The Socio-Economic Marine Research Unit (SEMRU)
National University of Ireland, Galway

Working Paper Series

Working Paper 19-WP-SEMRU-03

Coarse angler site choice model with user-based perceived site attributes

John Deely[1], Stephen Hynes[1], John Curtis[2,3]

1. Socio-Economic Marine Research Unit, Whitaker Institute, National University of Ireland Galway
2. Economic and Social Research Institute (ESRI), Dublin
3.Trinity College Dublin, Dublin, Ireland

If referencing this working paper please use:https://doi.org/10.1016/j.jort.2018.07.001

SEMRU *Working Paper Series*

*Corresponding author: J.DEELY2@nuigalway.ie

For More Information on the SEMRU Working Paper Series
Email: stephen.hynes@nuigalway.ie, **Web:** www.nuigalway.ie/semru/

Coarse angler site choice model with user-based perceived site attributes

John Deely, Stephen Hynes, John Curtis

Abstract

Choice models are applied to a sample of users of Irish coarse fishing sites. The site choice models are developed using respondent's perception of site attributes and revealed trip frequencies. The random parameter logit is employed to account for unobserved taste heterogeneity. Willingness to pay estimates are constructed for each site attribute and a number of policy changes. The results of the site choice model suggest that accessibility, variety, and the size of fish are significant positive determinants of site selection for the sampled anglers. Local services have a negative impact on site selection, whereas the quantity of fish and the level of encounters with other anglers does not play a significant role. Willingness to pay estimates suggests that the average willingness to pay for an improvement in access is €3.03. However, policy scenarios suggest that this figure is not evenly distributed for each site. The results suggest that the average sampled angler has a willingness to pay of €1.80 for an increase in fish size at Killykeen, and €2.39 for a marginal increase in size at Garadice.

Management Implication
A key aim of the Irish National Strategy for Angling Development is to increase the number of domestic anglers that regularly participate in the Irish angling scene. A comprehensive understanding of angler preferences may improve management's ability to reach this goal. This paper demonstrates that Irish coarse anglers are heterogeneous in their preferences. The implementation of policy should account for this by allowing for sites that vary with respect to important site attributes. The model results suggest that, on average, site access development to sites that contain large fish away from areas with high levels of amenities would benefit Irish coarse anglers most. However, due care is need when providing additional access as scenario estimates demonstrate that access is not uniformly appealing and, that, an improvement in access at the most visited sites will not necessarily benefit anglers the most. The results also suggest that stocking sites with large quantities of fish may not affect anglers, at least with respect to site choice.

Acknowledgement: Funding from Inland Fisheries Ireland is gratefully acknowledged. Our thanks to Paul and Shane O'Reilly for their help in the creation of the survey and choice set, to the individuals who took the time to take part in the focus group, and the survey respondents who graciously gave up their leisure time to fill out the survey.

Keywords: Site choice, travel cost, perceived site attributes, Angler, recreation, random parameter logit

1. Introduction

The value of a day spent fishing is impacted by a number of factors including; site management, site choice, and duration of stay. Anglers' preference for these factors have been demonstrated to be influenced by a wide range of personal, demographic, and site characteristics including; personal beliefs and attitudes (Arlinghaus and Mehner 2005), race and ethnicity (Hunt et al. 2007a), water quality (Curtis and Stanley 2016), objective site attributes (Curtis and Breen 2017), traditions and weather conditions (Hunt et al. 2007b), and duration since last trip (Provencher et al. 2002). In some cases, preferences for site attributes have been found to be influenced by the species the angler is targeting (Curtis and Breen 2017). This paper focuses on Irish coarse anglers, their preferences and what those preferences suggest in relation to managing Irish coarse fishing sites.

The economic contribution of coarse angling to the Irish economy has been measured by Tourism Development Ireland at €96 million (Inland fisheries Ireland 2015). However, direct expenditure measures, such as this, provide limited information and suggests nothing about the fishing site attributes that offer the greatest utility to the average angler. A number of recent studies have estimated the value of a day spent fishing in Ireland; Hynes et al (2015) suggested that per trip consumer surpluses for a day spent fishing ranges from €49 to €277, and Curtis and Stanley (2016) estimated a per trip value, at the upper end of Hynes et al.'s range, of €264. However, these estimates use a single demand function for multiple types of anglers, and as such, it may be inappropriate to attribute these euro values to a single group such as coarse anglers. Curtis and Breen (2017) suggest that a separate demand function for each type of angler is more appropriate as different angler types have distinct preferences. Curtis and Breen (2017) estimated that the per trip consumer surplus for game fishing in Ireland was more than three times the value of coarse fishing; €787 and €249 respectively.

In addition to welfare estimates, site choice analysis can provide a better understanding as to why certain sites are chosen over others. This, in turn, can facilitate better management and lead to a better quality site for consumers. Site choice models enable the modeller to create an approximation of the decision-making process undertaken by, in this case, an angler. When an angler is presented with a choice set containing a number of alternative sites, the choice is often informed by the bundle of attributes that each site possesses. These attributes will influence angler's choice in accordance with the angler's preferences. The analysis of angler's choice can reveal the trade-offs that are implicitly made in a given choice occasion. Policy can then be developed based on the analysis of revealed angler preferences.

Site choice models have been widely applied to recreational angling demand (see Hunt (2005) and Johnston et al. (2006) for literature reviews). In a site choice model, random utility style models are often used to determine the probability of site choice and by extension, determine the trade-offs anglers are willing to make to satisfy their preferences. The attributes of a site, used in the model specifications, can be quantified in one of two manners; a perceived rating, like the one used in this paper, or an objective measure, using a scientific measure of the site attributes. An extensive literature has grown debating the merits of using perceived measures over the often more convenient objective measures (Adamowicz et al. 1997; Jeon et al. 2005; Farr et al. 2016). However, the literature has not clearly determined which measures are superior in site choice models. Adamowicz et al. (1997) argued that models solely based on perceived measures slightly outperformed models solely based on objective measures. Elsewhere, Jeon et al. (2005) found that the inclusion of a perceived measure had a significant impact on site choice analysis of recreational anglers.

There have been some attempts, in the recreational angling literature, to extend models based on objective measures of site attributes with the addition of a limited set of perceived measures (Jeon et al. 2005; Artell et al. 2013). In all cases, the use of perceived measures has been limited to one or two attributes. No paper, to the best of our knowledge, within the recreational angling literature, has attempted to use a complete array of subjective site attributes as rated by anglers as the sole method of measuring site quality. In essence, the angling literature has yet to explore how angler's own perception of a site affects site choice. Through the collection of perceived site attributes and revealed preferences data, this paper explores the preferences of Irish recreational anglers using a random parameter logit. Additionally, this paper adds to the literature by exploring the effects of mean imputation on parameter estimation, which has not previously been dealt with in the recreational site choice literature.

2. Materials and Methods

2.1 Survey Design

The initial steps of the survey design were to identify a choice set and the attributes that are thought to impact the selection of a coarse angling site. An iterative approach was taken to accomplish this. The earliest draft of the survey was developed through an examination of the relevant literature and discussions with coarse angling experts at Inland Fisheries Ireland (IFI). The literature search incorporated both academic literature and recent National Strategy for Angling Development (NSAD) studies. Once a region was selected, where the survey would be conducted, a focus group of local anglers was assembled. The focus group helped in the selection of specific sites and site attributes, as well as giving valuable insight into their understanding of each element of the survey and how they would answer it if they were sampled. Finally, prior to the deployment of the finished survey, a pilot study ran from 28th of July to the 5th of August 2016.

