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Are objective data a suitable replacement for subjective data in site choice analysis?

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Abstract

Random utility theory is founded on the concept that an individual selects the alternative that gives them the highest level of utility, given the individual's preferences and perception of a good. Discrete choice analysis, however, seldom uses an individual's perception of a good, instead, more convenient objective data are employed. This paper aims to explore the viability of objective data as a suitable replacement for subjective data in recreational site choice modelling. Random parameter logits are applied to coarse angling site choice data where two site attribute data sets are used; the first is comprised of users' perception of the site attributes and the second is composed of fishery managers' perspective of those same attributes. The results reveal that models based on the subjective data outperform those of the objective data. The derived welfare estimates indicate a divergence between the two sources of data in terms of the magnitude of the estimates but not direction. Further analysis is conducted to determine if the manager's objective ratings are measuring the sites using a similar set of criteria as the user's subjective ratings. The results suggest that the managers' perspective is closely aligned with the anglers' who frequent the sites most often.

Keywords: Subjective, Objective, Recreation, Random Utility Model, Manager, Angling

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1. Introduction

Economic theory suggests that a rational agent makes decisions based upon their perception of a good (Puto 1987; Singh 1988; Poor et al, 2001; Artell, Ahtiainen, and Pouta, 2013). A rational agent chooses a recreational site based on her perception of a site's attributes (Adamowicz et al 1997), she buys a house because of the perceived bundle of goods the house possess (Chasco and Gallo 2013), and she decides whether or not to partake in risky behaviour founded on her perception of the risk she will be subjected to (Brewer et al 2004). One might, therefore, conclude that the econometric analysis of site choice should be based solely on perception-based data, but this is seldom the case. Instead, objective measures are often used.

Objective measures of site characteristics are determined by a source external to the user, whereas subjective measures are based on users' own judgement of site attributes. In general, the literature has favoured objective data over the theoretically preferred subjective data. This predilection for objective data often stems from the comparative ease at which objective data can be collected (Baranzini, Schaerer, and Thalmann, 2010; Artell, Ahtiainen, and Pouta 2013) as collecting subjective data is often more time consuming, and costly. Outside of the academic literature subjective data is rarely used as a measurement for the quality of a good as the variance that is present in subjective data can make it more difficult to use in policy formation. As noted by Hynes et al. (2008), policy decisions are typically set in terms of objective measures of attributes indicating that a trade-off exists in what is more useful in terms of predicting recreationists' behaviour and the implementation of environmental policy.
This paper aims to explore the appropriateness of using objective data in place of subjective data when applied to a random parameter logit (RPL) site choice model for coarse[1] angling. At present, the academic literature is lacking in its exploration of the viability of objective data as a source of recreational site choice attribute levels, with only two papers (Adamowicz et al, 1997; Jeon et al, 2005) tackling this subject. This paper adds to the existing literature; by being the first site choice paper to compare models with identical variables from an objective data source and from a subjective data source and is also the first to compare models using identical attributes and a single choice set. This paper also presents a comparison of parameter estimates, willingness to pay estimates and compensating variation from site choice models applied to the objective and subjective data. This comparison is presented to examine if the objective ratings of site attributes are in line with the subjective ratings of the users of the resource and to determine the impact, if any, of using different sources of data on welfare estimation.

2. Literature review

The relative convenience of objective data has meant that the theoretically grounded subjective data (Baranzini, Schaerer, and Thalmann, 2010; Artell, Ahtiainen, and Pouta 2013) are seldom used in large-scale revealed preference choice-based analysis. In response, literature has developed, assessing the relationship between subjective and objective data, and the appropriateness of the use one source over another. This literature has been varied and spans across an assortment of models and applications. Hedonic modelling, for instance, has been used to determine the effect of air quality, water quality and noise pollution on house prices using both subjective and scientifically measured attribute levels (Poor et al, 2001; Chasco and Gallo, 2013; Baranzini, Schaerer, and Thalmann, 2010). Site choice models have been developed using both managerial perception and users' perception of site attributes (Adamowicz et al, 1997), as well as site choice models comparing the scientific measure of water quality and users' perception of water quality (Jeon et al, 2005). Kappa statistics were

[1] Coarse anglers fish for freshwater non-salmonid species, including tench, roach, bream, carp, eel, dace, perch, rudd, and hybrids.

used by Ma and Dill (2017) to test 'mismatch' between perceptions of neighbourhood bike-ability and objective data. Elsewhere, Farr et al (2016) compared the extent to which objective or subjective perceptions of water quality affected willingness to pay estimates for an improvement in water quality at the Great Barrier Reef. Across these papers, the unified aim was to test the merits of using a single source of data. Essentially, determining if there is value in collecting the more time-consuming subjective data when objective data are available.

The literature has taken two approaches to determine the need, or use, of incorporating subjective data into economic models. The first is a comparative method; researchers test if one source of data is superior to another in terms of predicting the dependent variable. Adamowicz et al. (1997) used several site choice models, half of which were applied to data comprised of users' perception of sites and the other half were applied to data of expert opinion. Models using users' perception performed better indicating that, given Adamowicz et al.'s (1997) data, users' perception of sites is a better indicator of site choice. Adamowicz et al (1997) also demonstrated that the compensating variation estimate differed between the data sources.

The second objective of the literature is to determine if subjective data adds explanatory power to a model. This was examined by Baranzini, Schaerer, and Thalmann (2010), who saw no improvement in their hedonic price model through the addition of perceived levels of noise. It was determined that scientifically measured noise pollution sufficiently captured the effects of noise on house prices. Baranzini, Schaerer, and Thalmann (2010) note that there was a convergence between the subjective data and scientific data; this may be an indication as to why no improvement was found.

Additionally, the literature has also taken more explicate steps to test convergence between subjective and objective data. The literature has used correlation coefficients (Baranzini, Schaerer, and Thalmann, 2010), and Kappa statistics (Ma and Dill, 2017; Kirtland et al, 2003), while others (Artell, Ahtiainen, and Pouta, 2013) have tried to establish the factors that are correlated with systematic divergence between the two data sources. Using bivariate probit and multinomial models Artell, Ahtiainen, and Pouta (2013) investigated the factors correlated with the divergence between a subjective and an objective measure of water quality. They found that water body type, the level of objective classification, and distance to the site were all correlated with a difference between subjective and objective measures of water quality. This reveals that, in some cases, perceptions may be altered by objectively measurable variables.

Much of the literature looking at this issue has dealt with non-identical attributes. The levels of precision of subjective measures are usually much less than scientific measures. Scientific measures can, for instance, determine the exact decibel level of a source of noise pollution whereas subjective measures are often limited to a Likert scale. Additionally, a scientific measure can be extended to attributes that are unknown to users. In these cases, a researcher can restrict the scientific data to an aspect of water quality that is known to the users. Jeon et al (2005) followed this protocol by restricting their comparison to water clarity. They compare the users' perception of depth visibility to scientifically measured water clarity. They found that user's perception deviated from scientific data but models including both scientific data and subjective data outperformed models using either one separately. Jeon et al. (2005) report that subjective measures of water clarity, as measured using their method, did not sufficiently describe the impact of water quality on site selection. An alternative to restricting the scientific data is to make a composite variable. This method was employed by Chasco and Gallo (2013) who made a composite index for both air quality and noise pollution to compare subjective and scientific data sources. They found that the subjective hedonic price model was preferred, with the objective model presenting counterintuitive signs for pollutants.

