Received: 3 April 2020 | Revised: 25 March 2021 | Accepted: 1 April 2021

DOI: 10.1111/fme.12484

ORIGINAL ARTICLE

Fisheries Management and Ecology WILEY

The value of recreational fishing in Sweden – Estimates based on a nationwide survey

Ola Carlén[1,2] | Göran Bostedt[1,2,3,4] | Runar Brännlund[1,3] | Lars Persson[1,3]

[1]Centre for Environmental and Resource Economics, Umeå, Sweden

[2]Department of Forest Economics, SLU, Umeå, Sweden

[3]Umeå School of Business and Economics and Statistics, Umeå University, Umeå, Sweden

[4]Department of Business Administration, Technology and Social Sciences, Luleå University of Technology, Luleå, Sweden

Correspondence
Ola Carlén, Department of Forest Economics, SLU, SE 901 83 Umeå, Sweden.
Email: ola.carlen@slu.se

Abstract

A nationwide recreational fishing survey in Sweden was used to estimate the benefits of recreational fishing in Sweden. The survey targeted the Swedish population and, consequently, the sample contained a large fraction of zero fishing days. To consider this, a zero-inflated Poisson model was used in the estimations. Swedes fished about 15.6 million days in 2013, of which two-thirds were spent on inland fishing, and one-third on marine and coastal fishing. Expected consumer surplus per fishing day varied with the season; SEK 193 for winter fishing, SEK 787 for summer fishing and SEK 95 for autumn fishing. Although about 70 per cent of total fishing days were spent on inland fishing, the weighted consumer surplus per fishing day in marine and coastal areas were higher. The results also demonstrated strong positive effects of increases in expected catch per day on number of fishing days demanded and consumer surplus, which have important implications for fishery policies directed at recreational fishing.

KEYWORDS

consumer surplus, distribution effects, recreational fishing, Swedish survey, TCM, ZIP model

1 | INTRODUCTION

The basic motivation behind the study is the seemingly considerable gap in knowledge concerning societal values related to recreational fishing in Sweden, despite that recreational fishing is a major recreational activity. In 2017, for example, approximately 1.4 million Swedes between 16 and 80 years old (18% of the population within that age range) engaged in recreational fishing at some point during the year. On average, these fishers fished 9 days in the year (Statistics Sweden, 2017), with a total catch of 11 kg/person, adding up to about approximately 16,000 tonnes of fish. Furthermore, considerable amounts of money were spent on recreational fishing, on average €170 (variable cost) or €15 per kg caught fish. These examples serve to illustrate the importance of recreational fishing in Sweden. One of the reasons for the rather high recreational fishing activity is the abundance of natural conditions for fishing in the country: nearly 100,000 lakes, tens of thousands of kilometres of rivers and a long coastline from the Norwegian border in the west to the Finnish border in the east.

Given the scope of Swedish recreational fishing, understanding the different aspects of the attached values are of vital importance for policymakers, authorities and others at the municipality, county and national levels. Any decision or natural change influencing water quality, fish stocks, infrastructure, fishing regulations and catch rate will inevitably affect a large share of the society via recreational fishing aspects. Despite this, there is surprisingly limited knowledge on the drivers behind recreational fishing habits and, hence, what societal values are associated with recreational fishing. How are benefits related to catch and geographical regions, and how do these benefits relate to, for example, age groups? The last non-site-specific, large-scale, general population survey in the Nordic countries about recreational fishing was in 1999/2000 (Toivonen et al., 2004), and featured in a comparison across industrialised countries in Arlinghaus et al. (2015). This comparison, which compiled data from 20 countries in Europe and seven non-European countries, showed that the participation rates in recreational fishing were the highest for the Nordic and Baltic countries. Sweden was number four, only surpassed by Norway, Lithuania and Finland. More recent data on participation levels and effort in marine recreational fishing (i.e. the salt-water subset of recreation fishing) across Europe (Hyder et al., 2018) again showed highest participation rates in the Nordic countries. Sweden was again number four, now surpassed by Norway, Iceland, and Denmark. Altogether, this demonstrates the importance of recreational fishing in Sweden and highlights the importance of more information about fishing habits and societal values associated with recreational fishing in Sweden. The present study fills part of this knowledge gap and serves as a tool in studying value changes due to shifts in natural conditions and regulations. This study can also serve as a tool in decision-making processes related to fisher characteristics and the design of regulations related to fisheries and water management.

The two main objectives of this study were to: (i) estimate a demand function for recreational fishing in Sweden and analyse how demand relates to fishing quality, costs and individual characteristics; and (ii) estimate the value of recreational fishing in Sweden and analyse how it differs between types of households, and how it relates to fishing quality in terms of expected catch and type of fishing. To achieve these objectives, data from a nationwide recreational fishing survey targeting the general Swedish population, including both fishers and non-fishers, were used. Recreational fishing is defined here as any fishing activity not conducted for a commercial market.

2 | METHODS

2.1 | The Recreational Fishing Survey

The Swedish Recreational Fishing Survey collects information about the magnitude of recreational fishing in Sweden and targets the Swedish population of the age 16 to 80. It is conducted as a national survey with random selection, by Statistics Sweden. As a sample frame, Statistics Sweden's Register of the Total Population (Register över TotalBefolkningen RTB) is used. This sampling procedure is intended to make the sample representative for the Swedish population and visitors to Sweden are therefore not included.

There are two main challenges related to the use of the data from this survey. Firstly, the sample frame is the complete Swedish adult population, which means that a large share, about 80%, of the respondents, did no fishing at all during the period under consideration. Consequently, there is a large fraction of zero fishing days in the sample, which may lead to biased estimates if the econometric model does not consider this. This bias refers to that zero fishing days by a fisher is different from zero fishing days from a non-fisher.

The second challenge stems from the survey not containing any explicit information about the quality of the fishing sites. To overcome this, a model for estimating the expected catch per unit of effort was developed and used in the demand for recreational fishing.