The choice set comprises five angling sites that are thought to be feasible alternatives for coarse anglers, while still incorporating enough variability amongst the six site attributes. The six site attributes were to defined to the respondents as; accessibility to the site (this includes parking and ability to reach the location that you fished at), size of fish at the site (On average does this site provide access to good sized fish), Quantity of fish (on average does this site provide access to a large quantity of fish), encounters with other anglers, Variety of fish species (are there a large variety of species of fish at this site) and Local services (these include pub, shops, accommodation etc…). The respondents were expected to rate these attributes on a five-point Likert scale for each of the five sites they had visited. To ensure clarity, the lowest and highest points on the Likert scale were defined for the respondent, for example, for the attribute variety of fish species the first point on the Likert scale was marked 'little to no variety', the highest point was marked 'lots of variety'. Table 1 of the appendix contains an example attribute rating table; an identical table was used for all sites.

The sites of interest are located in the Cavan and Leitrim area of Ireland. Both counties are located in the north of the Republic of Ireland and border with Northern Ireland. This geographic location was selected because of its abundance of coarse fishing sites, making it a popular destination for anglers both north and south of the border as well as being home to many local coarse anglers.

The choice set is limited to five sites that could a) feasibly be alternatives b) have a reasonable amount of visitors and c) have ostensibly different attribute levels. The sites were purposely selected to maximise the number of sites, from the choice set, each angler may have visited. The five sites selected are Garadice (Leitrim), Killykeen Forest Park (Cavan), Eonish (Cavan), Dernaferst (Cavan) and Church Lake (Cavan). The five sites are situated within 30 kilometres of each other. Both Eonish and Killykeen are fishing sites on the water system Lough Oughter, Church Lake and Dernaferst are on Lough Gowna and Garadice is a lake with multiple access points.

All five sites have some level of road access but vary in the number of access points, accessibility for fishing boats, the proximity of parking to pegs, and the number of pegs available. In order to induce variability amongst fish species, the sites were chosen from three different water systems. However, in Ireland, most sites that hold coarse fish will hold similar species. The potential for variability of encounters with other anglers was determined by the perceived popularity of the site and the number of pegs it contains. The potential for variability in size of fish and quantity of fish between sites was informed by expert opinion and focus groups.

2.2 Sampling

Two methods of data collection were used to elicit responses from the coarse angling community; online and intercept surveying. The online survey was accessible via SurveyMonkey from the 6th of August 2016 to January 15th, 2017. Potential participants were contacted through Irish coarse angling Facebook pages, by emailing local coarse angling clubs, contacting local newspapers and through the IFI newsletter.

The online survey was completed by 62 individuals, making a total of 4,265 observations.

Intercept surveying began on the 6th of August and ran until the 7th of November. Individuals were approached and invited to complete the survey. Although this has the potential to increase ‘length of stay’ bias (Lucas, 1963), the alternative of interviewing people at the car park or site entrance, was not feasible as car parking facilities were seldom used as anglers chose to park beside where they fished. Eonish and Church lake were surveyed 15 times each, Killykeen Forest Park and Dernaferst were surveyed 13 times and Garadice was surveyed 12 times. The intercept survey accounts for 43 survey responses and 6,685 observations. In total, the sample is comprised of 105 survey respondents and 10,950 observations.

The respondents were asked a series of questions about their angling experience as well as socio-demographic questions. The respondents were also asked to rate each of the five sites on a set of six attributes as well as provide information on how many trips they made to each site during the 12 month period prior to completing the survey. The survey design is developed on the assumption that the choice set describes five sites that are possible alternatives for every angler in the sample. Any site that was not previously visited by a respondent was not rated by that respondent. Following Hynes et al. (2008) and Hanley et al. (2001) sites that were not rated by an angler, had their attribute levels set equal to the mean of the responses given by all other anglers for those attributes. The impact of replacing the missing values through this mean imputation process is further explored in section 4.4 sensitivity analysis.

The travel cost variable was constructed by calculating the distance from the respondent’s home address to each site and is specified as:

$$tc = ((travel\ disance * operating\ cost) + (travel\ time * \ opportunity\ cost\ of\ time)) \ * 2 \quad (1)$$

Here, operating cost equals 0.2475 cent per kilometre, which is the operating cost of running a medium sized car according to the Automobile Association of Ireland. This assumes that each trip is a day trip, where the individual travels from their home and back. The opportunity cost of time is taken as 33% of the average hourly wage rate (Parsons, 2003) assuming a 2000 hours’ work year. No opportunity cost of time is included to account for time spent on-site.

2.3 Considerations for Sampling Bias

Consideration needs to be given to the ability to combine the on-site and online survey responses; in particular, it may be the case that younger anglers are more likely to complete the online survey. The average age of the online cohort is 44 whereas the average age of the on-site cohort is 56. However, the sample as a whole seems to align almost perfectly with the estimated age range of Irish anglers (TDI, 2013). The current sample is comprised of 15% 18-34-year-olds, 54% 35 – 54, and 31% 55 +. The TDI (TDI, 2013) estimates suggest that 18% of the fishing population is aged between 18 – 34, 51% between 35 – 54, and 30% are older than 55 years of age.

Kolmogorov–Smirnov (KS) tests were also used to assess whether there are substantial differences between the two samples with regard to their perspective on site attributes. The KS test is a non-parametric test for equality of distribution which was first proposed by Kolmogorov (1933) and thought to be more powerful than chi-square test in most situations (Conover 1980). In Kolmogorov style tests the largest vertical distance between two samples is measured and used to test the hypothesis that; all values from, in this case, the online sample come from the same distribution as the on-site sample versus the alternative that at least one value from the online sample falls outside this distribution. Presented in table 2 of the appendix, the results suggest that for 24 out of 30 attributes the responses can be considered to be from the same distribution. Additionally, to control for the effects of the sampling methods used, several interaction terms are used to account for differences between the on-site cohort and online cohort.

A further consideration is how the sampling technique may cause biased parameter estimates. Two forms of bias may be present in the sample through the non-random sampling methods employed. The first relates to a sample selection bias. When individuals are intercepted at a particular site, the probability of inclusion in the sample is correlated with site choice, leading to biased parameter estimates (Hindsley et al. 2011). The elimination of this form of bias can be achieved by weighting sampled observations to reflect known population ratios of site choice (Manski and Lerman 1977). Alternatively, the bias in parameter estimates can be confined to a single set of parameters. Manski and Lerman (1977) have demonstrated that by including a full set of alternative specific constants (ASC) the bias can be fully restricted to these dummy variables. In the case of the models presented here, ASCs are included as the requisite population ratios are unknown.

The second form of bias is known as endogenous stratification or avidity bias, where the probability of being sampled is positively correlated with the number of trips the respondent has taken within some time frame (Hindsley et al. 2011). As a result of avidity bias, parameter estimates are more heavily influenced by avid anglers than would otherwise be true. As is common in many recreational site choice models we do not have accurate information on the total number of Irish anglers using the five sites or their associated trip frequencies to the five sites. This means that we cannot generate individual weights that could be used to reduce the influence of the avid anglers in the sample. Similar to other recreational site choice modelling studies such as Hanley et al. (2001) and Scarpa et al. (2005) we, therefore, are unable to correct this issue. However, as pointed out by Hynes and Hanley (2006), the addition of the online respondents to the sample should reduce the number of avid respondents by virtue of the fact that their response is not as a result of being intercepted on-site.

Researcher defined choice set may also lead to biased parameter estimates when respondent choice set and researcher choice set differ (Peters et al. 1995; Parson et al. 1999; Hick and Strand 2000; Li et al 2015). The literature discusses multiple consequences of inappropriate choice set assumptions[1]. Of particular note for the analysis presented here is how the missing data for unfamiliar sites is treated. The effects of the mean imputation process used to replace this missing data are explored in section 4.4 sensitivity analysis.