The literature has, in general, seemed to favour models based on subjective data. The inclusion of subjective data has been found to improve model fit (Jeon et al, 2005). Models solely using subjective data generally outperformed models using objective data (Adamowicz et al, 1997; Chasco and Gallo, 2013), or, in some cases, objective variables were found to have no statistically significant impact on the dependent variable (Farr et al, 2016; Lee et al, 2017). However, there are some examples where objective data outperforms subjective data (Poor et al, 2001; Baranzini, Schaerer, and Thalmann, 2010). With respect to site choice models, only two papers exist where subjective data are compared to objective data (Adamowicz et al, 1997; Jeon et al, 2005) and only Adamowicz et al (1997) uses multiple subjective site attributes. Although Adamowicz et al (1997) collected identical attributes from the two data sources the authors use different choice sets for the objective and subjective models as well as including different variables in each model. Jeon et al (2005) use the same choice set for both objective and subjective models but does not have identical attributes from both data source, and, consequently cannot have identical variables included in both models.

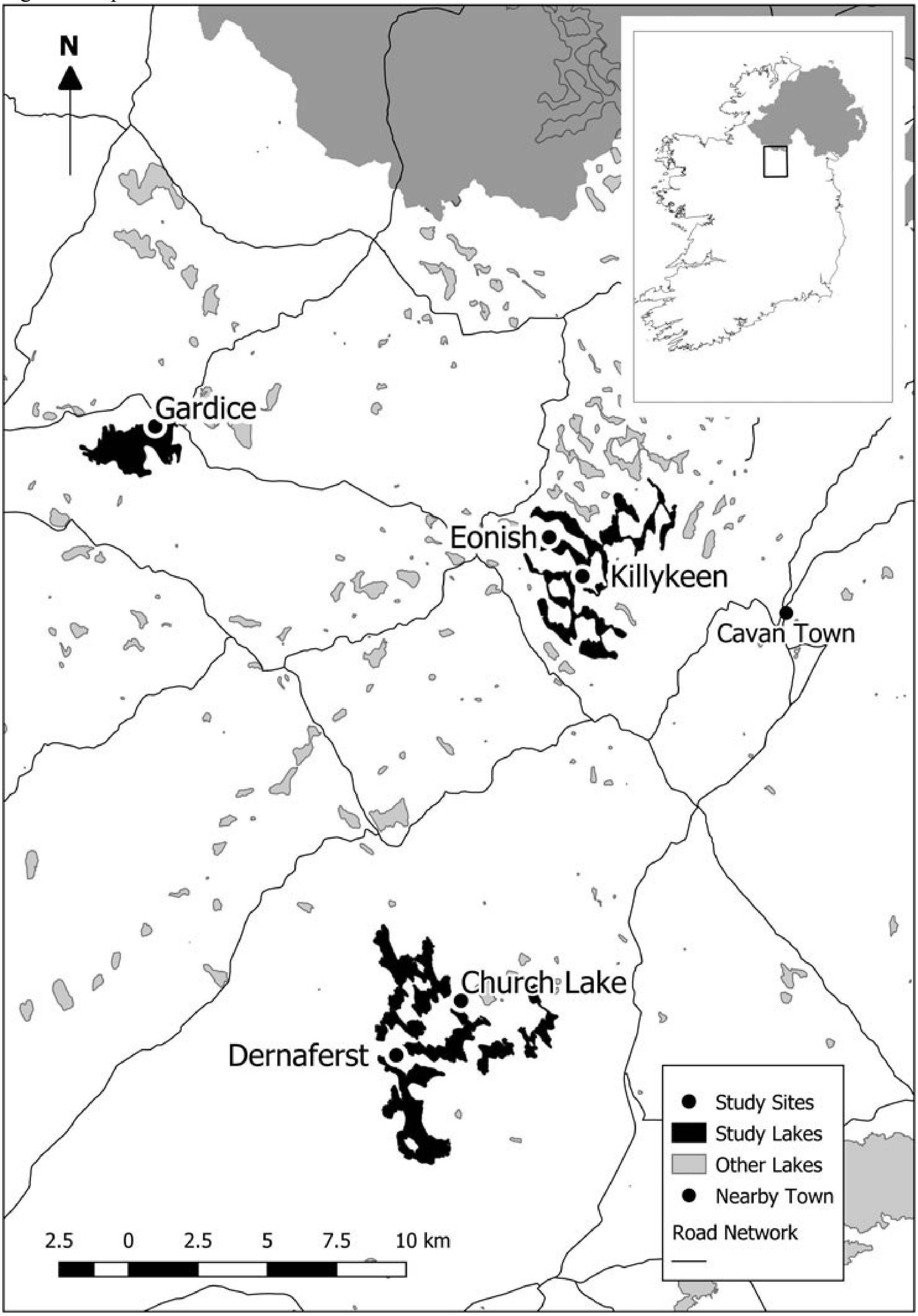
To the authors' knowledge, the comparison between identical measures of site attributes from objective and subjective data while incorporating preference heterogeneity in a site choice model or the use of identical measures and a single choice set has not been made in the literature. This paper adds to the existing literature by making both comparisons; using a RPL to account for preference heterogeneity. It also adds to the literature in a more general sense through further analysis of objective and subjective data.

3. Data

3.1 The Sites

The sites that comprise the researcher defined choice set (presented in Figure 1) are; Garadice, Killykeen Forest Park (referred to as Killykeen throughout this paper), Eonish, Dernaferst, and Church Lake. All sites are situated within the counties Cavan and Leitrim, in the Republic of Ireland, and both counties border Northern Ireland. Cavan and Leitrim were selected as this area is renowned for its coarse fishing due to the number of quality fishing sites available. As a result, there are multiple large fishing competitions held in both Cavan and Leitrim throughout the year. This area also has numerous fishing clubs indicating a strong contingent of enthusiastic anglers.

Figure 1 map of the sites of interest



Map display the study area and the five sites of interest

Garadice is a 3.9km lake situated in County Leitrim with multiple access points for boats and cars as well as parking beside fishing pegs[2]. Due to the layout of the lake, anglers can choose a fishing point that best suits the weather conditions on a given day, making it a popular year-round destination. Garadice is a popular site with both recreational anglers and match anglers, hosting large annual competitions and smaller club competitions year-round. Garadice is also the best developed of the sites, providing multiple toilet and showering facilities.

Killykeen, like the remaining three sites, is located in County Cavan. Killykeen provides a beautiful scenic area for anglers to fish from which is enveloped by a forest park with trails that draw non-anglers to the site. For the most part, anglers must walk from the car park to the fishing pegs. Although this is a short distance this may be inhibiting to the less firm or fit anglers, particularly given the large amounts of gear coarse anglers travel with. There are two main access points to Killykeen. These access points lead to either side of a reasonably narrow fishing stretch. However, simply due to the road network, it would take approximately 20 minutes to drive from one bank to the other. It is assumed, for analysis, that the respondent chooses the access point closest to their home. Fishing Quality was known to be particularly good at Killykeen as the coarse fish were drawn to the site by runoff from local chalets. Recently, these chalets have been shut down which may have impacted fishing quality.

