Title	Combining actual and contingent behaviour data to estimate the value of coarse fishing in Ireland
Author(s)	Deely, John; Hynes, Stephen; Curtis, John
Publication Date	2019-03-15
Publication Information	Deely, John, Hynes, Stephen, & Curtis, John. (2019). Combining actual and contingent behaviour data to estimate the value of coarse fishing in Ireland. Fisheries Research, 215, 53-61. doi: https://doi.org/10.1016/j.fishres.2019.03.008
Publisher	Elsevier
Link to publisher's version	https://doi.org/10.1016/j.fishres.2019.03.008
Item record	http://hdl.handle.net/10379/15198
DOI	http://dx.doi.org/10.1016/j.fishres.2019.03.008

Combining actual and contingent behaviour data to estimate the value of coarse fishing in Ireland

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Abstract:
The use of contingent behaviour style questions enables the presentation of scenarios that extended beyond previous experience, making it a valuable tool for the examination of a change in policy or management practices. This study uses anglers' responses to contingent behaviour survey questions, in combination with actual trip frequencies, to examine the effects of a change in fish quality on users and non-users of Garadice, an Irish coarse fishing site. Respondents, from an onsite and online survey, were asked how many more days they would spend fishing at Garadice if the number of specimen fish increased by 25% or 50%, or if the quantity of fish increased by 25% or 50%. Estimates indicate that the average consumer surplus for a day spent fishing is €93 per day. The marginal benefits from the contingent behaviour changes range from €50.86 for a 25% increase in the quantity of fish to €89.01 for a 50% increase in the quantity of fish.

Keywords: Contingent Behavior; Travel Cost; Combined Stated and Revealed Preference; Angling; Fishing Quality

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1. Introduction

Fishing quality, indicated by both the size and quantity of a fish stock, is generally considered to be an important determinant of angler participation. This assertion has been tested in a multitude of ways, from the use of site attribute variables such as, size, quantity, catch or simply quality of angling experience in site choice models (see Hunt 2005 for a review of the application of site choice model to fishing sites) and travel cost applications (Bilgic and Florkowski, 2007; Shrestha et al., 2002; Du Preez and Hosking, 2011) to explicit scenarios in contingent valuation (Rolfe and Prayaga, 2007) and contingent behaviour models (Alberini et al., 2007; Prayaga et al., 2010). However, these studies have produced mixed results, with some indicating that size and/or catch are positive corollaries of participation (Bilgic and Florkowski, 2007; Shrestha et al., 2002; Du Preez and Hosking, 2011) while others have not found a statistically significant relationship between size and/or catch and participation (Alberini et al, 2007; Prayaga et al., 2010).

Even if it assumed that an increase in fishing quality does have a positive impact on angler participation the distinction between the size of fish being the driver of increased participation or quantity being the primary reason for an increase in fishing days may have important implications for the angling community. Fisheries managers implement policies and practices based on the needs of the angling community. Legislation in many countries dictates how an angler can fish to preserve or improve some aspect of fishing quality. For example, it is common practice that countries will legislate how many fish can be kept and what size these fish can be. The primary goal of these laws is to maintain or improve fish numbers and to allow the larger fish to spawn or the juveniles a chance to reach reproductive age. However, these laws may come at a cost to the anglers who may wish to keep more, or larger fish than is permitted. It may then be of interest to policymakers to determine if both size and quantity of fish are important to anglers or if only one or neither is. Further to this, sufficient changes in both welfare and angler participation as a direct consequence of changes to fishing quality may point to the economic viability of stocking practices.

The principal aim of this paper is to determine if angler participation would change with an increase in either the number of specimen fish or the quantity of fish and what additional consumer surpluses (CS) are associated with these changes. To accomplish this, the contingent behaviour (CB) method is employed. The focus of this study is coarse anglers[1] who fish in Lake Garadice, a fishing site located in the north of the Republic of Ireland. Substantial benefits may arise from a comparison between a change in fish quantity to fish size in an Irish context as a report presented by Tourism Development Ireland stated that fish quality (both size and quantity) was the most important aspect of angling in Ireland (TDI, 2013). However, no distinction in the relative importance of size and quantity was made.