Finally, the variable *encounters,* which measures how often a respondent meets or sees other anglers at a particular site, is likely correlated with other angler's site choice leading to endogeneity issues. Reverse causality may indeed be an issue as *encounters* is likely a function of site choice, although not the sole determinate. However, the discussion with both the coarse angling experts and focus group, as well the angling literature on angler site choice (Hunt 2005) suggests that the level of likely encounters with other anglers is an important determinant of site choice.

3. Econometric models

3.1 Site choice model

McFadden's (1973) random utility model (RUM) asserts that an individual will choose the alternative that will maximize her utility on any given choice occasion. This utility can be written as:

$$u_{in} = V(X_{in}, y_n - p_{in} \mid \theta_n, z_n) + \varepsilon_{in}$$

$$= V_{in} + \varepsilon_{in}$$

(2)

Where u_{in} is the utility received by individual n from choosing site i, V is the indirect utility function, X_{in} is a vector of perceived attributes, y_n is individual n's income, p_{in} is the travel cost, θ_n is a vector of individual specific characteristics and z_n are individual specific covariates. ε_{in} is the stochastic error term, by definition, unknown to the modeller and is assumed to be independent and identically distributed (IID) extreme value type 1. The estimated variable parameters are homogenous across individuals and, by implication, each individual has the same taste preferences (Train

[1] the interested reader may wish to read Li et al. (2015) and Haab and Hicks (1999) for further insight into the multitude of assumptions and considerations that can be employed when trying to recreate an individual's true choice set or consideration set.

1998). The probability of individual *n* choosing site *i* from choice set *J* can then be given as:

$$\Pr(i) = \Pr(V\,(x_{in}, p_{in}\,|\theta_n, z_n) + \varepsilon_{ij}) \geq V(x_{jn}, p_{jn}\,|\theta_n, z_n) + \varepsilon_{jn})\ \forall j \in J$$

(3)

The probability of individual *n* choosing site *i* is equivalent to the probability that individual *n* will receive more utility from visiting site *i* than any other sites in choice set *J*. As only difference in utility matters when calculating the probability of site choice, individual characteristics like income are differenced away. When the distribution of the error terms are independently and identically drawn from an extreme value distribution, the RUM model takes the form of a conditional logit (CL) (McFadden 1973), where the probability of choosing site *i* is given as a logit with scale parameters μ which is assumed to be equal to 1 (Boxall and Adamowicz 2002).

$$\Pr(i) = \frac{\exp(\mu V_{in})}{\sum_{j=1}^{j}\exp(\mu V_{jn})}$$

(4)

3.2 Random parameter logit

The Random Parameter Logit (RPL) as outlined in Train (2009) overcomes the restrictive quality of the IID error term found in the CL by decomposing the error term into two separate elements. One part is correlated over alternatives and heteroskedastic, the other is IID over alternatives and individuals. In this form utility can be written as:

$$u_{in} = V_{in} + [\eta_{in} + \varepsilon_{in}]$$

(5)

Where η_{in} is a random term with zero mean which may be correlated across individuals and alternatives, ε_{in} remains IID. By decomposing the error term the RPL allows the coefficients of observed variables to vary randomly across individuals. The choice probability remains logit conditional on individual taste. Marginal probabilities across individuals need to be integrated over taste distributions which are specified by the modeller. η_{in} can take on multiple distribution forms (Hensher and Greene 2003). If it is assumed that it takes a multivariate normal form we can write:

$$\beta_n \sim N(\bar{\beta}, \Omega)$$

Where **Ω** is the variance-covariance matrix.

The conditional probability for any η_{in} is logit:

$$\Pr(i) = \frac{\exp(\mu V_{in} + \eta_{in})}{\sum_{j=1}^{j} \exp(\mu V_{jn} + \eta_{jn})}$$

(6)

This logit is then integrated over all values of η_{in} with appropriate density weightings to form the unconditional choice probability. After accommodating for an unbalanced panel data the unconditional choice probability becomes:

$$\int \prod_{t=1}^{t=T(n)} \frac{\exp(\mu V_{in} + \eta_{int})}{\sum_{j=1}^{j} \exp(\mu V_{jn} + \eta_{jnt})} \varphi(\bar{\beta},) \mathrm{d}\beta_n \tag{7}$$

Where T(n) is the revealed preference of each respondent, $\varphi(.)$ denotes the multivariate normal density, $\bar{\beta}$ and $\mathbf{\Omega}$ are the mean and variance parameters which are estimated from the sample data.

3.3 Welfare estimates

Willingness to pay (WTP) estimates are calculated following Train (2009):

$$WTP = \frac{\beta_n}{-\beta_{tc}}$$

(8)

Where β_n represents the coefficient of the attribute of interest for individual n and β_{tc} is the travel cost coefficient. For the RPL, the coefficient of the attribute of interest is estimated through simulation. As WTP is simply a ratio, with the travel cost parameter as the denominator, it is highly influenced by an individual's marginal utility of income. In the models presented in this paper, the travel cost coefficient is fixed to avoid infinite moments of the welfare estimates (Daly 2012). Consequently, all individuals are assumed to have the same marginal utility of income.

Confidence intervals are constructed using the Krinsky and Robb method (Krinsky and Robb, 1986), which takes a specified number of draws from a multivariate normal distribution. The mean and covariance of this distribution are specified to equal the estimated coefficients and covariance matrix of the site choice model (Hole 2005).
Haab and McConnell (2002) extend WTP estimates to measure the amount one would be willing to pay to achieve a certain attribute level at one or more sites:

$$WTP_{sitechange} = -(\beta_{tc})^{-1}$$

$$[\ln [\ \textstyle\sum_{j=1}^{j} exp\ (\hat{\beta}_n x_n^1)] - \ln[\textstyle\sum_{j=1}^{j} exp\ (\hat{\beta}_n x_n^0)]]$$

(9)

where β_{tc} is the marginal utility of income which, here, is the negative reciprocal of the travel cost coefficient, $\hat{\beta}_n$ is a vector of parameters for individual n, x_n^0 is a set of perceived site attributes (or travel cost) and x_n^1 is the same set of attributes after some exogenously imposed change to one or more of the site attributes. When applied to the RPL, WTP estimates for a specific change in a site's attribute follows the same specification but need to be integrated over taste distributions (Train 1998) which is approximated through simulation:

$$\widehat{WTP_{sitechange}} = \int WTP_n \varphi(\hat{\beta}, \hat{\Omega})\ d\beta$$

$$= \int\{-(\beta_{tc})^{-1}\ [\ln [\ \textstyle\sum_{j=1}^{j} exp\ (\hat{\beta}_n x_n^1)] - \ln[\textstyle\sum_{j=1}^{j} exp\ (\hat{\beta}_n x_n^0)]]\ \varphi(\hat{\beta},\hat{\Omega})\ d\beta$$

(10)

4. Results

4.1 Sample Statistics

Table i shows the perceived attribute levels as rated by the survey respondents. The within attribute variance is reasonable given that the attributes are rated on a five-point Likert scale with most attribute means lying between two and four on the Likert scale. As the sites were chosen, in part, by the fact that attendance should be reasonably large, it would be unlikely to see many attributes that were rated very low on the Likert scale.