The survey provides data for a valuation of recreational fishing using individual travel cost methods and/or random utility models. Data collection was done through questionnaires distributed by mail three times a year. Three reminders to non-respondents followed each round of mailings, but no specific non-response survey was conducted. In the first round, which concerned recreational fishing during January to April, when 2500 questionnaires were sent out. In the second round, 5000 questionnaires were sent out for the season May to August. Finally, in the third mailing, 2500 questionnaires collected information about recreational fishing during the season September to December. Sampling, distribution of the survey, collection, verification, follow-ups and compilation of the source data set were conducted by Statistics Sweden.

The full data set contains 6310 observations, including all three rounds of questionnaires. The three rounds corresponded to 1381 respondents (response rate: 55.2%), 2970 respondents (response rate 59.4%) and 1959 respondents (response rate 78.4%), respectively. The overall response rate across rounds was 63.1%. According to Statistics Sweden (2019), the likelihood of answering questions about recreational fishing was positively correlated with the propensity to fish, which might result in overestimations of catches and fishing days.

The questionnaire includes questions about where, when and how the respondents had fished, how much fish they had caught, and what species. Hence, the data set contains individual information on number of recreational fishing days, individual costs incurred when fishing, including costs for fees, equipment, petrol and capital investments (e.g. boats). Respondents reported catch data divided into different geographic areas, species and equipment, respectively. Socioeconomic information, such as age, gender, income and place of residence, was matched by Statistics Sweden and included in the data.

2.2 | Econometric modelling

The point of departure in measuring the values attached to recreational fishing is neoclassical consumer theory, where individuals (including fishers) are assumed to maximise utility derived from the consumption of a variety of goods and services. Recreational fishing is partly an ecosystem service, or good, meaning that there can be both market and non-market values attached to the activity. Ideally, the demand function for recreational fishing activities would give information on all the attached values. Some goods attached to recreational fishing are, however, not bought on regular markets, and there is therefore no observable market price. Instead, a non-market valuation method, such as the travel cost method (TCM), is required. The TCM is based on real choices and costs associated with the fishing activity of potential anglers. The intuition is that preferences for angling are reflected in their choice of whether to go fishing or not. This choice will depend on factors such as preferences for fishing, the quality of the fishing sites in their choice set and the cost associated with each choice. Given this knowledge, a demand function for recreational fishing can be derived.

More formally, this can be expressed as a utility maximisation problem (cf. Scrogin et al., 2004; Wallentin, 2016), where an individual maximises utility, u, originating from fishing, ω, and consuming a composite market good, z, subject to a budget constraint, that is:

$$max\ u(\omega, z \mid a, s) \text{ subject to } p\omega + bz = y \tag{1}$$

where a is a vector of fishing site characteristics and s is a vector of individual characteristics. In the budget constraint, p is the price/cost of the fishing activity, b is the market price of the composite good and y is the individual income.

Solving the maximisation problem gives the indirect utility function as:

$$v = v(p, b, y; a, s) \tag{2}$$

From this utility maximisation, the (Marshallian) demand for days of recreational fishing is, by the use of Roy's identity, derived as:

$$\omega = f(p, b, y; a, s) = \frac{-v_p(p, b, y; a, s)}{v_y(p, b, y; a, s)} \tag{3}$$

where the indices represent the respective partial derivative. This implies that demand for fishing, in this case the number of fishing days, is a function of the cost of a fishing activity, the price of the composite good, and income, but also of other factors such as site and individual angler characteristics. In principle, the value of recreational fishing, in terms of consumer surplus (CS), is found by integrating the demand function over the price. Data on fishing activity, costs, prices, income, as well as site characteristics, and a functional form for the demand function in (3) will then be sufficient to estimate the demand function, and hence the CS.

The dependent variable is number of fishing days, which is a non-negative integer number. This requires use of statistical models that consider the integer qualities of the data, so-called count data models (Phaneuf & Smith, 2005). The Poisson distribution is the basis of the count data model in this study. Furthermore, since the sample is the result of off-site sampling, each respondent's choice can be modelled as a two-step process. The first step reflects the decision to make a recreational fishing trip or not, that is a binary choice. The first step can be interpreted as whether the person is a fisher or not, whereas the second step concerns how many trips to take during the specific time period. The first step can be modelled as a bivariate choice model, and the second as a Poisson model. An additional issue, related to the off-site nature of the data collection, concerns the interpretation of zero-trip observations. The reason is that not only active recreational fishers are surveyed, but also non-fishers. It is not known if a zero-trip observation is a non-fisher, or if he/she is a fisher but did not fish that particular period. Moreover, the most common observation of fishing days is zero, that is the individual has not been fishing at all. Some 80 to 96% of the respondents in the survey (depending on survey seasonal batch) reported zero fishing days during the period under consideration. In other words, the distribution of fishing day count data was severely skewed. To take both these issues into account, a so-called zero-inflated Poisson model (ZIP model) is used, which is particularly suitable when facing a random event that includes a surplus of zero observations (Zuur et al., 2009).

The two-step choice process described above requires an econometric model that can characterise this type of decision. ZIP models consist of two components corresponding to two zero-generating processes (Lambert, 1992). The first process is controlled by a binary distribution that generates structural zeros, in this case non-fishers. The second process is controlled by a Poisson distribution, which generates integers, some of which may be zero (Zuur et al., 2009). Intuitively, one can understand this as follows: the structural zeros are people who are not recreational fishers, while the zeros that are governed by the Poisson distribution are people who are fishers, but who did not fish during the period examined.

The first process in the ZIP model is estimated using a logit model, while the second is estimated with a Poisson model adjusted by the result from the logit model (cf. Scrogin et al., 2004). The probability that fisher j's number of fishing days, denoted by ω_j, is either zero or a positive integer h is given, respectively, by equations (4) and (5) below:

$$Pr\left(\omega_j = 0\right) = \pi + (1 - \pi)\, e^{-\lambda_j} \tag{4}$$

$$Pr\left(\omega_j = h_j\right) = (1 - \pi)\, \frac{\lambda_j^{h_j} e^{-\lambda_j}}{h_j\,!},\ h_j \geq 0 \tag{5}$$

where λ_j is the expected number of fishing days for individual j, and π is the probability that the observed zero is the result of not being a fisherman, which is treated as a latent random variable. To explain the variation in the number of fishing days, ω_j, given the Poisson distribution, the following model was used; $\lambda_j = exp(\boldsymbol{\gamma}'\mathbf{x}_j)$ where $\boldsymbol{\gamma}$ is a vector of parameters to be estimated, and $\mathbf{x}$ is a vector of explanatory variables for individual j.