Like Killykeen, Eonish is part of the Oughter water system. The fishing pegs on Eonish are all accessed by one road, that allows parking beside each peg. Eonish is one of the quieter sites as there is no park (Killykeen), play area (Dernaferst) or numerous recreational walkers (Garadice). Eonish also provides boat access and is in the closet proximity to accommodation of any of these sites with numerous lodges only meters from fishing pegs.

Dernaferst is a fishing site on the Gowna water system. It has two access points and a large parking area. A sizeable portion of the recreational fishing at Dernaferst takes place on the large boat ramp, allowing anglers to park a few feet from where they fish. Shore fishing can also be found a short walk away but requires the angler to carry their equipment through a field for a short distance. Dernaferst also provides a picnic area, children's park and toilet facilities.

Like Dernaferst, Church Lake is part of the Gowna water system. Church Lake has some of the poorest access of all the sites, with anglers having to climb over a step gate to reach the fishing pegs. Until recently, Church Lake was renowned for its great fishing. However, there seems to have been a downturn in recent years. Church Lake also has some of the deepest shore fishing of all the sites of interest. As coarse fishing is a year-round activity this may make Church Lake a much better winter fishing site than the other sites.

3.2 Subjective Data

Data were collected from 105 coarse anglers who fished in at least one of the five sites and was limited to residents of the Island of Ireland. Intercept surveying began on the 5th of August and ran until the 7th of November 2016 garnering 43 responses. Each of the five sites was visited multiple times during surveying, including both weekends and weekdays. The remainder of the surveys were completed online, which ran from the 6th of August to January 15th, 2017. The potential online participants were contacted through Irish coarse angling Facebook pages, by emailing local coarse angling clubs, and through the Inland Fisheries Ireland (IFI) newsletter. In order to increase the number of anglers participating in the survey who fish less frequently, local newspapers printed the details of the survey and how individuals could complete the survey online.

Due to the sampling procedures employed the data is likely to over represent anglers who fish frequently, in comparison to a random sampling framework sample. Anglers who frequent

[2] A peg is a cleared designated area an angler can fish from.

one or many of the five sites often have a higher probability of being sampled than their less avid counterpart. Although methods do exist to correct this avidity bias (Hindsley, Landry, and Gentner 2011), like other recreational site choice models (Hanley et al. 2011; Scarpa and Thiene 2005; Deely et al 2018) the requisite information is not available for the sites of interest and, as such, is uncorrected for. As a result, due care may need to be taken when interpreting the results and considerations may need to be given to the fact that the perceived data may be more representative of experienced anglers.

The respondents were asked to rate all the five sites they had attended on a one to five-point Likert scale for six different attributes. An example of the rating system used for each site, containing the attributes and levels, is presented in table 1. These attributes were chosen based on a review of the relevant literature (Curtis and Stanley 2016; Hynes, O'Reilly, and Corless. 2015; NSAD, 2015), expert opinion, and focus groups[3]. In particular, the attributes were chosen so that the respondent's task of rating the sites would closely resemble the product criteria evaluation carried out by the National Strategy for Angling Development (NSAD, 2015) without being too cognitively difficult for the respondents to complete.

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

[3] Three focus groups were organised to improve the quality of the survey. The first group was comprised of environmental economists who gave insight into previous surveys they had undertaken which informed the overall formatting of the survey. The second group were employees of IFI who have expert knowledge of coarse angling and the Irish product. They had a large impact on both attribute levels, wording and the site choice. The final group was of local anglers. These individuals provided insight into their perception of the importance of the attributes, their ability to complete the survey and proposed new wording for some attributes. The focus groups were followed by a pilot study.

This site attribute rating table was repeated for each of the five sites. The users were asked to rate each site they had ever attended. The managers were asked to give their managerial opinion on all sites.

The product evaluation criteria was chosen as it has previously been used as 'objective data' (Curtis and Breen 2017) and represents a good source of information on the important attributes of an Irish coarse angling site. The six site attributes selected were; *accessibility* (how easy it is to get to the location the angler will fish from), average *size* of fish caught at the site, average *quantity* of fish caught at the site, *encounters* (how often do they meet or see other anglers at the site), *variety* of fish species and *local services* (including shops, pubs, restaurants and accommodation). The five sites of interest, the chosen attributes and their means are presented in table 2.

Table 2: Mean Subjective and Objective Site Attribute Rating

Site	Access at Site	Size of Fish	Quantity of Fish	Local Services	Encounters with Other Anglers	Variety Of Fish
			Subjective Data			
Garadice	4.40 (.72)	3.28 (.73)	3.09 (.78)	3.37 (1.06)	3.37 (1.09)	3.40 (.77)
Killykeen	3.56 (1.12)	2.97 (.68)	3.37 (.93)	3.24 (1.04)	3.49 (1.09)	3.49 (.81)
Eonish	3.68 (.83)	3.05 (.48)	3.18 (.60)	3.22 (.83)	2.90 (.86)	3.38 (.65)
Dernaferst	3.48 (.83)	3.03 (.60)	3.20 (.66)	3.58 (.68)	3.29 (.82)	3.34 (.57)
Church Lake	3.12 (.74)	2.93 (.57)	2.87 (.67)	3.44 (.61)	2.86 (.77)	2.96 (.56)
			Objective Data			
Garadice	5 (0.0)	4.5 (0.5)	4.5 (0.5)	4 (1.0)	4 (0.0)	3.5 (0.5)
Killykeen	4.5 (0.5)	4 (0.0)	4.5 (0.5)	3.5 (0.5)	3 (1.0)	4.5 (0.5)
Eonish	4.5 (0.5)	4 (0.0)	4 (0.0)	4 (1.0)	2.5 (0.5)	3.5 (0.5)
Dernaferst	5 (0.0)	3.5 (0.5)	3.5 (0.5)	2.5 (0.5)	2.5 (0.5)	3.5 (0.5)
Church Lake	2.5 (0.5)	3 (0.0)	3 (0.0)	3 (1.0)	2 (0.0)	3.5 (0.5)

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

When filling out the survey the respondents were asked to report the number of trips they had taken to each of the five sites of interest in the 12-month period prior to completing the survey. Angling experience and demographic questions were also asked, including the hometown or village where each respondent lived. The travel cost variable is calculated using

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

Where travel distance is the distance from the individual's home to the fishing site, operating cost is equal to 0.2475 cent per kilometre[4] and opportunity cost is calculated as 33% of the individual's hourly wage (Parsons, 2003). Following Hynes, Hanley, and Scarpa. (2008) and Hanley et al. (2001), if an angler did not rate a site on any of the site attributes the missing value was set equal to the mean response of other anglers for that attribute.