Table i: Mean Perceived Site Attribute Rating

Site	Accessibility	Size	Quantity	Encounters	Variety	Services
Garadice	4.27	3.32	3.18	3.57	3.49	3.17
	(.79)	(.68)	(.74)	(1.05)	(.85)	(1.11)
Killykeen	3.19	3.00	3.18	3.64	3.47	2.86
	(1.12)	(.69)	(.83)	(1.06)	(.85)	(1.02)
Eonish	3.44	3.02	3.17	3.17	3.49	2.96
	(0.92)	(.53)	(.64)	(.91)	(.70)	(.83)

Dernaferst	3.43	3.08	3.38	3.62	3.35	3.4
	(.95)	(.72)	(.72)	(.77)	(.68)	(.80)
Church Lake	2.93	2.93	2.98	3.13	3.00	3.34
	(.80)	(.68)	(.74)	(.80)	(.60)	(.69)

Ratings are rated on a 1- 5 Likert scale. Standard deviation given in parenthesis

As shown in table ii, Garadice was visited by the greatest number of anglers as well as having the highest number of mean trips. Garadice's much higher number of total trips is due, in part, to anglers who took more than 50 trips to the site during the survey year, with two reporting to have visited Garadice 100 times. Approximately 40% of the respondents who visited Church Lake only visited it once within the past 12 months. In comparison, less than 20% of respondents who visited Garadice or Killykeen only visited once.

Table ii: Mean and Total Trips Per Site

	Number of anglers who have visited each site in the last 12 months	Mean trips	Total Trips
Garadice	71 (67.61%)	15.39	1,093
Killykeen Forest Park	70 (66.67%)	7.06	494
Eonish	45 (42.86%)	4.36	196
Dernaferst	43 (40.95%)	6.02	259
Church Lake	33 (31.4%)	4.48	148

Percentage of sample who visited each site is given in parenthesis

The vast majority of respondents stated that angling was their most important pastime. Nearly 95% of the anglers considered their abilities to be intermediate or advanced. The average number of years the sampled anglers have been fishing for was 37 with 80% fishing for more than 20 years.

Table iii: Angling Related Experience of Respondents

Items	Frequency	Percentage
Importance of angling as recreation:		
Most important outdoor activity	85	80.95%

Second most important outdoor activity	13	12.38%
Third most important outdoor activity	4	3.81%
One of many outdoor activities	3	2.86%
Ability level:		
Basic	6	5.71%
Intermediate	43	40.95%
Advanced	56	53.33%
Years fishing:		
10 years or less	7	6.67%
11 – 20 years	14	13.33%
21 – 30 years	24	22.86%
31 – 40 years	33	31.43%
41 – 50 years	19	18.10%
51 – 60 years	5	4.76%
61 + years	6	1.20%

The vast majority of respondents were from the Republic of Ireland with only 13% residing in Northern Ireland at the time of completing the survey. The average sampled angler was 49 years old, and just over half the sample has completed third level education.

Table iv: Sociodemographic Characteristics of Respondents

	Mean	Standard deviation
Age	48.6 years	13.39 years
Income	€43,281	€30,258
Education:		
Third level education	50.48%	

Secondary	43.81%
Primary	5.71%
Country of residence:	
Ireland	86.67%
Northern Ireland	13.33%

4.2 Estimation Results

Both conditional logit and random parameter logit models were estimated. The Akaike information criterion statistics suggest that the RPL specification is the preferred model, compared to the CL. On a more fundamental level, the advantages that the RPL provides, by allowing correlations in the decision-making process for individuals across choice occasions, is a much more logical interpretation of how individuals act in a real-life situation. By allowing for unobserved taste heterogeneity, in the manner that the RPL does, a closer approximation of the decision-making process of individual anglers and the sample as a whole is provided. Additionally, the CL model failed the test for independence of irrelevant alternatives (IIA); a problem that is overcome by using the RPL. The discussion on estimated results and welfare estimates will, therefore, focus on the RPL, and will only refer to the CL where explicitly stated.

Table v shows the results of the econometric analysis. The estimated parameters are not obviously interpretable; however, direction, magnitude, and significance are easily understood. A positive coefficient means a ceteris paribus increase in this variable increases the probability of site selection; the greater the absolute value of the coefficient the larger the absolute increase in this probability. The alternative specific constants are dummy coded with Garadice, the most visited, as the reference site. As discussed in section 2.3, these parameters may be biased, and care should be taken when interpreting them.

The first set of parameters, presented in table v, are the variables which are allowed to vary randomly in this application of the RPL. All site attribute coefficients are assumed to be normally distributed, so that negative, as well as positive values, are permitted[2]. The second set of parameters contains the travel cost parameter and

[2] One could argue that it would make more sense to specify the quantity and size coefficients to be log-normally distributed to ensure only positive estimates. Indeed, alternative specifications of the model were attempted, which included specifying these coefficients as log-normal. However, these models failed to converge. This is not an uncommon result with RPL models; as pointed out by Hynes et al.

alternative specific constants, which aim to capture the attractiveness of a site that remains unaccounted for by the variables of interest. In order to capture heterogeneity between the on-site and online cohorts, four interaction terms are created. Each of the four variables is created by interacting a dummy indicating that the individual completed the survey online interacted with a dummy for each of the alternative specific constants. The aim of these interaction terms is to capture any difference that may exist between the two cohorts with respect to their site preference.

Table v: Results of Conditional Logit & Random Parameter Logit

	Conditional Logit	**Random Parameters Logit**	
	Mean of Coefficient	Mean of Coefficient	Standard Deviation of Coefficient
Random Parameters			
Access at Site	0.092(0.032)***	0.354 (0.081)***	0.714 (0.067)***
Local Services	-0.300 (0.034)***	-0.335 (0.109) ***	0.752 (0.106)***
Size of Fish	0.053 (0.051)	0.225 (0.113)**	1.589 (0.128)***
Quantity of Fish	0.113 (0.042)**	0.024 (0.104)	1.472 (0.175)***
Variety of Fish	0.182 (0.053)***	0.331 (0.111)***	1.366 (0.143)***
Encounters with other Anglers	-0.008 (0.038)	0.014 (0.075)	1.060 (0.138)***
Fixed parameters			
Travel cost	-0.065 (0.004)***	-0.080 (0.009)***	
Killykeen Forest Park	-1.108 (0.097)***	-0.761 (0.251)***	
Eonish	-2.114 (0.118)***	-1.400 (0.224)***	
Dernaferst	-1.189(0.120)***	-0.508 (0.294)*	
Church Lake	-2.336 (0.208)***	-1.267 (0.355)***	
Heterogeneity in mean, parameter:			
Killykeen Forest Park: online	-0.879 (0.135)***	0.087 (0.337)	
Eonish: online	-1.479 (0.170)***	0.561 (0.299)*	
Dernaferst: online	-0.725(0.164)***	0.490 (0.381)	
Church Lake	-1.728(0.235)***	0.357 (0.394)	
Log likelihood function	-2551	-2066	
Akaike information criterion	5132	4174	
Bayesian information criterion	5241	4327	

*Figures in parenthesis are standard errors. All figures under conditional logit are fixed parameters. *** indicates significant at 1% ** indicates significant at 5% * indicates significant at 10%*

As expected the *travel cost* coefficient is negative and significant, indicating that an increase in cost will result in a decrease in the probability of site selection. The coefficients of the alternative specific constants are all negative, indicating that, Garadice has some features that draw the sampled anglers to it, as opposed to the other four sites in the choice set. Only one of the four interaction terms is significant,

(2008) non-convergence may result in cases where restrictions in the choice of distributions are employed when using maximum simulated likelihood because of its reliance on gradient methods to find the maximum.

suggesting that the online respondents are more likely to choose Eonish in comparison to their on-site counterparts.

For the sampled anglers an increase in *access* is associated with a higher probability of site selection. *Services*[3], which include; accommodation, pubs, and shops, has a negative and significant impact on site choice. This may indicate that the sampled anglers generally choose sites that are more remote and require few local amenities on their fishing trips. *Variety* plays a positive and significant role in site selection for the sample. The estimated parameter for *encounters* is non-significant suggesting that for the average sampled angler site choice is not correlated with the level of *encounters with other anglers*. The *quantity of the fish* at the site was not a significant driver of site choice amongst the sample. However, the *size of the fish* at a site seems to play an important role in site choice for the sampled anglers as they tend to choose sites with large fish.