Given equation (4) and (5), and the specific functional form for λ, the per fishing day consumer surplus across the total population can be expressed as:

$$CS = -\frac{1}{\gamma_k}(1 - \pi) \tag{6}$$

where γ_k is the estimated cost coefficient per season k in the model for explaining number of fishing days (see e.g. Bilgic & Flowkowski, 2007).

The explanatory variables, vector $\mathbf{x}$, are socioeconomic descriptors for each recreational fisher, as well as costs of fishing per fishing day for the recreational fisher. Data for fishing site quality are missing in the survey data, and a drawback considering that the expected quality of fishing probably is an important determinant for fishing or not. A natural choice of variable describing fishing quality would be the expected catch per fishing trip, but this was unfortunately not part of the survey. However, data on actual catch per fishing trip are part of the survey and makes it possible to estimate the expected catch per trip as a function of where they go fishing.

Denoting the total catch of all species per fishing day for each respondent and fishing season by F_j, respectively, the equation for the expected catch per fishing day for individual j can be written as:

$$F_j = c + \sum_{i=1}^{n-1} d_i \times AREA_{ij} + \sum_{m=1}^{2} g_m \times SEASON_{mj} + e_j \tag{7}$$

where j = 1,…, J = number of individuals, i = 1,…, n = areas; $AREA_{ij}$ is a dummy variable equal to 1 if individual j has fished in area i, and zero otherwise; $SEASON_{mj}$ is a dummy variable with value 1 if the respondent has fished during seasons one (Jan–Apr) or two (May–Aug) respectively; e_j is a random error term with the expected value zero. Equation (7) is estimated using OLS for a subset of respondents with at least one fishing day in each season respectively (j = 1030 observations). Equation (7) can be used to calculate the expected catch per unit of effort, $\hat{F}_j$, for individuals included in the data set (see equation (8)).

$$\hat{F}_j = \hat{c} + \sum_{i=1}^{n-1} \hat{d}_i \times AREA_{ij} + \sum_{m=1}^{2} \hat{g}_m \times SEASON_{mj} \tag{8}$$

where $\hat{c}$, $\hat{d}$, and $\hat{g}$ are the estimated parameters in the model. Notice that the expected catch per unit of effort is not due to individual-specific factors, but only depends on where the fishing takes place and the season. This means that if all individuals fish in the same area and the same season, they would all have the same expected catch. However, since they fish in different areas, and in many instances several areas, there will be an individual variation in expected catch. This method is a simplified way of obtaining the expected catch per unit of effort for each respondent. One could argue that expected catch per unit of effort should also depend on the fishing skills on the individual fishers. However, from a modelling point of view, the individual-specific factors are included in the demand function rather than in the expected catch function, as using these factors as explanatory variables in both equations will result in biased estimates of the coefficients.

The first empirical step estimates the catch using equation (7) above across all seasons (see Appendix 1). This enabled the prediction of the variable *Expected total catch per fishing day* for each respondent. The ZIP model was then specified using the number of fishing days, as dependent variable, during all seasons, respectively. The model was estimated over all seasons, with season dummies allowing for varying conditions. For instance, in the wintertime, inland fishing is mainly conducted in the form of ice fishing—a less popular form of fishing.

It is important to explain each season separately, and note there are no "rules" for how to specify the variables included in the two "estimation-steps" for the ZIP model outlined above. To avoid collinearity, the variables *Earned income* and *Expected total catch* were excluded from the logit model. The models were estimated using Limdep 9.0.

Finally, the results from the ZIP model were used to calculate the consumer surplus per fishing day, and in total for each respondent in the sample, based on equation (6) above. Consumer surplus was defined as the difference between the maximum willingness to pay (WTP) for a fishing day, and what was actually paid or spent. Hence, consumer surplus can be interpreted as the value added to experience of using time and resources to go fishing. The consumer surplus plus the total expenditure gives the total consumer value of fishing in a specific area. Calculating a predicted consumer surplus for each respondent in the sample was a necessary step for the regional analyses. Using the results from estimating equation, (8) the expected consumer surplus per season and fishing day was calculated using equation (6). Since the model includes slope dummies, γ_k is be a sum of the cost coefficient and the slope dummy coefficients, respectively.

3 | RESULTS

3.1 | Demand equations, overall mean estimates and effects of changes in expected catch

The differences between men and women were marginal, but response rates increased with age, from 23% in the 17–30 year age group to 56% in the 51–80 year age group. Dividing the respondents into four income groups showed that the response rates also increased with income, from 24% in the low-income group to 50% in the high-income group (Statistics Sweden, 2019). Statistics Sweden found that non-response might affect the reliability of the estimates, but that it was difficult to determine the extent of that problem. The number of respondents who had fished at least one day in the respective season was 185 for January to April (13.4% participation rate), 642 for May to August (21.6% participation rate) and 232 for September to December (11.8% participation rate). However, respondents with zero fishing days were still important in the analysis, since they helped explain whether people fish or not. Statistics Sweden (2017) estimated a 11% margin of error in the estimation of number of fishing days.