The remainder of this paper is structured as follows, section 2 describes the relevant previous literature on recreation angling. Section 3 then presents the study area, discusses the sampling method and data, and describes the contingent behaviour questions presented to the respondents. Section 4 describes the contingent behaviour model and its application within this paper. Section 5 presents the results of the travel cost models using the revealed trip preferences of Irish and overseas anglers who fish in Lake Garadice. This is followed by a set of contingent behaviour models that examine changes to the quantity of fish and the number of specimen fish. Finally, a discussion of the results within the context of the literature is offered with concluding remarks in section 6.

[1] Coarse anglers fish for freshwater non-game species which includes bream, tench, roach, rudd, hybrids, and eels.

2. Previous research

The first application of the panel data approach to CB data was presented by Englin and Cameron (1996) in their assessment of the effects of changing prices on recreational fishing demand in Nevada. Since then, CB analysis has been widely applied to recreational demand. For example, Hanley et al. (2003) examined the effects of improvements in coastal water quality on Scottish seaside bathers, Christie et al. (2007) used a series of CB scenarios to determine the value of a number of changes to Great British forest and woodland areas for a variety of recreational users, Barry et al. (2011) estimated welfare changes from a proposed trail along the Irish coastline and, more recently, the CB method was used by Filippini et al. (2017) in their assessment of welfare changes caused by the provision of an alpine centre that would provide services that aim to reduce risk of both injury and death. The literature has also explored some of the more methodological issues of CB analysis; tests for validity have been undertaken within several papers (Grijalva et al., 2002; Lienhoop and Ansmann, 2011; Hoyos and Riera, 2013), survey non-response has been explored (Cameron et al., 1996), and methods of incorporating preference heterogeneity have been presented by Hynes and Greene (2013, 2016).

Numerous studies have applied the CB method to data on recreational angling. In addition to Englin and Cameron (1996) the application of the CB method to recreational fishing has included but is not limited to; examining how changes to water levels would affect the users of a drying Nevada lake (Eiswerth et al., 2000), exploring how price changes effect stated trip frequencies (Egan and Herriges 2003), examining the welfare impact from changes in water clarity for a Wisconsin lake (Eiswerth et al., 2008), while Cameron et al. (1996) used the CB method to "break near perfect multicollinearities among water levels at some waters".

The CB method, in application to fish quality, has been applied less often. Prayaga et al. (2010) used an onsite sample to look at how four levels of change in catch rate, ranging from a decrease of 25% to an increase of 25%, would affect anglers who fish in Australia's Capricorn Coast. Their results indicate that none of these changes had a statistically significant impact on trip frequency. Prayaga et al. (2010) also found that a 50% increase in the probability of catching a legal sized red emperor, a 30% increase in crowding or an increase in the length of algae blooms did not have a statistically significant impact on user behaviour.

Alberini et al. (2007) used a mail survey of users of the Lagoon of Venice to examine the effects of a 50% increase in catch. They report that respondents revealed angling participation was positively correlated with a respondent's historical experience of catch rates but the estimated effects of a hypothetical change in catch rate were non-significant. This non-significance remained consistent across numerous model variations containing variables that interact respondent characteristics with the hypothetical change dummy.

The results of Prayaga et al. (2010) and Alberini et al. (2007) may demonstrate several important differences between the revealed and stated data for fish quality. In both cases, individuals demonstrated a preference for higher catch rates, but this did not result in statistically significant results for hypothetical changes in catch. Based on the results of Prayaga et al. (2010) this is understandable; although the parameter associated with historical catch rate was significant it was small, and one may not expect that the level of hypothetical changes would induce more trips. However, the results of Alberini et al. (2007) reveal that for an extra kilogram of fish historically caught respondents would take an extra 10 trips per year. With an average catch of about 3kg, the hypothetical increase of 50% should have resulted in about 15 more trips per year, instead of a non-significant negative value. It may be the case that for both the Prayaga et al. (2010) and Alberini et al. (2007) samples, the revealed data do not perform well in predicting future behaviour, or that their respondents may have reached some threshold on the amount of time they would like to spend fishing at the respective sites.

Poor and Breece (2006) examined how a water quality change would affect anglers who fish in the Chesapeake Bay through CB analysis. However, the results are difficult to interpret. The CB dummy was positive and significant, but the framing of the question makes it difficult to know why the respondents are willing to take more trips. Respondents were informed, before the CB question, that due to poor water quality both fish size and population had been affected. The CB question specially stated that an improvement in water quality would result in larger rockfish. It is difficult then to parse why an individual would take more trips; more fish, larger fish, larger rockfish, better water quality or a combination of all these factors.