3.3 Objective Data

The objective data were collected in the same manner as the angling product evaluation criteria (NSAD, 2015) using some of the same respondents and, coincidentally, the same method as employed by Adamowicz et al (1997). The two fisheries managers for the area containing the sites of interest were asked to rate the sites using an identical questionnaire as the one presented to the angler respondents. To ensure that the management perspective is as objective as possible a number of tactics were employed; firstly, to provide consistency between the NSAD measurements and the objective data used in this study, the managers who completed the NSAD survey, for the study area, were also asked to complete the present survey. Secondly, the managers were informed of the aim of the study and that comparison would be made between the management perspective, provided by them, and the users' perspective. This step was taken so that the managers understood that it is their perspective as a manager that was of concern to this study.

The decision not to use the product evaluation criteria already available from IFI was multifaceted. Firstly, the product evaluation criteria evaluated much larger areas than the sites the user respondents were expected to rate. These areas often encompassed multiple fishing sites, which would complicate estimates of travel distance as these areas frequently included sites miles apart. Secondly, the cost of getting management to rate the sites was negligible compared to the possible drop in respondent retention through the necessary expansion of the user survey to match the product evaluation criteria. And, finally, by getting management to rate the sites, an exact comparison between subjective and objective rating can be made[5]. Mean objective ratings are presented in the lower portion of table 2.

In order to test if the objective data can be considered to be from the same distribution as the subjective data, a Kolmogorov-Smirnov test was conducted. The test results are found in table 3. The results indicate that for the attributes *size*, *access* and *quantity* the objective data cannot be considered to be from the same distribution as the subjective data. A visual inspection of the objective and subjective ratings also reveals that objective ratings tend to be higher. In many cases, the objective ratings are above the mean of the subjective ratings by more than one standard deviation of the subjective data. This may explain why these variables failed the Kolmogorov-Smirnov test of equal distribution. The disparity between the two data sources is particularly evident for the variables rating the average *size* and *quantity* of fish at each site. In six of the ten cases the objective rating for *size* or *quantity* was more than one standard deviation above the mean of the subjective rating.

Table 3: Results of Kolmogorov–Smirnov tests

	Kolmogorov-Smirnov test statistic

[4] This is running cost of operating a medium sized vehicle according to Automobile Association of Ireland.

[5] Unfortunately, it is not possible to assess how closely the management rating and the NSAD product evaluation coincide; the NSAD areas include so many sites that it is impossible to know the contribution of any one site in order to compare them.

Access at Site	0.027*
Size of Fish	0.000*
Quantity of Fish	0.012*
Local Services	0.568
Encounters with other Anglers	0.113
Variety of Fish	0.104

*Note: P values reported, *indicates significance at the 5% level suggesting that for these attributes the expert opinion does not come from the same distribution as user's opinion.*

The variable *variety* has almost no variability suggesting that management view all the sites as having the same *variety* of fish species. This may render the objective variable *variety* unsuitable for predicting site choice. It is also unclear if management and users rated the variable *variety* using the same criteria. It may be the case that management rated each site based on the presence of different species or their abundance. This lack of *variety* could be due to management considering only the presence of the species. For the users, abundance might play a much more vital role in their rating, particularly for anglers who seldom fish at the sites of interest. One would expect that an angler would rate the *variety* of fish species based on the fish they have caught or heard of others catching, in this case, the abundance of each species could play a pivotal role in each anglers rating. In relation to the subjective data, a lack of variety between respondents is not a problem and as such models applied to this data set can support all site variables.

To test how attribute rating move between sites, for a given attribute simple correlation tests are employed, the results of which can be seen in table 4. A correlation coefficient of less than one indicates that a unit change in the objective rating of an attribute is not met with an equal change in the subjective rating. However, as the subjective rating varies between people, the expectation is that none of the variables will present with a coefficient of one, although a positive coefficient is expected for all variables.

Table 4: Correlation Statistics between Subjective and Objective Variables

	Pearson's correlation	Spearman's correlation
Access at Site	0.3175 (0.000)*	0.3267 (0.000)*
Size of Fish	0.1804 (0.000)*	0.3027 (0.000)*
Quantity of Fish	0.0662 (0.000)*	0.1418 (0.000)*
Local Services	-0.1867 (0.000)*	-0.2276 (0.000)*
Encounters	0.2501 (0.000)*	0.3220 (0.000)*
Variety	0.1008 (0.003)*	0.1141 (0.000)*

*Note: * indicates significance at 5% level. P values given in parenthesis.*

The correlation coefficients indicate that there is a consensus between the subjective and objective data on the direction of the ratings but no coefficient is close to one, meaning that the rates of change between sites vary. However, in the case of *services*, there is a negative and significant relationship demonstrating that users' perception of the quality of *services* near a site runs in the opposite direction to the objective data. Due to the difference in how these variables change between sites, as measured by the correlation statistics, there is an expectation that parameter estimates will vary between data sources.

3.4 Trip Frequencies

In total 2190 trip observations were taken to one of the five sites of interest. The mean and total number of trips taken to each site as well as the number of respondents who visited them can be seen in table 5. Garadice was the most popular site with almost as many trips taken there as the other four sites combined. Although seeing fewer trips, Killykeen was visited by the most anglers; just six more than Garadice. At the other end of the spectrum, Church Lake was visited by the fewest anglers and had the lowest mean number of trips. In general, those who went fishing at one of the sites of interest once a month, or once a week tended to spread out their site choice in a similar manner. However, for those who went fishing more than once a week, there is a strong preference for Garadice. In part, this may be due to local intraclub matches being held there, but also Garadice's ability to provide different fishing points that are distinct enough to make fishing more hospitable during any weather condition.

In order to test whether the perspective of the on-site cohort and online cohort were similar Kolmogorov–Smirnov tests were used to determine if they came from the same distribution. Although not present here, the test shows that the two cohorts' responses can be considered to be from the same distribution for all but 6 of the 30 attributes. These attributes are *access* at Garadice and Eonish, *services* at Garadice, *encounters* at Garadice and Killykeen and *variety* in Eonish. To account for this difference an interaction term is added to the analysis.

Table 5: Mean and Total Trips Per Site

	Number of anglers who have visited each site in the last 12 months	Mean Trips	Total Trips
Garadice	112 (60.22%)	11.49	1287
Killykeen	118 (63.44%)	5.47	645
Eonish	67 (36.02%)	4	268
Dernaferst	58 (31.18%)	5.48	318
Church Lake	42 (22.58%)	3.81	160

Note: Percentage of sample who visited each site is given in parenthesis. Mean number of trips refers to the average number of trips taken by anglers who visited at least once.

4. Methods

To test the suitability of objective data to accurately represent the sites as perceived by site users a number of procedures are undertaken. A RPL is applied to both the subjective data and objective data, measures of fit are compared between the models, as well as the number of correct predictions made by each model. Then, the magnitude and direction of the coefficients are compared between models to assess differences. Willingness to pay (WTP) estimates are used to compare welfare effects. Compensating variation is used to demonstrate, under the two different sources of data, the welfare loss to anglers from the closure of each of the five sites of interest. Finally, a further two datasets are created in order to examine if the perspective of the management is representative of the average perspective of the users.