Broadly speaking the results of the CL and RPL are similar. Nevertheless, some noteworthy differences do appear. The results of the CL suggest that *size of fish* has a non-significant effect on site choice whereas once preference heterogeneity is controlled for the RPL results suggests that *size of fish* has a mean positive impact. Conversely, the *quantity of fish* plays a significant role in the CL model but does not in the RPL.

4.3 Welfare Estimates

WTP estimates for a marginal change in a site attribute are presented in table vi. As outlined in section 3.2 these estimates were computed using the Krinsky-Robb method (Krinsky and Robb, 1986) with 5,000 draws.

Table vi: Willingness To Pay Estimates (€ per person/trip)

Attribute	**Conditional Logit**	**Random Parameter Logit**
Access at site	1.42 (0.43 – 2.41)	4.44 (2.49 – 6.79)
Size of fish	0.82 (-0.75 – 2.38)	2.79 (0.10 – 5.77)
Local Services	-4.62 (-5.72 – -3.51)	-4.20 (-6.95 – -1.57)
Quantity of fish	1.74 (0.45 – 3.03)	0.30 (-2.24 – 2.98)

[3] The initial sample set used for this analysis included overseas anglers. They were not used in the final estimation due to the absence of travel cost information. However, the results of an RPL model that included the foreign visitors suggested that for Irish anglers, services had a negative and significant impact on site choice but for overseas anglers, local services had a positive and significant impact.

Encounters with Other Anglers	-0.13 (-1.29 – 1.02)	-0.18 (-1.67 – 2.06)
Variety	2.80 (1.13 – 4.6)	4.15 (1.40 – 7.41)

Estimates indicate a euro value WTP per trip for a marginal increase in the perceived value of an attribute. 95% confidence intervals shown in parenthesis.

The sampled anglers have a WTP of €4.44 per trip for a marginal increase in the perceived level of *access*. Estimates suggest that these anglers, on average, would be willing to pay €2.79 per trip for a marginal increase in the perceived *size of the fish* at a site. The estimates suggest that the sampled anglers are willing to pay €4.20 per trip for a decrease in *local services*. After accounting for the observed heterogeneity, the average sampled angler, has a WTP of €4.15 for an increased in perceived *variety*. WTP estimates for both encounters with other anglers and quantity of fish were not statistically different from zero.

WTP estimates are extended to assess how a variety of changes to a site's attribute would affect the sampled anglers. The first estimate presented investigates how an increase in *access* at each of the five sites would impact the sample on a per choice occasion basis. Then, WTP estimates are presented for an increase in size at Garadice and Killykeen, the two most popular sites, as well as averaged across all five sites. In both cases the exogenously imposed change is a one unit increase on the five-point Likert scale e.g. for those who said that accessibility was three at Garadice, their WTP is calculated as the difference between accessibility being three and four for Garadice. Importantly, attribute ratings are restricted to five on the Likert scale. This will have a significant impact on the WTP estimates for sites that are already highly rated for that attribute. Anglers who rated a site as being five out of five on accessibility will, in essence, be excluded from the WTP calculation (i.e. there is no difference between the status quo and a change in policy for those anglers).

Table vii: Willingness to Pay for a Change in a Site's Attributes

Site	Attribute	Per person/choice occasion, €	95% confidence intervals
Garadice	Unit increase in access	2.26	2.05 – 2.47
Killykeen	Unit increase in access	3.53	3.29 – 3.78
Eonish	Unit increase in access	3.27	3.05 – 3.49
Dernaferst	Unit increase in access	2.71	2.53 – 2.89
Church Lake	Unit increase in access	3.39	3.18 – 3.61
Garadice	A unit increase in the size of fish	2.39	1.80 – 2.98

Killykeen	A unit increase in the size of fish	1.80	1.21 – 2.39
Average across all five sites	Unit increase size of fish	2.17	1.59 – 2.76

The results suggest that the sampled anglers may benefit most from an increase in *access* at Killykeen and least from an increase in *access* at Garadice. The relatively low WTP for an increase in *access* at Garadice is, in part, due to the large number of anglers who rated Garadice as having *access* worthy of a five out of five rating.

As a TDI (TDI 2013) report suggests that fish quality (both *size* and *quantity*) is the most appealing aspect of Ireland as an angling destination. Consequently, analysis has been extended to demonstrate how a change in *the size of fish* may affect coarse anglers. Simulations were conducted demonstrating how a change in *the size of fish* at Garadice, Killykeen and averaged across all five sites would impact the sampled anglers. This change has been specified to be a one unit increase in the perceived *size of fish* as measured on the five-point Likert scale.

The results of this simulation suggest that the per choice occasion increase in welfare, for a 1 unit Likert scale increase in the *size of fish* is €2.39 at Garadice and €1.80 at Killykeen. Averaged across all five sites the WTP is €2.17 per choice occasion. Additionally, it may be true that an increase in the *size of fish* may induce anglers to take more fishing trips during the year, which would have a much greater impact on consumer welfare.

4.4 Sensitivity analysis

Biased parameter estimates are often an issue of concern in economic modelling. Parameter estimates can be biased through numerous mechanisms, some of which have been previously discussed in section 2.2. Of particular concern with the methods used here and elsewhere (Hynes et al. 2008 and Hanley et al. 2001) is the practise of replacing unrated site attributes with the mean rating given by all other anglers. Following Hick and Strand (2000), Peters et al. (1995), and Adamowicz et al. (1997) we create two data sets; the first is the full data set with mean imputed missing values, the second is a restricted data set using only familiar sites, in this case, the sites that were rated by the respondents.

As suggested by Parson et al. (1999) the results of the restricted choice set may undervalue the disutility of an individual's travel cost For example, if an angler is sufficiently satisfied with Garadice he/she may not be willing to travel 45 more minutes to Church Lake, even though they are aware of the site. In this example, the angler has a preference for less travel cost and as a result, Church Lake is not visited by the angler and is, consequently, unrated. The restricted choice set will not capture this disutility as Church Lake is simply dropped from the individual's choice set. This may result in a travel cost coefficient biased upward towards. Of particular interest is the comparison between the site attribute coefficients across the two choice set specifications. If the parameter estimates are the same, across the models, this would suggest no bias through the mean replacement procedure.

Table ix: *Results of Conditional Logit & Random Parameter Logit* using constricted and extended choice sets

Attributes	Conditional Logit Extended Choice Set	Conditional Logit Restricted Choice Set	Random parameter Logit Extended Choice Set	Random parameter Logit Restricted Choice set
Random Parameter				
Access at Site	0.092(0.032)***	0.053(0.034)	0.354(0.081)***	0.225(0.091)**
			0.639(0.062)***	0.568(0.066)***
Local Services	-0.300(0.034)***	-0.183(0.038)***	-0.335(0.109)***	-0.102(0.103)
Standard Deviation			1.837(0.183)***	0.971(0.120)***
Size of Fish	0.053(0.051)	0.123(0.054)**	0.225(0.113)**	-0.140(0.118)
Standard Deviation			1.432(0.129)***	0.963(0.160)***
Quantity of Fish	0.113(0.042)***	0.154(0.046)***	0.024(0.104)	-0.025(0.085)
Standard Deviation			0.592(0.092)***	0.070(0.069)
Variety of Fish	0.182(0.053)***	-0.089(0.060)	0.331(0.111)***	0.272(0.107)**
Standard Deviation			1.462(0.177)***	0.561(0.089)***