Duffield et al. (2001) took a two-stage approach to CB modelling fish quality changes to five stocked Alaskan rivers. Using a mail survey of registered sport anglers respondents were asked to first rate a series of stocking practices which included stocking fewer but larger fish or a greater numbers of smaller fish. For the CB scenario question, the respondents were asked how they would change their trip pattern if their preferred stocking method was implemented. However, by only asking respondents about their preferred stocking practise there is no way of knowing the impact of any scenario for an individual who ranked the stocking practice anywhere lower than first. Ultimately, Duffield et al. (2001) did not produce the results of the CB model but suggested that the raw data indicated that the respondents would increase the number of trips taken if any of the proposed stocking practises were employed.

No application of the CB method has been applied to Irish angling. However, travel cost models have been extensively applied to estimate CS for a day spent fishing (Curtis and Breen, 2017; Hynes et al., 2015, 2017; Grilli et al., 2017). The exploration of angling behaviour in Ireland has also extended beyond the application of TCM. Anglers' own perception of site attributes have been used to determine how coarse anglers choose where they go fishing (Deely et al., 2018a), and how the use of objective or subjective data may impact parameter estimates (Deely et al., 2018b). Also, Curtis and Stanley (2016) found that a higher rating of the quality of fish stocks was positively correlated with the number of days spent on a trip but was not with the number of days spent fishing in a year or the number of trips taken in the year for a sample of game and coarse anglers.

At present the Irish angling literature seems to suggest that the quantity of fish at a site, or the catch rate, plays limited to no role in angler participation. Conversely, the number of specimen fish or size of fish has been shown to be a significant determinant of angling demand (Curtis and Stanley, 2016; Curtis and Breen, 2017; Deely et al., 2018a, Deely et al., 2018b). The international literature, on the other hand, has presented positive results for both size and quantity of fish (Bilgic and Florkowski, 2007; Shrestha et al., 2002; Du Preez and Hosking, 2011) using the TCM.

This paper explores the relationship between angler participation and the number of specimen fish and quantity of fish available at an Irish fishing site. To the best of the authors' knowledge, no attempt has been made to compare an increase in specimen fish to an increase in the quantity of fish using the CB method. This comparison may be of particular interest to managers and legislators as policy current dictates both the size and quantity of fish that can be kept. This paper is also, to the best of the authors' knowledge, the first recreational angling CB analysis to combine an onsite survey with an online survey as well as being the first to incorporate non-users into an analysis of either a change in fish size or quantity which should give a better estimate of the effect of the CB scenarios on a more diverse group of anglers.

3. Data

Coarse angler data were collected in relation to the respondent's use of Lake Garadice. Garadice is a 3.9 km^2 lake located in County Leitrim, Ireland, which is a border county to Northern Ireland. Garadice provides year-round freshwater fishing, with road access to a large number of pegs[2] distributed around the lake. The site also contains boat access at two designated points as well as showering and toilet facilities. Numerous fishing competitions are held at Garadice every year. These competitions include regular local intraclub matches and international competitions, the latter providing an important source of revenue for the local communities.

Data were collected through a survey constructed with the assistance of experts in the field of Irish coarse angling, a focus group of anglers who fish in Garadice and a pilot study. The data collection process took two forms, an online survey and intercept sampling. The online survey ran from the 6th of August 2016 to the 15th of January 2017. Potential participants were contacted through Irish coarse angling Facebook pages, by emailing local coarse angling clubs, through the Inland Fisheries Ireland newsletter, and, in an attempt to contact less avid anglers, local institutes of learning and local newspapers assisted in disseminating the survey link. In total, 45 respondents completed the contingent behaviour questions through the online survey, only two of which were from an overseas country. Intercept sampling also began on the 6th of August 2016 and finished on the 7th of November 2016, garnering 78 respondents.

Although the respondents were only asked CB questions related to Garadice, data were collected at four other sites as a portion of the survey was constructed for a site choice model. Before surveying began Garadice was chosen, for the CB portion of the survey, over the other four sites as it is the largest, most popular, and best known of these sites. By collecting data at other sites as well as the site of interest, the correlation between the number of days spent at Garadice and the probability of being surveyed is reduced for the sample, in comparison to traditional onsite sampling. This should reduce avidity bias.

During the survey, respondents were asked a series of questions pertaining to their angling experience, the number of days spent fishing at Garadice and all other angling sites in Ireland, expenditure on angling within the last year and demographic questions including the location of their home. The anglers were also asked a series of contingent behaviour questions.

