., 2010. Pohjois-Suomen lohijokien suomalaiset vapakalastajat. Riista- ja kalatalous – Selvityksiä 15/2010, 22 pp.

Shaw, D., 1988. On-site samples' regression: problems of non-negative integers, truncation, and endogenous stratification. J. Econometrics 37 (2), 211–223.

Smith, V.K., Kopp, R.J., 1980. The spatial limits of the travel cost recreational demand model. Land Econ. 56 (1), 64–72.

STECF, 2018. The 2018 Annual Economic Report on the EU Fishing Fleet (STECF-18-07). Scientific, Technical and Economic Committee for Fisheries, Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/56158. JRC112940.

Tabachnick, B., Fidell, L., 2007. Using Multivariate Statistics, 5th ed. Allyn & Bacon/Pearson Education, Boston.

Toivonen, A.-L., Roth, E., Navrud, S., Gudbergsson, G., Appelblad, H., Bengtsson, B., Tuunainen, P., 2004. The economic value of recreational fisheries in Nordic countries. Fish. Manage. Ecol. 11 (1), 1–14.

Yong, A.G., Pearce, S., 2013. A beginner's guide to factor analysis: focusing on explanatory factor analysis. Tutor. Quant. Methods Psychol. 9 (2), 79–94.