4.1 Model

McFadden (1973) stated, through the use of a random utility model (RUM), that an individual will select the site that maximises her utility on a given choice occasion. This utility can be written as:

$$u_{in} = V(X_{in}, y_n - p_{in} \mid \theta_n, z_n) + \varepsilon_{in}$$
$$= V_{in} + \varepsilon_{in} \tag{1}$$

Where u_{in} is the utility that individual n receives from choosing site *i*, V is the indirect utility function, X_{in} is either a vector of subjective attributes or a vector of objective attributes, y_n is the income of individual *n*, p_{in} is the travel cost, θ_n is a vector of individual *n*'s characteristics and z_n are individual *n*'s covariates and ε_{in} is the stochastic error term and is unknown to the modeller. It is assumed that the error term is independent and identically distributed (IID) extreme value type 1. The resulting estimated parameters are homogenous across individuals; implying that every individual sampled has the same taste preferences (Train 1998). The RUM model takes the form of a conditional logit (CL) (McFadden 1973) when the error terms are independently and identically drawn from an extreme value distribution.

As noted by Train (2009), by decomposing the error term the restrictive IID quality of the CL is overcome. The decomposed error term has two distinct elements, the first is correlated over alternatives and is heteroskedastic, the second is IID over alternatives and individuals. The resulting model is the RPL. The utility equation with a decomposed error term can be written as:

$$u_{in} = V_{in} + [\eta_{in} + \varepsilon_{in}] \tag{2}$$

Where η_{in} is a zero mean random term, which may be correlated across alternatives, and individuals, ε_{in} remains IID. The decomposition of the error term allows the parameter estimates to vary randomly across individuals but remain homogenous across choice occasions for an individual. The probability of individual *n* selecting site *i* is logit and can be written as:

$$\Pr(i) = \frac{\exp(\mu V_{in} + \eta_{in})}{\sum_{k=1}^{j} \exp(\mu V_{jn} + \eta_{jn})} \tag{3}$$

where μ is a scale parameter and η_{in} can take on a number of distributional forms (Hensher and Greene 2003), which must be specified by the modeller. Assuming that η_{in} takes a multivariate normal distribution, it can be written that:

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

where $\bar{\beta}$ is the mean of the parameter and **Ω** is the variance-covariance matrix.

Accommodating for an unbalanced panel data the logit is integrated across all values of η_{in}, with appropriate density weightings. This forms the unconditional choice probability and can be written as:

$$\int \prod_{t=1}^{t=T(n)} \frac{\exp(\beta_{in} + \eta_{int})}{\sum_{j=1}^{j} \exp(\beta_{jn} + \eta_{jnt})} \varphi(\bar{\beta}) d\beta_n \tag{4}$$

Where T(n) is each respondent's revealed preference, $\varphi(\cdot)$ is the multivariate normal density, $\bar{\beta}$ and **Ω**, the mean and variance parameters, are estimated from the sample data.

4.2 Welfare estimates

Two methodological approaches to estimating welfare are employed in this paper. The first is willingness to pay estimates (WTP) and the second is compensating variation (CV). WTP estimates measure marginal value. WTP estimates are calculated following Train (2009):

$$WTP = \frac{\beta_n}{-\beta_{tc}} \qquad (5)$$

Where β_n is the coefficient of the attribute of interest for individual *n* and -β_{tc} is the negative of the travel cost coefficient, which, here, represents the marginal utility of income. In the context of this paper, WTP estimates have an added advantage. WTP estimates are standardised into a monetary value. This standardisation allows for a meaningful comparison across models.

The second method used is CV. CV determines the amount of money an individual would have to pay or receive for their utility to be unchanged after a change to a site in their choice set. Following Hanemann (1982) CV is calculated as:

$$CV_n = -(\beta_{tc})^{-1}\left[\ln\left[\,\Sigma \exp(\hat{\beta}_n x_n^1\right) - \ln[\Sigma \exp(\hat{\beta}_n x_n^0)]]\right] \qquad (6)$$

The negative of the travel cost coefficient β_{tc} represents the marginal utility of income, which in the models presented in this paper is fixed across all individuals. $\hat{\beta}_n$ is a vector of parameters for individual *n*. x_n^0 is either a vector of subjective site attribute or objective site attributes and x_n^1 is the same vector after some exogenous change to the site. For RPLs CV must be integrated over simulated taste distributions (Train 1998):

$$\widetilde{CV} = \int CV_n \varphi(\hat{\beta}, \widehat{\Omega})\, d\beta$$
$$= \int\{-(\beta_{tc})^{-1}\left[\ln\left[\,\Sigma \exp(\hat{\beta}_n x_n^1\right) - \ln[\Sigma \exp(\hat{\beta}_n x_n^0)]]\right]\, \varphi(\hat{\beta}, \hat{\Omega})\, d\beta$$
(7)

CV, in this paper, focuses on the closure of each of the five sites individually is presented as the average per person per choice occasion. State zero is the value of all five sites to an individual *n* and state one is the value of four of the sites to the same individual. Although it is conceivable that a site could be estimated to have a negative value to any one individual, it is assumed that an individual cannot be made better off by the closure of a site and as such all negative values are set equal to zero.[6] Additionally, although the researcher defined choice set is comprised of five sites, each individual's choice set can, and more than likely do, contain more sites.

[6] Negative cases range from 1 at Killykeen using the extended subjective model to 32 at Church Lake using the objective model. Nearly 50% of the sites are all three models had less than 10 cases where the value was less than zero.

4.3 Model comparison procedure

Parameters are estimated for three models; the first model is applied to the objective data, the second model is applied to the subjective data based on the same set of attributes as in the first model, the final model uses an extended set of parameters that could not be used in the model applied to the objective data. Comparison is made both between the estimated parameters of each model, and between their corresponding welfare estimates. The second stage of comparison is to determine if the subjective data can replicate the findings of the objective data, through a number of logical contractions of the subjective data. The aim of this comparison is to determine if the managers and the users are rating the site attributes using the same criteria. If this is the case then a strong argument can be made that the added variability of the subjective data, assuming a better fitting model, allows for more precise estimation of real-world preferences. For this comparison, two adjustments to the dataset were used to create new attribute levels with accompanying site choice models. The first was a simple averaging of the subjective data. Through the use of this averaged subjective data hypothesis tests are conducted to determine if the coefficients of the objective data align with the coefficients from the site choice model applied to the average ratings of the attributes. A second and maybe more plausible consideration is that management perspective is more closely aligned with the anglers who fish at these sites most often. To test this hypothesis the observations in the dataset are reweighted by the number of trips an angler has taken to each of the five sites, in essence, the more often an angler went fishing the heavier their weight. As the survey was not conducted using a random sampling framework the sample is composed of more avid anglers than the national average. This combined with the weighted mean system employed could result in a data set that is much closer to the views of the more avid angler than would be expected from a national survey. Consequently, due care should be taken when interpreting the results.