The contingent behaviour questions (Table 1) explore how respondents' number of fishing days would change in response to a change in two characteristics of fishing quality; the number of specimen fish and quantity of fish. The respondents were first asked how many days they had spent fishing at Garadice in the 12-month period prior to completing the survey. They were then asked how many days they intended on spending at Garadice next year if conditions remained the same. Following this, the respondents were asked how many more days they would spend next year under each of the four contingent behaviour scenarios; a 25% increase in the number of specimen sized fish, a 50% increase in the number of specimen sized fish, a 25% increase in the quantity of fish, or a 50% increase in the quantity of fish. The CB questions and levels were constructed during meetings with Irish fisheries managers but were not chosen as definitive changes that may result from stocking practice or changes to management policy. The combination of revealed preference and stated preference data makes a sample of 738 observations, 6 for each individual. However, it should be noted that each CB scenario is modelled and presented separately in the results section presenting a panel of 3 observations in each case.

3.1 Summary Statistics

The survey was completed by 123 coarse anglers. They differed with respect to country of origin, income, angler type, self-reported ability level, and many other aspects of both angler and personal characteristics. Every respondent is, by construction, an adult over the age of 18. Only two respondents were female.

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[2] A peg is a designated area to fish from.

Approximately 38% of the sample are overseas anglers (Table 2); this is larger than the TDI (2013) estimate. TDI (2013) estimated that 28% of the anglers who fish in Irish waters come from overseas. A possible reason for the apparent oversampling of overseas anglers may be Leitrim's (the county Garadice is situated in) proximity to Northern Ireland. The majority (61%) of the overseas anglers came from Great Britain. The single currency between Great Britain and Northern Ireland may result in Northern Irish counties been visited more often by British anglers, and by extension, nearby fishing sites in counties such as Leitrim may have a higher representation of British anglers than the national average. Additionally, the TDI (2013) study includes all angler types and is not necessarily reflective of coarse anglers. Curtis and Breen (2017) state that 37% of the game and coarse anglers from the same TDI sample are from overseas, which is almost identical to the present sample.

The sample average one-way distance to Garadice is 287.45 kilometres and the average per day expenditure is €76.75. Per day expenditure[3] is composed of three components; angling expenditure[4], accommodation, and transport cost. The transport cost element of the total travel cost is computed differently for the overseas anglers as opposed to the Irish anglers. For the Irish anglers, transport cost was computed as the operating cost of running a medium-sized vehicle from the respondent's home to the fishing site and back. This accounts for 61% of the total travel cost of the Irish angler. For the overseas anglers, their self-reported cost of fuel and vehicle rental spent was divided by the total number of days spent fishing in Ireland. For the average overseas angler, transport cost accounts for just 23% of their total per day expenditure.

Although it is unusual, in the literature, to calculate any element of the travel cost variable differently for two segments of the sample, the Irish and overseas are pooled to form one sample for the TCM and CB models. While not reported here we also ran models with spilt samples for domestic and overseas visitors and compared the results to the pooled sample model. The results were extremely similar with respect to almost all of the variables of interest and, the consumer surplus calculated from the Irish only model fell into the confidence interval from the overseas model. There remains some difference in magnitude between the estimated travel cost coefficients of the Irish model and the overseas model. As a consequence, the pooled model contains an interaction term between the dummy overseas and the travel cost variable.

The average number of days spent fishing at Garadice is 10.21. However, the trip frequency is not truncated at one for all respondents as some (17) of these respondents took zero trips to Garadice within the previous 12 months before completing the survey. For the users that spent at least one day at Garadice, the mean cost per day is €68.41, the average one-way distance is 273.15 kilometres, and the average active angler spent 11.85 days fishing at Garadice.

The average respondent has been fishing for almost 38 years and is 53 years old with nearly a quarter being retired. The mean angler targets 1.7 species of fish[5]. This suggests that the sampled anglers may attend more than one type of site during the year and may have further implications on their total financial investment in fishing as targeting certain types of fish may require specialised equipment. For the current sample, those who targeted 3 or more fish species spent about 60% more on angling related expenses in the twelve-month period before completing the survey in comparison to those who fished for one or two species. Ten income brackets were provided to the respondents in order to ascertain the respondent's income: the minimum was less than €15,000 and the maximum was €150,000 plus.