Descriptive statistics for the variables included in the ZIP model included 14 independent variables (Table 1). The average value for the dependent variable, "Number of fishing days," is 1.790. Most fishing days are observed in the summer season, while least days are observed during the winter season. The variable "expenditure per fishing day" has an average value of SEK 472. This includes a time cost amounting to 30% of the individual's income (before tax) per day (calculated on the assumption of 225 working days per year). The specific proportion of the income per day, used as a proxy for the opportunity cost of time, is a difficult choice. Fractions ranged from zero to one in the literature, although Feather and Shaw (1999) argued that the opportunity cost of time for those on a fixed working week could exceed their wage. However, it is quite common to use 1/3 of a wage as the opportunity cost of time (Hagerty & Moeltner, 2005;

TABLE 1 Means and standard deviation of variables included in the model

	Seasons 1–3 (Jan–Dec)	
	Mean	SD
Dependent variable		
Number of fishing days	1.790	7.040
Independent variables		
Variable expenditure per day, SEK (1000s)	0.472	0.209
Expected total catch, kg per fishing day	0.320	0.751
Age, 100s of years	0.508	0.163
Fished last year (dummy variable)	0.318	0.466
Earned income, households, SEK (million)	0.303	0.106
Male	0.696	0.460
Lives in a coastal area (dummy variable)	0.592	0.491
Lives in a metropolitan area (dummy variable)	0.380	0.485
Season 1 (Jan–Apr)	0.219	0.414
Season 2 (May–Aug)	0.470	0.499
No of observations	6310	

Liston-Heyes & Heyes, 1999), and according to Amoako-Tuffour and Martínez-Espiñeira (2012), the recreation demand literature has more or less accepted 25% as the lower bound and the full wage as the upper bound. Following Sarker and Surry (1998) and Sohngen et al. (2000), the value of 0.3 was used throughout. An increased cost is expected to reduce demand for fishing days. A negative sign of the coefficient for the variable "expenditure per day" was therefore expected. To control for season-specific costs, two slope dummies, ("Season 1" and "Season 2," respectively, were included in the empirical model.

Expected average total catch per fishing day, calculated using estimates based on equation (7), was 0.320 kg. An increase in expected catch is expected to increase the demand for fishing, and hence a positive sign of the coefficient is expected.

The average age of the respondents was 50.8 year. As cost of time may diminish after retirement, age can be expected to have a positive effect on demand for number of fishing days and a positive coefficient is therefore expected.

The variable "Fished last year" is an indicator variable taking with value one if the respondent fished during the previous calendar year, and zero otherwise. In this sample, 31.8% of respondents had fished the previous calendar year. If the respondent had fished during the previous year, it is expected to have a positive impact on the probability of fishing also during this year, implying a positive sign for the coefficient.

The mean of the variable *Earned income* was SEK 303,000. If recreational fishing is a normal good, such that demand increases when income increases, the sign of the variable *Earned income* was expected to be positive (cf. Curtis & Breen, 2017; Dalton et al., 1998; Paulrud & Laitila, 2013). However, since income and age presumably interact (pensions are lower than working income), an interaction variable (Earned income × Age100) is included and expected to have a negative impact.

Three additional demographic explanatory variables are included in the model; (1) *Male*, (2) *Lives in a coastal area* and (3) *Lives in a metropolitan area*. Men represent 69.7% in the sample, while 59.2% live in coastal areas, and 38% live in metropolitan areas (Table 1). For these three demographic variables, anticipated signs were more difficult to predict. Finally, the model included two intercept dummies controlling for *Season 1* and *Season 2*, respectively.

In the results from the ZIP model (Table 2), 13 of the 14 coefficients in the Poisson regression model were statistically significant (10% level or higher), and the signs of cost and catch coefficients were as expected. *Season 1* was the only statically insignificant estimate. In addition, the variable *expenditures per season* were statistically significant, as shown by the two slope dummies, implying that the variable expenditure varies across season. *Earned income* was positive, implying that the number of recreational fishing days increases with income and hence was a normal good. Regarding the other demographic variables, if the respondent fished any time during the previous calendar year, was male, or lived in a coastal area, the number of *expected fishing days* increased. Unsurprisingly, *living in a metropolitan area* means that the respondent was less inclined to practice recreational fishing. Furthermore, as expected, the interaction variable between income and age was negative and statistically significant. *Season 2* was also statistically significant, implying that the demand for recreational fishing days was different from the other two seasons.

In the Zero inflation model (part of Table 2, logit model estimation), *Age* had no effect on the demand for fishing, while *Fished last year* reduced the probability of no recreational fishing. Negative signs for the variables *Male* and *Living in a coastal area* were found, while *Living in a metropolitan area* was positive. Finally, *Season 1* and *Season 2* were negative and statistically significant, implying a higher probability for fishing in the summer season.

TABLE 2 Zero-inflated Poisson model estimates of the expected number of recreational fishing days in Sweden (dependent variable) over all three seasons

Variable	Coefficient (*t*-value)		
Poisson model			
Constant	0.530 (13.80)***		
Variable expenditure per day, SEK (1000) of	−0.250 (−7.50)***		
Variable expenditure per day, Season 1 (Jan–Apr), slope dummy	0.090 (1.79)*		
Variable expenditure per day, Season 2 (May–Aug), slope dummy	0.104 (3.02)***		
Expected total catch, kg per fishing day	0.219 (37.58)***		
Age, 100s of years	1.820 (31.88)***		
Fished last year (dummy variable)	0.472 (35.86)***		
Earned income, households, SEK (million)	0.863 (8.70)***		
Male	0.369 (40.65)***		
Lives in a coastal area (dummy variable)	−0.066 (−11.58)***		
Lives in a metropolitan area (dummy variable)	−0.181 (−27.00)***		
Age × Earned income (interaction variable)	−3.765 (−17.17)***		
Season 1 (Jan–Apr), intercept dummy	0.051 (1.60)		
Season 2 (May–Aug), intercept dummy	0.352 (16.83)***		
Zero inflation model			
Constant	5.865 (15.52)***		
Age, 100s of years	−0.020 (−0.25)		
Fished last year (dummy variable)	−4.104 (−33.29)***		
Earned income, households, SEK (million)	−1.610 (−1.27)		
Male	−0.780 (−5.94)***		
Lives in coastal area (dummy variable)	−0.195 (−2.02)**		
Lives in a metropolitan area (dummy variable)	0.314 (2.92)***		
Age × Earned income (interaction variable)	1.217 (0.42)		
Season 1 (Jan–Apr), intercept dummy	−0.263 (−2.17)**		
Season 2 (May–Aug), intercept dummy	−1.671 (−15.66)***		
Voung statistic[a]	5.010		
No. of observations	6310		
No of observations with at least one fishing day	1060		
	Season 1 (Jan-Apr)	**Season 2 (May-Aug)**	**Season 3 (Sep-Dec)**
Estimated probability of a fishing day	0.031	0.115	0.024
Expected consumer surplus (CS) per fishing day, SEK	193	787	95
95% confidence interval of consumer surplus (CS)[b]	93–293	599–975	69–121

Note: The table also reports the estimated probability to fish, calculated consumer surpluses for each season respectively.