5. Results

The first model (column 1 in table 6) is a RPL applied to the objective data. Two of the site attributes have been excluded from this analysis; *variety* because it lacked variance across the sites and *encounters* due to collinearity issues. In the case of a site choice model a dummy variable, indicating whether the angler completed the survey online, cannot be fit directly to the model as there would be no variance between sites for an individual. Consequently, the interaction term *access: online*, is used to capture differences between the online cohort and the onsite cohort. It is constructed by multiplying a dummy variable indicating that the survey was completed online with the variable *access*. This interaction term shows heterogeneity in the mean, indicating that, in the event of a significant coefficient, the average of the online cohort has a statistically different preference to the onsite cohort for *access*. The second model is a replication of the first model applied to the subjective data. This allows for a direct comparison between the two models. The third model is the extended model given the subjective data. The subjective data set has much more variability than the objective data; this allows for the inclusion of all the site attributes thought to impact site choice as well as alternative specific constants for each site.

Table 6: Results of Random Parameter Logits

	Objective Model	Reduced Subjective	Extended Subjective
	Mean of Coefficient	Mean of Coefficient	Mean of Coefficient
Random Parameters			
Access at Site	0.657 (0.277)***	0.828(0.075)***	0.569(0.092)***
Size of Fish	1.372(0.420)***	0.399(0.108)***	0.307(0.116)***
Quantity of Fish	0.847(0.277)***	0.263(0.094)***	-0.004(0.092)

Local Services	-1.025 (0.241)***	-0.394(0.094)***	-0.510(0.095)***
Encounters with other Anglers	-		-0.165(0.080)**
Variety of Fish	-		-0.287(0.117)**
Fixed parameters			
Travel cost	-0.092 (0.008)***	-0.074(0.007)***	-0.066(0.009)***
Killykeen			-0.472(0.172)***
Eonish			-0.882(0.163)***
Dernaferst			-0.804(0.164)***
Church Lake			-0.797(0.197)***
Heterogeneity in mean, parameter:			
Access: Online	-1.056 (0.226)***	-0.379(0.159)**	-0.321(0.122)***
Model fit			
Log likelihood function	-2131.05	-2110.03	-2062.77
Akaike information criterion	4282.09	4240.07	4161.53
Bayesian information criterion	4355.105	5303.829	4292.95
Akaike weight w_i			
Correct Predictions	27%	30%	32%

*Notes: Figures in parenthesis are standard errors. *** indicates significant at 1%, ** indicates significant at 5% and * indicates significant at 10%*

The best fitting model is the extended subjective model as it has the log-likelihood function that is closest to zero. This is to be expected in some respects; it should be the case that the extended subjective model should outperform the reduced subjective model as it has additional parameters. In this case, the Akaike information criteria (AIC) (Akaike 1998) and the Bayesian information criteria (BIC) (Schwarz 1972) may be a more appropriate measure of fit as both add penalties for the number of parameters estimated. Both the BIC and AIC also indicate that the best fitting model is the extended subjective model. The extended subjective model also predicts the correct site choice in the largest percentage of cases, predicting the right site choice in 32% of choice occasions. This is 2% more often than the reduced subjective model, and 5% more often than the objective model

A comparison of the three models shows that in all cases but one direction is identical across parameter estimates. The variable *Quantity of fish* is significant in both reduced models but not in the extended subjective model. For all three models the *travel cost* parameter is negative and significant, suggesting that, all else being equal, anglers will choose to visit the site with the lowest travel cost. The results of all three models also indicate that *access* plays a significant role in site choice. However, the significance of the interaction term *Access: online* indicates that the online cohort have a statistically different preference for *access* than the onsite cohort. There are some reasonable explanations as to why this may be. *Access* may be correlated with general activity at the fishing site. Good *access* may be correlated with high volumes of recreational activities other than fishing; examples of recreational activities that occur at some of the sites of interest are dog walking, cycling, kayaking, and picnics. This level of activity may be a deterrent for some of the sampled anglers. It may also be the case that the scenery or atmosphere of the fishing site is detracted from, in some way, by the development of *access*. All of which could make a site less appealing for certain anglers.

Across all models *local services* play a negative and significant role in site choice indicating that anglers tend to pick sites that are away from good local services. This may suggest that the more appealing sites are more remote and further away for bigger towns or villages. The *size of fish* variable had a positive and significant role in all three models, indicating that anglers prefer sites with bigger fish. The effect that average *quantity of fish* played on site choice differed between the models; it was positive and significant for the objective model and the reduced subjective model but non-significant for the extended subjective model. The significance of the standard deviation suggests that there are some individuals that prefer sites with larger quantities of fish while others prefer sites with smaller quantities of fish. However, with this variable, and all others used in this analysis, a somewhat strong assumption is that all attributes are considered when choosing a fishing site. It may well be the case that for some anglers, or even just some choice occasions for individual anglers, the *quantity of fish* did not play a role in their decision on where to go fishing resulting in them choosing a site that has, by their own estimation, a lower *quantity of fish* than other sites. This could result in a coincidental correlation between site choice and low rated *quantity of fish* rather than a purposeful decision to choose a site where they have a lower chance of catching a fish.

The extended subjective model contains a number of variables not contained in either the objective or reduced subjective models. Both *variety of fish* species and *encounters with other anglers* are included in the model. *Variety* seems to play a positive role in site selection, indicating that anglers prefer sites with more species of fish. *Encounters with other anglers* has a positive effect indicating that anglers tend to pick sites where there is a good chance of meeting other anglers. It is worth considering that there may be an endogeneity issue as there is likely correlation between *encounters* (or more accurately number of anglers at a site) and being sampled. The extended model also contains four alternative specific constants. The ASCs are all negative and significant implying that these sites possess attributes that negatively affected site selection in comparison to Garadice, the base case, which are unaccounted for by the other variables presented in the model. Conversely, Garadice may contain positive attributes that the other sites do not. Garadice seems to hold certain attributes that were not quantifiably measured that may have induced this result. For instance, as there are multiple points to fish around Garadice an angler can be assured some level of shelter from the weather regardless of wind direction. It was also a popular spot for local angling clubs, often booking pegs for regular intraclub matches.

In order to test the similarity of the estimated parameters across models, simple hypothesis tests are employed. Following Clogg (1995), hypothesis testing was conducted using the formula …

$$Z = \sqrt{\frac{\beta_1 - \beta_2}{SE\beta_1{}^2 + SE_{\beta_2}{}^2}} \quad (8)$$

Where β_1 and β_2 are parameter estimates of the same variable from two different models and $SE_{\beta_1}{}^2$ and $SE_{\beta_2}{}^2$ are the respective coefficient variances.

Table 7 shows the results of the hypothesis tests. A P-value of less than 0.05 signifies that the null, $\beta_1 = \beta_2$, can be rejected. The results indicate that the coefficient estimates from the objective model are statistically different to the estimates provide by the subjective models for almost all variables; four of the six estimated coefficients are different when comparing the results of the objective model against the reduced subjective model and five of the estimated coefficient are different from the objective model to the extended subjective model. In comparison, only two of the estimated coefficients are statistically different from the reduced subjective model to the extended subjective model. These results seem to suggest that, for our samples, parameter estimates do vary based on the source of the data.