The surveyed anglers were also asked what type of angler they considered themselves to be; a match angler (someone who participates regularly in fishing competitions), a specimen

[3]All expenditure except transport cost for Irish anglers is self-reported for the 12-month period prior to filling out the survey. This expenditure refers only to money spent by the individual in Ireland.

[4] Angling expenditure only includes items that are purchased for each trip such as bait and excludes investment items such as gear or tackle.

[5]For the purpose of this metric coarse fish are considered to be one species.

angler (someone who aims to catch large fish of a particular breed) or a pleasure angler. The largest proportion of respondents considered themselves to be pleasure anglers, followed closely by match anglers, with only 14% declaring they were specimen anglers, and only one overseas angler was a specimen angler. The respondent's self-reported ability level could take one of three categories; basic, intermediate or advanced. Only 10% of the surveyed anglers considered themselves to be of a basic level, while 45% believed they were of an intermediate level, and a further 45% believed they were an advanced level angler.

4 Methodology

Within the travel cost modelling framework, the economic value of a non-market good is estimated through the uses of revealed preference data, individual characteristics, site characteristics, and an estimated price. The estimated price usually includes the cost of reaching the site of interest and may also include the cost of all the necessary equipment needed to take the trip, accommodation and opportunity cost of time (Parsons, 2003). The demand function for the travel cost model can be written as:

$$Y_i = f(X_i) \tag{1}$$

where Y_i, the dependent variable, is the number of trips taken by individual i, and X_i is the vector of variables that impact the individual's decision to take these trips e.g. price, site characteristics, and individual characteristics. The dependent variable, number of trips taken, is a non-negative integer value by definition. Consequently, count data estimation approaches, such as the Poisson and Negative Binomial models, are routinely employed to determine the probability of the number of trips taken by an individual equalling some integer value.

Contingent behaviour models can be thought of as an extension to the traditional travel cost model, in which revealed trip frequencies are combined with stated trip frequencies to form a panel data set. Like the TCM, the dependent variable in the CB framework is also the number of trips, consequently, panel count models are used. The most common of these count data models are the Poisson and negative binomial. Following Hausman et al. (1984) the panel Poisson probability function can be specified as:

$$pr\ (y_{ij}) = \frac{e^{-\lambda_{ij}}\lambda^{y_{ij}}}{y_{ij}!}; y_i = 0,1,.,., \infty \tag{2}$$

where y_{ij} is the number of trips taken or intended to be taken per year, x_{ij} is a vector of explanatory variables, i denotes individual i, j is one of the six CB scenarios, and λ, the rate parameter, is equal to the mean and variance of y_{ij} which can be expressed as an exponential function (Hausman et al., 1984):

$$\lambda_{ij} = \exp(X_{ij}\beta) = E(Y_{ij}|X_{ij}\beta) \tag{3}$$

where β is a vector of parameters to be estimated.

An assumption of the Poisson model is equidispersion, where the mean and variance are equivalent. In the case where data are overdispersed a negative binomial distribution may be more suitable. Following Simõeset al. (2013) and assuming that $Y_{ij}|\ \alpha_{ij}\sim$ Poisson$(\alpha_{ij})$and $Y_{ij}|\ \delta_i \sim$ gamma (λ_{ij}, δ_i) distribution a panel negative binomial distribution can be expressed as:

$$Pr(Y_{ij}) = \frac{\Gamma(Y_{ij}+\lambda_{ij})}{\Gamma(Y_{ij}+1)\Gamma(\lambda_{ij})}\left(\frac{\delta_i}{1+\delta_i}\right)^{\lambda_{ij}}(1+\delta_i)^{-Y_{ij}} \tag{4}$$

When revealed and stated preference data are combined, as they are in CB analysis, assumptions over the correlations of the error terms play a fundamental role in model specification. Correlated error terms imply that the individual's responses are correlated with unobservable tastes and characteristics which remain consistent across their responses. Data with correlated error terms are treated using a random or fixed effects approach. Uncorrelated error terms are assumed to be independent and identically distributed across all observations. In the presence of uncorrelated error terms, standard statistical models can be used as the pooled data observations do not require models that address this issue. Although not presented here, both pooled and panel methods were employed on the data set used for this study. However, chow tests indicated that a panel approach is appropriate for the data.

Welfare estimates are often a primary concern in non-market valuation papers, for the TCM consumer surpluses are estimated and, for the CB method, the marginal effect of the proposed change is estimated. CS, in this case, is the value of a day spent fishing to an individual above the money spent. It has been demonstrated, by Hellerstein et al. (1993), to be the sum of the values under the demand function of a TCM over the relevant price range. The per-day CS can be conveniently calculated as:

$$CS = -1/\beta_{tc} \tag{5}$$

whereβ_{tc} is the estimated parameter of the travel cost variable.