[a]The Voung statistic is used to test whether a ZIP model preforms better than the standard Poisson model. It is distributed as standard normal; a value greater than +1.96 favours the ZIP model on the 95% confidence level.

[b]Calculated using a Taylor expansion around the mean (Wald command in Limdep).

*Statistically significant at 10% level.; **Statistically significant at 5% level.; ***Statistically significant at 1% level.

The logit equation (9) predicted the expected probability for demanding recreational fishing for each season, respectively, using the coefficients from the Zero inflation model along with the average values for the independent variables as:

$$Prob\left(Season_j\right) = 1 - \frac{1}{1 + \exp^{\hat{b}_i \bar{x}_i'}} \qquad (9)$$

where $\hat{b}_i$ are the estimated coefficients and $\bar{x}_i$ the corresponding average value across all seasons respectively, except for the season intercept dummies, for which the values are one or zero. These values correspond to 1−π in equation (6) and were used to calculate the per day consumer surplus, with average values of the independent variables across seasons and controlling for season using intercept and slope coefficients. The expected consumer surplus per day ranged from SEK 95 in Season 3 to 787 in Season 2 (Table 2). For Season 1, the expected consumer surplus was SEK 193.

The sensitivity of the number of fishing days per respondent and consumer surplus, respectively, with respect to a 50% increase in catch was calculated across seasons using partial derivatives and CS estimates from Table 2, and the average value for expected catch from Table 1. The mean value of expected catch equalled 0.32 kg/fisher/day. A 50% increase in expected catch changed the number of fishing days by 0.05 (0.05 = 0.5 × 0.32 × 0.297), and the resulting change in consumer surplus equalled SEK 9 (9 = 0.05 × 215), where 215 was the calculated average consumer surplus per day across all seasons. The above partial derivative of expected catch with respect to the vector of characteristics, computed at the sample means, 0.297, was obtained using LIMDEP. Finally, by dividing the change in consumer surplus (9) by the change in expected catch (0.16), the value per kg catch was SEK 57.

3.2 | Distribution of recreational fishing values and costs

Statistics Sweden used a stratified sampling strategy over the respective seasons, and representative weights (w_j) (provided by Statistics Sweden) were used to aggregate the predicted individual consumer surplus estimates over the seasons to obtain a representative estimate of the total consumer surplus for the full calendar year in 2013. To capture each fishing area's contribution (see Figure 1 for fishing areas) to the consumer surplus, the total consumer surplus was distributed according to the respondent's record of actual fishing days in the respective areas while assuming that the individual consumer surplus per day was independent of fishing area. With this approach, it was possible to show a distribution of different cost measures and consumer surplus estimates for different fishing areas. To exemplify, if fisher j in the sample had a total predicted consumer surplus of SEK 450 (a prediction based on the parameters in ZIP model) and had fished for three days, the consumer surplus per fishing day would be SEK 150. If two of these days were in the fishing region Norrlands inland, the consumer surplus that this region contributed to the fisher would be SEK 300. Multiplying by weights (w_j) and aggregating fishing days in the respective fishing area gives the regional weighted total consumer surplus attributed to a specific fishing area.

There were relatively large differences in the total value of fishing in the different regions (Figure 2). Inland fishing, except for the great lakes area, contributed the highest values, while the central Baltic area contributed most among the coastal and marine areas. Overall, variable costs and total costs were to a larger extent spent on inland fishing. Inland fishing was more common than coastal fishing—about 70% of fishing days were spent on inland fishing—which helped to explain the pattern in Figure 2. About two-thirds of the weighted total consumer surplus and the weighted variables costs, and about 59% of the weighted total cost, accrued to these areas. The lower share for weighted total cost was mainly explained by total expenditure generally being

FIGURE 1 Maps of fishing areas used in the survey and the division of Sweden into traditional "lands." Legend: Bottenviken = Gulf of Bothnia, Mellersta Östersjön = Central Baltic Sea, Södra Östersjön = Southern Baltic Sea