Encounters with other Anglers	-0.008(0.038)	0.035(0.042)**	0.014(0.075)	0.168(0.082)**
Standard Deviation			0.0163(0.064)	0.382(0.083)***
Fixed parameters				
Travel cost	-0.065(0.004)***	-0.041(0.005)***	-0.080(0.009)***	-0.062(0.010)***
Killykeen Forest Park	-1.108(0.097)***	-1.105(0.117)***	-0.761(0.251)***	-1.404(0.283)***
Eonish	-2.114(0.118)***	-1.933(0.125)***	-1.400(0.224)***	-1.407(0.213)***
Dernaferst	-1.189(0.120)***	-1.450(0.177)***	-0.508(0.294)*	-1.529(0.376)***
Church Lake	-2.336(0.208)***	-2.27(0.267)***	-1.267(0.355)***	-2.577(0.477)***
Heterogeneity in mean, parameter:				
Killykeen Forest Park: online	0.879(0.135)***	0.967(0.150)***	0.087(0.337)	1.037(0.343)***
Eonish: online	1.497(0.170)***	1.418(0.182)***	0.561(0.299)*	0.808(0.302)***

Dernaferst: online	0.725(0.164)***	1.307(0.215)***	-0.490(0.381)	0.717(0.426)*
Church Lake: online	1.728(0.235)***	1.968(0.291)***	0.357(0.394)	1.808(0.519)***
Log likelihood function	-2551.1284	-1989.4099	-2066.001	-1756.6589
Pseudo R2	0.2762	0.2005		
Akaike information criterion	5132.257	4008.820	4174.001	3555.318
Bayesian information criterion	5241.773	4112.412	4327.324	3700.346

For the majority of the parameter estimates the sign remains constant throughout. Access is positive across all models with overlapping confidence intervals in the CL and in the RPL. However, it is not significant in the restricted choice set model. **Local services** is negative with overlapping confidence intervals in the RPL estimates. The variable *size of fish* is positive and significant in both the restricted choice CL and the extended choice set RPL but non-significant in the extended choice set CL and the restricted choice set RPL. The variable *quantity of fish* is positive and significant in both CL models and non-significant in both RPL models with overlapping confidence intervals in both cases. **Variety of fish** is positive and significant for all models except the restricted choice set CL.

Encounters with other anglers was positive and significant for both the restricted choice set models but non-significant in the extended choice set models. This may indicate bias from the mean imputation process. As expected, for both estimates of the *travel cost* variable based on the restricted choice set data are lower than the estimates based on the extended choice set models. It is also interesting to note that the pseudo R-squared indicates a better fit for the full choice CL model in comparison to the restricted choice set CL model.

5. Discussion

Although many of the results presented in this paper conform to a priori expectations (*access, size of fish,* and *variety of fish species)* some results seem to have counterintuitive parameter estimates. The parameter estimates for *services* and *quantity of fish* do not suggest, as one would expect, that an angler would prefer a site with greater levels of these attributes. However, these results seem to align with the most relevant literature on the topic.

The parameter estimate for local *services* was negative and significant suggesting that anglers prefer sites away from areas with good local services. The effects of local *services* on angler participation have been relatively unexplored within the Irish recreational angling literature as only one paper (Curtis and Breen 2017) has employed any form of services to determine angler participation. Curtis and Breen (2017) found that the presence of tackle shops had a negative but non-significant role in the determination of trip length for a sample of Irish and overseas coarse angler. For a sample of game anglers, Curtis and Breen (2017) found that accommodation, and a good provision of pubs, dining, and family activities had a non-significant impact on trip duration[4]. However, the presence of a fishing guide was positively correlated with trip duration for game anglers. Although the sample used for our analysis was solely Irish coarse anglers, previous estimation results, that used a sample of both Irish and overseas anglers, suggested that Irish anglers preferred less *local services* and overseas anglers preferred more *local services*. In light of these results, it may not be surprising that Curtis and Breen's sample of Irish and overseas coarse angler would have a non-significant impact on angler participation.

The non-significant parameter estimate for the variable *quantity of fish* is in direct contention with a priori expectations that anglers prefer sites with more fish. However, this result is also supported by the literature; the level of fish stock did not have a significant impact on the number of days spent fishing or the number of trips taken in a year for a sample of Irish game, coarse and sea anglers (Curtis and Stanley 2016) fish yield was found to be a non-significant determinant of trip length for Irish game anglers (Curtis and Breen 2017), and using, a sample of Irish coarse anglers, Curtis and Breen (2017) found that the ability to catch specimen fish was a positive and significant determinate of trip length but bag weight (total weight of fish caught) was negative and significant. Curtis and Breen (2017) have interpreted their results to mean that anglers spend more days at a site that has larger fish but less overall quantity of fish. Given the results presented here and the literature on coarse angler participation in Ireland further analysis is warranted to determine the importance of fish quanity to Irish coarse anglers.

Although highlighted by Hunt (2005) as an influential variable in angling site choice models *encounters with other anglers* had been unexplored within the Irish recreational angling context. As such, the results presented here are difficult to compare. However, the non-significant parameter estimate is, in some senses to be

[4] Curtis and Breen (2017) did not report how accommodation, a good provision of pubs, dining, and family activates, or fishing guides affect coarse anglers.

expected. Although encounters with other anglers is thought to reduce the enjoyment of an angling experience (Martinson and Shelby 1992), there are a number of sampled anglers who will only attend a site during competitions (these include large competitions and weekly local matches). For these anglers, one would expect a positive correlation between site choice and *encounters with other anglers*. Consequently, a non-significant parameter estimate with a relatively large degree of variation (as indicated by the standard deviation of the coefficient) may be a logical result.

In all cases, the standard deviation of the coefficients was statistically significant and relatively larger in comparison to the parameter estimates. This variance suggests that there is a large degree of heterogeneity in the sample (McConnell and Tseng 1999). The application of the RPL in this paper implicitly acknowledges this heterogeneity exists but, suggests that the source is unknown to the researcher (see Hunt 2005 for a detailed explanation of how heterogeneity has been dealt with in the recreational angling site choice model literature). The current study suggests very high levels of heterogeneity, some of which may be of a knowable variety. However, a portion of this may be unknowable to researchers. Further research may be warranted; in particular methods such as the latent class logit may be used to elucidate different coarse angler types which may provide valuable insight into this heterogeneity.

The results of the sensitivity analysis suggest that bias may have occurred specifically from the method by which unrated variables have been replaced, i.e. mean imputation. The variable encounters with other anglers was positive and significant in both the CL and RPL for the restricted choice set model, whereas, the parameter estimates for the full choice set models are both non-significant. Without knowing the respondent's true choice set it is difficult to know what the likely true parameter estimates are. However, as noted by others a change in the magnitude of a parameter estimate may be expected (Peters, Adamowicz, & Boxall, 1995; Parsons et al., 1999; Hicks & Strand, 2000). Further research may be needed which could explore alternative methods of replacing missing perceived data, such as alternative means of data imputation like hot deck or multiple imputations. Not fully explored in this paper is what should be considered the respondent's consideration site. The consideration set may, in fact, contain sites that are unrated and potentially not contain sites that have been previously rated. This too may impact parameter estimates even if mean imputation is a good approximation for the missing data.

6. Conclusion

Through the application of a site choice model, this paper aimed to develop a better understanding of Irish coarse anglers' preferences. For the first time, in the context of the recreational angling literature, it has been assumed that the perception of multiple site attributes varies across individuals and that these perceived site attributes can be used to model site choice in recreation anglers. A key aim of the NSAD (NSAD, 2016) is to increase the number of domestic anglers that regularly participate in the Irish angling scene. A comprehensive analysis of angler preferences, as was carried out in this paper, may improve management's ability to reach this goal.