Table 7: Equality of Coefficient Hypothesis Testing

Variable	Objective versus reduced	Objective Versus extended	Reduced versus extended
Access at Site	0.549	0.762	0.029*
Size of Fish	0.025*	0.015*	0.562
Quantity of Fish	0.046*	0.004*	0.042*
Local Services	0.014*	0.047*	0.385
Travel Cost	0.091	0.031*	0.483
Access: Online	0.014*	0.014*	0.773

Note: P-value reported, * denotes significance at 5% level.

5.2 Welfare estimates

WTP estimates are presented in table 8. Each estimate was computed using the Krinsky-Robb method (Krinsky and Robb 1986) with 5,000 draws. Estimates for interaction terms follow the approach used by Nahuelhual, Loureiro, and Loomis (2004):

$$WTP = \frac{\beta_r + \sum_i \frac{\beta_{r*it\,i}}{n}}{\beta_{tc}} \quad (9)$$

Where β_r is the random coefficient (i.e. *access*), $\beta_{r*it\,i}$ is the interaction term for individual *i,* that is associated with that random coefficient (i.e. *access: online*), n denotes the sample size and β_{tc} remains the marginal utility of income.

Table 8: Willingness to Pay Estimates (€ per choice occasion)

Attribute	Objective Model	Reduced Subjective Model	Extended Subjective Model
Access at Site	7.11(1.22 , 13.33)	11.17(8.68 , 7.83)	8.61(5.25 , 13.87)
Size of Fish	14.84(5.94 , 24.66)	5.38(2.52 , 8.57)	4.64(1.22 , 9.02)
Quantity of Fish	9.16(3.33 , 15.82)	3.55(1.03 , 6.35)	-0.50(-2.79 , 2.94)
Local Services	-11.08(-16.49 , - 5.97)	-5.31(-8.13 , - 2.74)	-7.71(-10.94 , - 5.04)
Encounters with Other Anglers			2.49(0.16 , 5.45)
Variety of Fish			4.33(0.72, 8.81)
Access: online	-4.31(-10.21 , - 1.91)	6.06(3.57 , 9.28)	3.74(0.39 , 9.00)

Note: 95% confidence intervals in parenthesis

For all but two variables the estimates are of the same sign. The WTP estimates for *quantity of fish* is negative but non-significant from the subjective extended model results but positive and significant from the two smaller models. This ranged from -€0.50 in the extended subjective model to €9.16 in the objective model. *Access: online* has a negative WTP estimate from the objective model but a positive WTP estimate from the models applied to the subjective data. The estimates from the objective data indicate that anglers who completed the survey online have a negative WTP of €4.31 for an increase in *access*, whereas the estimates based on subjective data results in WTP of €6.06 and €3.74 for the reduced and extended models, respectively. Although a negative WTP for an increase in *access* may seem counter-intuitive this may suggest a more complex relationship between the use of the site by non-anglers and the sites desirability for anglers.

WTP estimates for *Local Services* were negative for all three models, indicating in each case, that anglers are willing to pay for a reduction in *local services*, although it is more likely that this may be acting as a proxy for remoteness. Across all three models, anglers have a positive WTP for an increase in the *size of fish* at a site. This ranges from €4.64 in the subjective model to €14.84 in the objective model.

The remaining estimates for the extended subjective model show that there is a positive WTP for both *variety* and *encounters*. As indicated by the significant standard deviation estimate of the RPL model, for some anglers the level of *encounters* may be a deterrent and a positive draw for others. In particular, it would be expected that anglers who regularly fish in competitions or are members of local clubs will have a strong correlation between *encounters* and site choice. The remaining alternative specific constants are not shown here but mirror the results of the RPL model. All four have negative WTP, suggesting that an angler would have to be compensated to pick one of these sites over Garadice.

*Table 9: Compensating Variation for Site Closure (*per person per choice occasion, €)

Site closure Objective Model		Reduced subjective Model	Extended subjective model
Garadice	57.54 (45.08, 70.00)	48.78 (38.39, 59.17)	52.39 (42.25, 62.53)
Killykeen	64.50 (55.27, 73.73)	49.03 (41.15, 56.91)	51.88 (44.33, 59.43)
Eonish	45.56 (37.41, 55.71)	34.92 (27.29, 42.55)	32.19 (25.56, 38.82)
Dernaferst	33.82 (27.18, 40.46)	27.47 (19.84, 35.10)	27.70 (21.50, 33.90)
Church Lake	14.65 (9.96, 19.34)	16.59 (12.38, 20.90)	13.87 (9.91, 17.83)

Note: 95% confidence intervals given in parenthesis.

The average, per person, per choice occasion, welfare loss from a site closure, displayed in table 9, is similar for each site across all models. The ranked order of the sites, in terms of CV, is almost identical across the three models with the exception that; Killykeen has the largest CV, and Garadice has the second largest CV in objective and reduced subjective models, whereas the reverse is true for the extended subjective model. In all cases but one, the value of CV for a site closure is larger for the objective model than either of subjective models. CV for the closure of Church Lake is larger in the reduced subjective model than the objective model. However, the difference between these estimates is not large with the greatest difference being between the CVs for Killykeen from the reduced subjective model to the objective model. In this case the objective model estimate is 31% larger than the reduced subjective model.

The top two most visited sites, Garadice and Killykeen, were also the sites that would need the greatest compensation for their closure. Compensation for a closure of Garadice ranges from €48.78 to €57.54 per trip and compensation for Killykeen ranges from €49.03 to €64.50. The two sites that would cost the least, in terms of CV, if the sites were closed are; Dernaferst and Church Lake. These were also the two sites visited by the lowest number of surveyed anglers; however, Eonish received a lower number of total trips than Dernaferst. In part, Dernaferst and Church Lake had the lowest CV because the average sampled angler had to travel the furthest to reach these sites.

Compensation for the closure of the sites to the sampled anglers for the survey year ranged from €30,375 for the closure of Church Lake based on the results of the extended model to €141,255 based on the results of the objective model. However, these results are based on a sample that could be overrepresented by the most eager anglers and, as such, due care should be taken when interpreting these results.

5.3 Management Perspective and the Average Angler

Table 10 shows the results of the reduced objective model (repeated from table 6), the unweighted mean model, and the weighted mean model. The results of the data set comprised of anglers' mean perception seem unlike any other model presented in this paper. Although the direction of the parameter estimates is the same as all the previously presented models the magnitudes differ greatly. The most striking is the parameter estimate for the variable *Size of Fish;* it is estimated to be over six times greater than either the objective or weighted mean models. This may be the result of the averaging process reducing variability across the sites; the difference between the site with the largest fish and the smallest fish is 0.35 on the five-point Likert scale. Consequently, if an angler chooses one site over another, based on *size*, they are making a decision based on a small change in average *size*, which in turn produces a relatively large coefficient for a one-unit change in *size*.