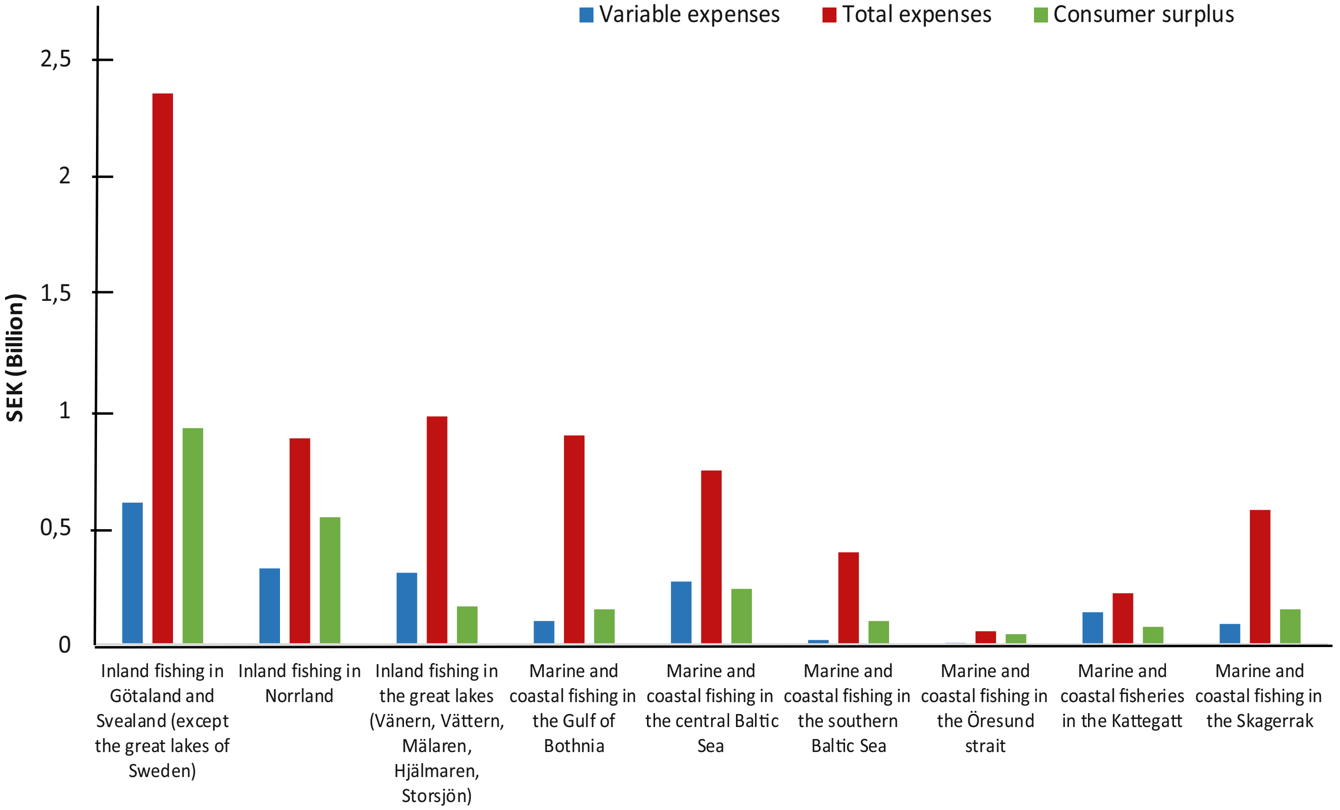

FIGURE 2 Estimates of weighted variable expenses, weighted total expenses and weighted total consumer surplus for fishing in the various fishing areas, SEK (billion)

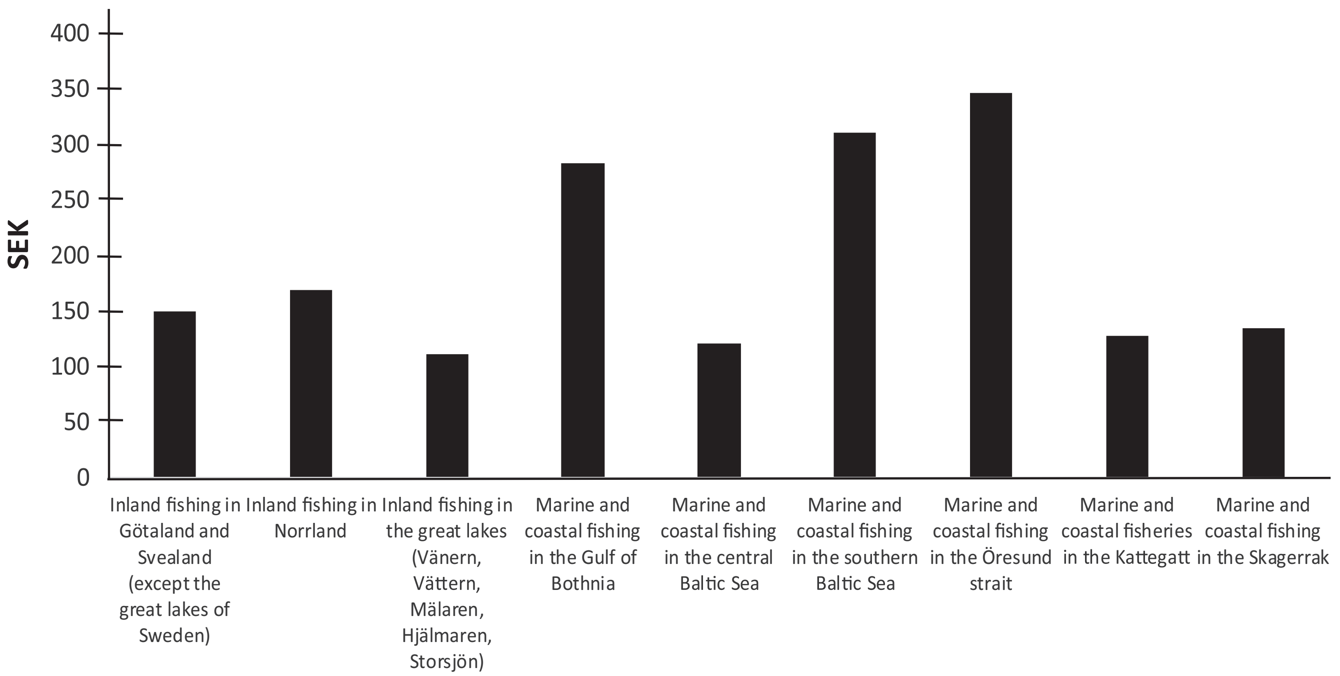

FIGURE 3 Calculated weighted consumer surplus per day for fishing in the various fishing areas, SEK

higher for marine and coastal fishing than inland fishing, since the former was often associated with increased fixed investment in terms of equipment, such as boats and quantity-catching gear such as nets and fish traps.

Finally, weighted consumer surpluses per day and fishing areas were calculated by dividing the weighted total consumer surpluses by the weighted number of fishing days for each fishing area, respectively (Figure 3). The weighted consumer surpluses per fishing day for three marine and coastal areas (Gulf of Bothnia, southern Baltic Sea and Öresund strait) varied between SEK 282 and 347, whereas other areas varied from SEK 112 to 170. Although the three marine and coastal areas mentioned above have a small share of the weighted total consumer surplus, the weighted consumer surplus for a fishing day was almost twice as large. This pattern was mainly driven by the differences in number of fishing days.