To allow for both anglers' preferences and anglers' perception of a site to be heterogeneous between individuals a random parameter logit was applied to a dataset of site attributes constructed from anglers' perception of the site. The estimated parameters are used to constructed willingness to pay estimates that show the value of a marginal increase in site attributes as well as WTP for a range of policy changes. Sensitivity analysis was conducted to determine if the practise of replacing unrated sites with the mean rating by those who visited the site may induce biased parameter estimates.

The results suggest that there is a statically significant correlation between anglers' perception of site attributes and their choice of a fishing site. The average size of the fish, the level of access, and the number of different fish species at the site all played a positive and significant role in site selection. The level of local services had a negative and significant impact on site choice, with a WTP of negative €4.20 for a marginal increase. One of the attributes conventionally thought to increase the probability of site selection does not seem to play a dominant role in angler's site choice. In our application, the quantity of fish variable was not statistically significant suggesting, somewhat counter intuitively, that the average angler does not choose a site based on the quantity of fish the site holds.

Two policy changes were examined during analysis; the first of which was an increase in access, as it is the most feasible attribute management can develop. The results of this analysis suggest that anglers would not benefit uniformly from an increase in access across all sites, as WTP ranged from €2.26 at Garadice to $3.53 at Killykeen. The second explored avenue for development was the average size of fish at the site. This was selected as a TDI (TDI 2013) report suggests that fish quality is the most appealing aspect of Ireland as an angling destination. The estimates again varied between sites, with the average WTP being estimated as €2.17 per choice occasion.

The sensitivity analysis suggests that for most variables there is a consensus in both direction and significance of the parameter estimates between the restricted and full choice sets. However, for the variable variety of fish, there is reason to believe that the parameter estimates may be biased as a result of the methods used to construct ratings for the unvisited sites. In both the CL and RPL using the full choice set, variety of fish is positive and significant. However, the results of the CL and RPL using the restricted choice set suggests that variety does not play a significant role in site selection.

Some care needs to be taken when applying the results of this paper to all Irish coarse anglers as we do not have accurate information on the total number or composition of the entire population of Irish coarse anglers using the chosen sites. Consequently, the results should only be viewed as being representative of the sample. However, they still provide an indication of the likely preferences of Irish coarse anglers and a useful example of how angler attribute perspectives can be incorporated into angler site choice models.

A possible avenue for future research is to further examine how a change in size and quantity might affect the number of trips taken to a particular site. This could be accomplished through contingent behaviour analysis which would extend the estimates presented here to determine how an improvement in the quality of fish at a site would affect trip frequencies. Another area for future research would be to compare the model results here, that used the anglers own subjective ratings of each attribute, to a model that uses expert's/management's objective ratings for the same attributes. Finally, alternative methods of constructing values for unrated sites may be employed and tested; modal and imputations may be possible alternatives. However, this sort of analysis may be more ideally suited to a data set in which respondents have explicitly stated what their consideration sites are.

References:

1. Adamowicz, W., Swait, J., Boxall, P., Louviere, J., & Williams, M. (1997). Perceptions versus objective measures of environmental quality in combined revealed and stated preference models of environmental valuation. *Journal of environmental economics and management*, *32*(1), 65-84.
2. Arlinghaus, R., & Mehner, T. (2005). Determinants of management preferences of recreational anglers in Germany: habitat management versus fish stocking. *Limnologica-Ecology and Management of Inland Waters*, *35*(1), 2-17.
3. Artell, J., Ahtiainen, H., & Pouta, E. (2013). Subjective vs. objective measures in the valuation of water quality. *Journal of environmental management*, *130*, 288-296.
4. Astanei, I., Gosling, E., Wilson, J. I. M., & Powell, E. (2005). Genetic variability and phylogeography of the invasive zebra mussel, Dreissena polymorpha (Pallas). *Molecular Ecology*, *14*(6), 1655-1666.
5. Boxall, P. C., & Adamowicz, W. L. (2002). Understanding heterogeneous preferences in random utility models: a latent class approach. *Environmental and resource economics*, *23*(4), 421-446.
6. Conover, W. J., & Conover, W. J. (1980). Practical nonparametric statistics.
7. Curtis, J., & Breen, B. (2017). Irish coarse and game anglers' preferences for fishing site attributes. *Fisheries Research*, *190*, 103-112.
8. Curtis, J., & Stanley, B. (2016). Water quality and recreational angling demand in Ireland. *Journal of Outdoor Recreation and Tourism*, *14*, 27-34.
9. Daly, A., Hess, S., & Train, K. (2012). Assuring finite moments for willingness to pay in random coefficient models. *Transportation*, *39*(1), 19-31.

10. Farr, M., Stoeckl, N., Esparon, M., Larson, S., & Jarvis, D. (2016). The importance of water clarity to Great Barrier Reef tourists and their willingness to pay to improve it. *Tourism Economics*, *22*(2), 331-352.
11. Feather, Peter, and W. Douglass Shaw. "Estimating the cost of leisure time for recreation demand models." *Journal of Environmental Economics and management* 38.1 (1999): 49-65.
12. Haab, T. C., & Hicks, R. L. (1999). Choice set considerations in models of recreation demand: History and current state of the art. Marine Resource Economics, 14(4), 271-281.
13. Haab, T.C and McConnell, K.E. (2002) Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation. Edward Elgar Publishing, Northampton.
14. Hanemann, W. M. (1982). Applied welfare analysis with qualitative response models. *Department of Agricultural & Resource Economics, UCB*.
15. Hanley, N., Koop, G., Alvarez-Farizo, B., Wright, R. E., & Nevin, C. (2001). Go climb a mountain: an application of recreation demand modelling to rock climbing in Scotland. *Journal of Agricultural Economics*, *52*(1), 36-52.
16. Hensher, D. A., & Greene, W. H. (2003). The mixed logit model: the state of practice. *Transportation*, *30*(2), 133-176.
17. Hicks, J. R. (1942). Consumers' surplus and index-numbers. *The Review of Economic Studies*, *9*(2), 126-137.
18. Hicks, R. L., & Strand, I. E. (2000). The extent of information: its relevance for random utility models. Land Economics, 374-385.
19. Hindsley, P., Landry, C. E., & Gentner, B. (2011). Addressing onsite sampling in recreation site choice models. *Journal of Environmental Economics and Management*, *62*(1), 95-110.
20. Hole, A. R. (2007). A comparison of approaches to estimating confidence intervals for willingness to pay measures. *Health economics*, *16*(8), 827-840.
21. Hunt, K. M., Floyd, M. F., & Ditton, R. B. (2007)A. African-American and Anglo anglers' attitudes toward the catch-related aspects of fishing. *Human Dimensions of Wildlife*, *12*(4), 227-239.
22. Hunt, L. M. (2005). Recreational fishing site choice models: insights and future opportunities. *Human Dimensions of Wildlife*, *10*(3), 153-172.
23. Hunt, L. M., Boots, B. N., & Boxall, P. C. (2007)B. Predicting fishing participation and site choice while accounting for spatial substitution, trip timing, and trip context. *North American Journal of Fisheries Management*, *27*(3), 832-847.
24. Hynes, S. and Hanley, N. 2006. Preservation versus Development on Irish Rivers: Whitewater Kayaking and Hydro Power in Ireland. Land Use Policy 23: 170 - 180.
25. Hynes, S., Hanley, N., & Scarpa, R. (2008). Effects on welfare measures of alternative means of accounting for preference heterogeneity in recreational demand models. *American journal of agricultural economics*, *90*(4), 1011-1027.