Table 10: Results of RPL applied to Mean and Weighted Mean data sets

	Objective Model	Mean Model	Weighted Mean Model
	Mean of Coefficient	Mean of Coefficient	Mean of Coefficient
Random Parameters			
Access at Site	0.657 (0.275)***	0.323(0.573)	0.182(0.200)
Size of Fish	1.372(0.420)***	8.308(1.903)***	1.264(0.697)***
Quantity of Fish	0.847(0.277)***	2.028(0.601)***	2.849(0.717)***
Local Services	-1.025 (0.241)***	-2.60(0.414)***	-1.208(0.280)***
Fixed parameters			
Travel cost	-0.092 (0.008)***	-0.130(0.0145)***	-0.088(0.014)***
Heterogeneity in mean, parameter:			
Access: Online	-1.056 (0.226)***	-0.800(0.292)***	-0.952(0.256)***
Log likelihood function	-2131.05	-2084.17	-2073.81

Akaike information criterion	4282.09	4188.35	4167.61
Bayesian information criterion	4355.11	4261.36	4240.62

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

The weighted mean model produces results that are similar to the objective data, with all but one variable having overlapping confidence intervals. In the case of the variable whose confidence intervals do not overlap, *Quantity of Fish,* the WTP, although not presented here, do overlap. This level of similarity is not found between any two other models, even the reduced subjective and extended subjective models do not share overlapping confidence intervals for two of their variables. This may reveal that management perspective is more closely aligned with anglers who spend a lot of time fishing these waters. It may, in fact, be the case that the less experienced anglers, who make up a small but not negligible portion of the weighted mean sample, may pull the results away from the objective model results. Although alternative specification of contracting the subjective data set could have been attempted, like removing all anglers who have only been fishing for a certain period of years, or taken less than a certain amount of trips, these tests were not conducted as cut-offs would be arbitrary and not informed by any *apriori* assumptions.

Hypothesis tests are applied to the results of the objective model and the models of the newly created samples and presented in table 11. Comparisons are made between the objective model results and the mean sample model results, as well as between the objective model results and the weight mean model results. The null hypothesis that $\beta_1 = \beta_2$, where β_1 is the estimated parameter of a particular variable from one model and β_2 is the estimated parameter of the same variable estimated from a different model, can be rejected if P is less than 0.05. In the comparison between the objective and mean model result, the hypothesis tests indicate that $\beta_1 = \beta_2$ can be rejected for half of the variables. This result is slightly better than the earlier comparison between the objective model results and two subjective model results. Although it should be noted that the absolute difference between the estimated parameters is much larger when comparing the objective model results against the mean model results as opposed to the objective model results against either of the subjective model results. The results of the comparison between the coefficients of the objective and weighted mean models reveal that for all but one variable we fail to reject the null hypothesis. This result indicates a level of similarity that is not found between any other two models estimated within this paper and may suggest that the results of models applied to samples of objective data may be similar to the results of models applied to samples of data giving heavier weight to frequent users.

Table 11: *Equality of Coefficient Hypothesis Testing*

Variable	Objective versus Mean	Objective Versus Weighted mean
Access at Site	0.599	0.162
Size of Fish	0.000*	0.894
Quantity of Fish	0.074	0.009*
Local Services	0.001*	0.620
Travel Cost	0.022*	0.804
Access Online	0.488	0.760

P-value reported, * denotes significance at 5% level

6. Discussion and Conclusion

The prevalence of objective data used in the recreational, environmental and hedonics literature could lead to biased estimates. It has been argued (Puto 1987; Singh 1988; Poor et al, 2001; Artell, Ahtiainen, and Pouta, 2013) that economic agents act based on the perception of the bundle of attributes a good (site) possess. Additionally, the use of objective data instead of subjective data may lead to poor policy development and implementation if there is dissonance between objective measure and users' opinion. It is then worth assessing if the objective data used are a reasonable substitute for the perceptions it is believed decisions are based on. This paper has compared two contrasting sources of data for revealed preference discrete choice analysis; objective and subjective site attribute ratings, to determine if objective data is indeed a reasonable substitute when subjective data is unavailable.

RPL models were applied to both sources of data resulting in three different models; an objective model, a comparable 'reduced' subjective model, and an extended subjective model. The reduced subjective model is a direct replication of the objective model in terms of variables. The extended subjective model incorporates the variables excluded from the reduced subjective model and alternative specific constants. Parameter estimates were used to compute willingness to pay for an increase in site attributes, as well as compensating variation for the closure of each site.

The results reveal that both subjective models outperform the model based on objective data; a finding in accordance with Adamowicz et al (1997). For all but one variable the direction of estimated parameters is the same across all three models. However, the magnitude of the parameters differs substantially, with hypothesis testing demonstrating that most coefficient estimates are not statistically equivalent.

The confidence intervals of the willingness to pay estimates overlapped in only one of the variables found across all three models. However, some differences are to be expected. The extended subjective model includes variables that are not present in the other two models. In many cases this should reduce omitted variable bias, which in turn affects parameter estimates and therefore WTP estimates. The compensating variation estimates demonstrate that the rating of the sites, in terms of how much it would cost to compensate an angler for a site's closure, remains similar regardless of the source of the data. In contrast to Adamowicz et al (1997)'s finding, the CV estimates for the objective data indicate that a greater compensation would need to be paid for site closure. Adamowicz et al (1997) state that, in the case of their data, the higher CV for a site closure is due to the fact that, on average, the subjective data had a higher rating. In the instance of the current data, the objective data had the higher rating and the higher CV.

Comparison between the results of the objective data and the mean and weighted mean models seem to demonstrate that the objective data, based on management perspective, is most closely aligned to the anglers who fished the sites most often. This has an intuitive appeal as one would expect the management to have a similar view of the sites as those who frequent it most often. It may also suggest that the two data sets are fundamentally using the same criteria to value the sites. It could be the case that this type of objective data is an appropriate substitute for avid angler data but may be less suitable for data of those anglers who have spent less time at each site.

For the purpose of practical application, we find that the welfare estimates presented from the results of the objective model are in many respects similar to the results of the subjective data. The direction and significance of most parameter estimates are the same across the models, as are the willingness to pay estimates for a marginal change of a site attribute. Additionally, the ranked order of the CV for a site closure was almost identical across the three main models.

The real difference between the objective and the subjective was the magnitude of the parameter estimates which in turn dictate the magnitude of the welfare estimates. In most case the objective estimates were higher than the subjective estimates; often to a degree that meant the objective parameter estimates could not be considered to be the same as the subjective estimates. The consequence of this on policy may be nuanced but there is a consistency between the objective and subjective results that could result in the similar policies being implemented; both data sets suggest the same attributes are positive or negative and the ranked order of site values in terms of CV are the same. However, estimates based on objective measure, as used here, could result in an overly generous estimate of the value placed on coarse angling within Ireland. It is also important to reiterate that, because of the sampling techniques used, the sample may over represent the keenest anglers and as such these results may not be representative of the national view.

The benefits of the subjective data are not to be overstated; Hynes et al. (2008) cautioned that while they used subjective ratings in their site choice analysis doing so meant that “there could be a potential trade-off between possible bias (if the use of subjective measures leads to endogeneity) and a loss of efficiency (if the loss of information from moving from the individual to some sort of average or objective measure is important)”. The authors suggest that the direction of the possible bias will depend on whether the respondent overestimates or underestimates the true value of the quality of the site attribute. This bias may be low in cases where respondents are very familiar with the good.

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