4 | DISCUSSION

It was estimated that Swedes fished about 15.6 million days and spent about SEK 1.88 billion in 2013. Two-thirds of the days were spent on inland fishing, while the rest on marine and coastal fishing. If investments in fishing equipment and other more durable equipment are included, the estimated weighted total expenditure on recreational fishing in 2013 was about SEK 7.11 billion. Expected consumer surplus per fishing day varied with the season; SEK 193 for winter fishing, SEK 787 for summer fishing and SEK 95 for autumn fishing. The economic values were estimated through the travel cost method, using data from a recreational fishing survey conducted under the auspices of the Swedish Agency for Marine and Water Management. Weighted total consumer surplus was about 2.40 billion SEK, which is equivalent to SEK 162 per fishing day. Furthermore, the weighted total consumer surplus was highest for inland fishing in Götaland and Svealand, since the greatest number of fishing days were conducted in this region (around 40%). Weighted consumer surplus per fishing day was, however, highest in the three marine and coastal areas. The study thus shows that the benefits differ widely across region and time of the year.

The estimates of consumer surplus for the winter and autumn seasons based on the travel cost model vary from SEK 38–229 per day (in 2006 prices) and were within the range (SEK 21–308 per fishing day) reported from a Contingent Valuation meta-study conducted by the Swedish EPA (Swedish Environmental Protection Agency, 2009). For the summer season, the estimate was significantly higher. This can be partly explained because most of the marine and costal recreational fishing takes place during the summer and is highly valued by fishers according to the calculated weighted consumer surplus per day.

The effects of a hypothetical increase in expected catch per day on number of fishing days and consumer surplus was within the range estimated by Paulrud (2006). In Paulrud (2006), the WTP range for one extra kg of catch was SEK 11 to 172 (lowest for coastal angling and highest for river angling), whereas the estimate in this study was SEK 57. This can be compared with an increase of between US$ 2.01 and 2.74 (i.e. between SEK 14.9 and 20.3, using 2004 exchange rates) in compensating surplus, following a 25% increase in expected catch, reported for Maine anglers (Scrogin et al., 2004).

The increase in value as a result of increased expected catch has important implications for fishery policies that may affect expected catch. Examples of such policies in Sweden are the introduction of temporary no-take zones (NTZs) to restore populations of specific target species. Bostedt et al. (2020) presented a cost–benefit analysis of two real case temporary NTZs closed during a 5–6 year period in the coastal zone of the Baltic Sea, using scenario analysis to account for uncertainty in both the biological and economic effects. The results of the cost–benefit analyses for the two NTZs were positive in most scenarios. The biological effects of the temporary NTZs were estimated using fishing surveys with trap nets during the spawning season on a yearly basis from the year of establishment of the NTZ. The total effect on abundance in the NTZ in one of the two areas was a factor of 4.4 to 4.9 (depending on fish species), and for the other area a factor of 11, compared with the start of the regulations. This highlights the positive effects on fish populations as well as the potential socioeconomic benefits of temporary NTZs, in addition to the positive ecological effects generally achieved by areas closed to fishing.

A comparison of mean catch, valuation and characteristics of respondents with other studies is difficult since most other surveys of recreational fishing are on-site studies of a specific area—usually a popular fishing area where catches are above average for the country in which the area is situated. Also, mean estimates might not be calculated in a comparable way. For example, the mean catch per trip for a sample of anglers in the Swedish county of Bohus (Paulrud, 2006) of between 0.8 and 6.1 kg (depending on fishing technique) is not directly comparable to the mean of 0.320 kg/fishing day for fishing reported above. First, the figures reported here are national averages for Sweden, while Paulrud (2006) referred only to anglers in the county of Bohus. Second, Paulrud's (2006) estimates were based on a per trip basis. The mean price of a fishing day estimated by Toivonen et al. (2004), which varied between US$ 5.5 and 27.1, was also based on a general population survey, but was slightly lower than this study, although the mean age of fishers and number of fishing days in Toivonen et al. (2004) were comparable.

The SwAM Recreational Fishing Survey is a useful instrument for analysing and monitoring recreational fishing in Sweden, but several questions need to be addressed in future research. From a social perspective, it would be of interest to study whether fishing habits differ across social groups, and thus how the value of the recreational fishing is distributed. Common distributional dimensions like income, education, age, gender and geographical affiliation could all be studied. If it turns out that certain groups are over- or under-represented, and/or that there are large differences in valuation, it may be important for policymakers and politicians to consider how this type of information should be used. As argued by Potts et al. (2019), informed national fisheries policies require that individual nations "assess and recognise the socio-ecological importance of recreational fisheries" and "monitor biological, economic and social impacts of the recreational fishery." At least, in Sweden such monitoring is not at odds with the recreational fishing community, quite the contrary. van den Heuvel et al. (2020) showed support for a potential centralised catch reporting programme was high for most anglers. In other words, the importance and value of recreational fishing are affected by whether it concerns enough people in society.

ACKNOWLEDGEMENTS

We are grateful for comments from two anonymous reviewers. We would also like to thank the Swedish Agency for Marine and Water Management for allowing us access to the data from the Swedish Recreational Fishing Survey.

REFERENCES

Amoako-Tuffour, J. & Martínez-Espiñeira, R. (2012) Leisure and the net opportunity cost of travel time in recreation demand analysis: An application to Gros Morne National Park. *Journal of Applied Economics*, *15*, 25–49.

Arlinghaus, R., Tillner, R. & Bork, M. (2015) Explaining participation rates in recreational fishing across industrialized countries. *Fisheries Management and Ecology*, *22*, 45–55.

Bilgic, A. & Florkowski, W.J. (2007) Application of a hurdle negative binomial count data model to demand for bass fishing in the southeastern United States. *Journal of Environmental Management*, *83*, 478–490.

Bostedt, G., Berkström, C., Brännlund, R., Carlén, O., Florin, A.-B., Persson, L., & Bergström, U. (2020). Benefits and costs of two Temporary No-take zones. *Marine Policy*, *117*, Article 103883.

Curtis, J. & Breen, B. (2017) Irish coarse and game anglers' preferences for fishing site attributes. *Fisheries Research*, *190*, 103–112.