26. Hynes, S., O'Reilly, P., & Corless, R. (2015). An on-site versus a household survey approach to modelling the demand for recreational angling: Do welfare estimates differ? *Ecosystem Services*, *16*, 136-145.
27. Inland Fisheries Ireland, 2015. The Economic Contribution of Coarse Angling in Ireland. IFI publication, Dublin.
28. Jeon, Y., Herriges, J. A., Kling, C. L., & Downing, J. (2005). The Role of Water Quality Perceptions in Modeling Lake Recreation Demand.
29. Johnson, N. S., & Adams, R. M. (1989). On the marginal value of a fish: some evidence from a steelhead fishery. *Marine resource economics*, *6*(1), 43-55.
30. Johnston, R. J., Ranson, M. H., Besedin, E. Y., & Helm, E. C. (2006). What determines willingness to pay per fish? A meta-analysis of recreational fishing values. *Marine Resource Economics*, *21*(1), 1-32.
31. Kolmogorov, A. (1933). Sulla determinazione empirica di una lgge di distribuzione. *Inst. Ital. Attuari, Giorn.*, *4*, 83-91.
32. Krinsky, I., & Robb, A. L. (1986). On approximating the statistical properties of elasticities. *The Review of Economics and Statistics*, 715-719.
33. Kuriyama, K., Hilger, J., & Hanemann, M. (2013). A random parameter model with onsite sampling for recreation site choice: an application to southern California shoreline sportfishing. *Environmental and Resource Economics*, *56*(4), 481-497.
34. Larson, D. M., & Lew, D. K. (2014). The opportunity cost of travel time as a noisy wage fraction. *American Journal of Agricultural Economics*, *96*(2), 420-437.
35. Li, L., Adamowicz, W., & Swait, J. (2015). The effect of choice set misspecification on welfare measures in random utility models. Resource and Energy Economics, 42, 71-92.
36. Loomis, J., Yorizane, S., & Larson, D. (2000). Testing significance of multi-destination and multi-purpose trip effects in a travel cost method demand model for whale watching trips. *Agricultural and Resource Economics Review*, *29*(2), 183-191.
37. Lucas, R. C. (1963). Bias in estimating recreationists' length of stay from sample interviews. *Journal of Forestry*, *61*(12), 912-914.
38. Manski, C. F., & Lerman, S. R. (1977). The estimation of choice probabilities from choice based samples. *Econometrica: Journal of the Econometric Society*, 1977-1988.
39. Martinson, K. S., & Shelby, B. (1992). Encounter and proximity norms for salmon anglers in California and New Zealand. *North American Journal of Fisheries Management*, *12*(3), 559-567.
40. McConnell, K. E., & Tseng, W. C. (1999). Some preliminary evidence on sampling of alternatives with the random parameters logit. *Marine Resource Economics*, *14*(4), 317-332.
41. McFadden, D. (1973). Conditional logit analysis of qualitative choice behavior. P. Zarembka (Ed.), Frontiers in Econometrics, Academic Publishing, New York 105-142

42. NSAD (2015). National strategy for angling development: Angling product evaluation criteria. http://www.fisheriesireland.ie/550-angling-product-evaluation-criteria/file Accessed 07.09.2017
43. NSAD (2016). National strategy for angling development: Policy document for coarse angling. http://www.ncffi.ie/new/wp-content/uploads/2016/01/NSAD-Submission-Jan-2016.pdf Accessed 07.09.2017
44. Parsons, G. R. (2003). The travel cost model. In *A primer on nonmarket valuation* (pp. 269-329). Springer Netherlands.
45. Parsons, G. R., Massey, D. M., & Tomasi, T. (1999). Familiar and favorite sites in a random utility model of beach recreation. *Marine Resource Economics*, *14*(4), 299-315.
46. Peters, T., Adamowicz, W. L., & Boxall, P. C. (1995). Influence of choice set considerations in modelling the benefits from improved water quality. *Water Resources Research*, *31*(7), 1781-1787.
47. Provencher, B., Baerenklau, K. A., & Bishop, R. C. (2002). A finite mixture logit model of recreational angling with serially correlated random utility. *American Journal of Agricultural Economics*, *84*(4), 1066-1075.
48. Raguragavan, J., Hailu, A., & Burton, M. (2013). Economic valuation of recreational fishing in Western Australia: statewide random utility modelling of fishing site choice behaviour. *Australian Journal of Agricultural and Resource Economics*, *57*(4), 539-558.
49. Scarpa, R., & Thiene, M. (2005). Destination choice models for rock climbing in the Northeastern Alps: a latent-class approach based on intensity of preferences. *Land economics*, *81*(3), 426-444.Samuelson, P. A. (1948). Consumption theory in terms of revealed preference. *Economica*, *15*(60), 243-253.
50. Shaw, D. (1988). On-site samples' regression: Problems of non-negative integers, truncation, and endogenous stratification. *Journal of Econometrics*, *37*(2), 211-223.
51. Shaw, W. D., & Ozog, M. T. (1999). Modelling overnight recreation trip choice: application of a repeated nested multinomial logit model. *Environmental and Resource Economics*, *13*(4), 397-414.
52. Strayer, David L., Kathryn A. Hattala, and Andrew W. Kahnle. "Effects of an invasive bivalve (Dreissena polymorpha) on fish in the Hudson River estuary." *Canadian Journal of Fisheries and Aquatic Sciences* 61.6 (2004): 924-941.
53. TDI (2013). TDI Socio-Economic Study of Recreational Angling in Ireland http://www.fisheriesireland.ie/media/tdistudyonrecreationalangling.pdf Accessed 29.01.2018
54. Train, K. E. (1998). Over People. *Land economics*, *74*(2), 230-39.
55. Train, K. E. (2009). *Discrete choice methods with simulation*. Cambridge university press.

56. Yeh, Chia-Yu, Timothy C. Haab, and Brent L. Sohngen. "Modelling multiple-objective recreation trips with choices over trip duration and alternative sites." *Environmental and resource economics* 34.2 (2006): 189-209.

Appendix:

Table 1: Example Site Attribute Rating Table

Factor	Score/Level of Factor				
Accessibility to the site (this includes parking and ability to reach the location that you fished at.) Score from 1 = very difficult to access to 5 = easily accessed	1 Difficult to access	2	3	4	5 Easy to access
Size of fish at the site (On average does this site provide access to good sized fish) Score from 1 = small fish to 5 = large fish	1 Small fish	2	3	4	5 Large fish
Quantity of fish (on average does this site provide access to a large quantity of fish) Score from 1 = low quantity to 5 = high quantity	1 Low quantity	2	3	4	5 High quantity
Encounters with other anglers Score from 1= none to 5 = frequent	1 No encounters	2	3	4	5 Frequent encounters
Variety of fish species (are there a large variety of species of fish at this site) score from 1 = low level of variety of fish to 5 = high level of variety of fish	1 Little to no variety	2	3	4	5 Lots of variety
Local services (these include pub, shops, accommodation etc…) Score from 1 = low level of local services to score 5 = high level of services	1 Lacks local Services	2	3	4	5 Plenty of local services

This site attribute rating table was repeated for each of the five sites. The respondent was expected to rate each site they had ever attended

Table 2: Results of Kolmogorov–Smirnov tests

	Garadice n = 64	Killykeen n = 75	Dernaferst n = 49	Eonish n = 58	Church Lake n = 43
Access	0.002*	0.068	0.782	0.000*	0.226
Size	0.697	1.000	0.946	0.997	0.950
Quantity	0.845	0.459	0.914	0.647	0.688
Services	0.024*	0.813	0.338	0.850	0.515
Encounters	0.002*	0.006*	0.164	0.143	0.518
Variety	0.332	0.227	0.846	0.034*	1.000

*P-values reported. * denote significance at the 5% level, suggesting that for these attributes at a particular site the online cohort perceived the site differently to the on-site cohort. Critical values for the two sample K-S test were calculated using the sample size presented in the table at a significan* semru

Socio-Economic Marine Research Unit