Dalton, R.S., Bastian, C.T., Jacobs, J.J. & Wesche, T.A. (1998) Estimating the economic value of improved trout fishing on Wyoming streams. *North American Journal of Fisheries Management*, *18*, 786–797.

Feather, P. & Shaw, W.D. (1999) Estimating the cost of leisure time for recreation demand models. *Journal of Environmental Economics and Management*, *38*, 49–65.

Hagerty, D. & Moeltner, K. (2005) Specification of driving costs in models of recreation demand. *Land Economics*, *81*, 127–143.

Hyder, K., Weltersbach, M.S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A. et al. (2018) Recreational sea fishing in Europe in a global context-Participation rates, fishing effort, expenditure, and implications for monitoring and assessment. *Fish and Fisheries*, *19*, 225–243.

Lambert, D. (1992) Zero-Inflated Poisson regression, with an application to defects in manufacturing. *Technometrics*, *34*(1), 1–14.

Liston-Heyes, C. & Heyes, A. (1999) Recreational benefits from the Dartmoor National Park. *Journal of Environmental Management*, *55*, 69–80.

Paulrud, A. (2006) Marginal valuation of improving the sport-fishing catch. *Tourism Economics*, *12*(3), 437–449.

Paulrud, A. & Laitila, T. (2013) A cost-benefit analysis of restoring the Em River in Sweden: valuation of angling site characteristics and visitation frequency. *Applied Economics*, *45*, 2255–2266.

Phaneuf, D.J. & Smith, V.K. (2005) Chapter 15 Recreation Demand Models. In: Mäler, K.-G. & Vincent, J. (Eds.) *Handbook of environmental economics*. *2*, Dordrecht: North-Holland, pp. 671–761.

Potts, W.M., Downey-Breedt, N., Obregon, P., Hyder, K., Bealey, R. & Sauer, W.H.H. (2019) What constitutes effective governance of recreational fisheries?—A global review. *Fish and Fisheries*, *21*(91), 103.

Sarker, R. & Surry, Y. (1998) Economic value of big game hunting: The case of moose hunting in Ontario. *Journal of Forest Economics*, *4*, 29–60.

Scrogin, D., Boyle, K., Parsons, G. & Plantinga, A.J. (2004) Effect on regulations on expected catch, expected harvest, and site choice of recreational anglers. *American Journal of Agricultural Economics*, *86*(4), 963–974.

Sohngen, B., Lichtkoppler, F. & Bielen, M. (2000) *The value of day trips to Lake Erie beaches*. Technical Report TB-039 Columbus, OH, Ohio Sea Grant Extension.

Statistics Sweden. (2017) *Fritidsfisket i Sverige 2013*. Statistiska Meddelanden JO57/SM 1701, Statistics Sweden, Jönköping.

Statistics Sweden. (2019) *Kvalitetsdeklaration: Fritidsfiske i Sverige*. Jönköping: Statistics Sweden.

Swedish Environmental Protection Agency. (2009) *Monetära schablonvärden för miljöförändringar*. Rapport 6322, Swedish Environmental Protection Agency, Stockholm.

Toivonen, A.-L., Roth, E., Navrud, S., Gudbergsson, G., Appelblad, H., Bengtsson, B. et al. (2004) The economic value of recreational fisheries in Nordic countries. *Fisheries Management and Ecology*, *11*, 1–14.

van den Heuvel, L., Blicharska, M., Blyth, S. & Rönnbäck, P. (2020) Catch reporting in recreational fishing: Swedish anglers' attitudes and preferences, and the effect of social factors. *Fisheries Research*, *223*, 105444.

Wallentin, E. (2016) Choice of the angler: Estimating single-site recreation demand using revealed preference data. *Tourism Economics*, *22*(6), 1338–1351.

Zuur, A.F., Ieno, E.N., Walker, N.J., Saveliev, A.A. & Smith, G.M. (2009) Zero-truncated and zero-inflated models for count data. In: Zuur, A.F., Ieno, E.N., Walker, N.J., Saveliev, A.A. & Smith, G.M. (Eds.) *Mixed effects models and extensions in ecology with R*. New York: Springer-Verlag.

How to cite this article: Carlén O, Bostedt G, Brännlund R, Persson L. The value of recreational fishing in Sweden – Estimates based on a nationwide survey. *Fish Manag Ecol*. 2021;28:351–361. https://doi.org/10.1111/fme.12484

APPENDIX 1
CATCH PER FISHING DAY ESTIMATES

In correspondence with equation (7), all independent variables are dummy variables, indicating whether the respondent had fished in a certain region. For all models, marine and coastal fishing in the Skagerrak is the reference alternative for the area dummies. These equations are necessary for obtaining an estimate of expected catch per fishing day, which is then used as an explanatory variable in the ZIP model.

TABLE A1 OLS regression for calculating the expected catch (dependent variable), in kg per fishing day in Sweden. The table also reports the average catch (kg) per fishing day

Variable	Coefficient (*t*-value)	Average catch per fishing day (kg)
Constant	2.332 (10.82)	
Inland fishing in Götaland and Svealand (except the great lakes of Sweden), dummy variable	0.137 (0.70)	0.384
Inland fishing in Norrland, dummy variable	0.004 (0.02)	0.237
Inland fishing in the great lakes (Vänern, Vättern, Mälaren, Hjälmaren, Storsjön), dummy variable	0.523 (1.89)	0.105
Marine and coastal fishing in the Gulf of Bothnia, dummy variable	0.725 (2.00)	0.059
Marine and coastal fisheries in the central Baltic Sea, dummy variable	0.619 (2.55)	0.163
Marine and coastal fishing in the southern Baltic Sea, dummy variable	0.250 (0.55)	0.036
Marine and coastal fishing in the Öresund strait, dummy variable	1.620 (3.44)	0.034
Marine and coastal fisheries in the Kattegatt, dummy variable	0.012 (0.03)	0.053
Season 1 (Jan–Apr), dummy variable	−1.041 (−3.80)	
Season 2 (May–Aug), dummy variable	−0.900 (−4.23)	
Number of observations	1060	
Adj. R^2	0.03	
Chi-Sq test	43.31	