The marginal effect is the additional value that is associated with the CB change. Following (Prayaga et al., 2010), it can be calculated using the formula:

$$ME = \beta_{cb} * [\frac{-1}{\beta_{tc}}] \tag{6}$$

whereβ_{cb} is the coefficient for the contingent behaviour scenario.

An important consideration when employing CB analysis is biased parameter estimates as a direct consequence of the data collection procedure. Two common forms of bias in CB analysis are endogenous stratification and zero truncation. Endogenous stratification has been well documented in applications of the TCM (Shaw, 1988; Englin and Shonkwiler, 1995) as well as for CB analysis (Egan and Herriges, 2006; Hynes and Greene, 2016). Endogenous stratification is a consequence of the respondent's probability of attending a site being correlated with their probability of being sampled. As a result, onsite samples are often overpopulated with respondents who have a particular predilection for the site of interest, which is not representative of the population as a whole. By combining intercept samples from several sites and an internet sample, the entanglement of the correlated probabilities is only attributable to a reasonably small portion of our sample i.e. those sampled at Garadice. As such, no correction for endogenous stratification is applied to the data presented in this paper.

Although endogenous stratification is not corrected for, the probability of inclusion in the sample is still correlated with the avidity of the respondent, which may imply that the sample is more reflective of avid coarse anglers than a random sampling of coarse anglers. The implications of a sample being relatively overpopulated with avid anglers are nuanced and may impact the contingent behaviour analysis in numerous ways. However, these implications are beyond the scope of this paper.

The second, and equally well documented, form of bias is zero truncation (Shaw, 1988; Grogger and Carson, 1991; Hynes and Greene, 2013; Egan and Herriges 2006). This problem arises due to the simple fact that, for an angler to be surveyed at a site the must have taken at least one trip; excluding individuals who took zero trips from the analysis. Parsons (2003) states that this may lead to less accurate estimates of the choke price and, consequently, less accurate estimates of CS. Fletcher (1990) suggests that zero truncation can lead to an upward bias of CS estimates. Additionally, zero truncation may undervalue improvements to a site as the allure of the proposed changes to anglers with zero trips is not explored. As the data collection process of the current study employed an online sampling component as well as sampling at other sites than the site of interest, the sample is not truncated. This allows for a more precise estimate of

CS and a more effective examination of how the CB changes may impact anglers, including those who are currently non-users of Garadice.

Although, neither endogenous stratification nor zero truncation is corrected for in the current study, the sample has been restricted to anglers who have some knowledge of the site. In particular, the respondents needed to know where the site is situated and have a general knowledge of both the number of specimen sized fish and the quantity of the fish at the site even if they have stated that they have not visited the site in last 12 months. This, in turn, may result in a sample of more 'enthusiastic' users of Garadice than would be expected from a random sampling framework. However, the requisite statistics to transform the results presented here into more nationally representative results do not exist. Consequently, no transformation is made and as such the results found in this paper should be seen as representative of the sample only.

5. Results

5.1 Travel Cost Model

The results of a negative binomial TCM estimated on the revealed trip frequency observed in the data are reported in Table 3. A Poisson model was also fitted but are not presented as the data are overdispersed with regard to its mean and variance, which can be seen in the significant overdispersion parameter of the negative binomial model.

The results of the model indicate that, as expected, travel cost has a negative and significant impact on the number of days spent fishing at Garadice. The statistically significant interaction term *travel cost overseas* suggests that the negative effect from increasing travel cost is less for the overseas anglers. This may be reflective of a number of overseas anglers receiving a higher level of utility from a day spent at Garadice. Alternatively, overseas angler may be receiving utility from other activities that may justify their lower disutility for travel costs.

A priori expectations were that the number of years the respondent has been fishing is related to their devotion to the sport, experience, and their age and as such the variable *Years Fishing* would have a positive effect on angling demand. The *Years Fishing* variable conformed to expectations as the estimated coefficient was positive and significant. This implies that the predicted number of trips to Garadice increases with every year of fishing experience the respondent obtains.

Self-reported *ability level* does not seem to have a statistically significant impact on the number of trips an angler took to Garadice. This suggests that respondents who consider themselves to be an advanced level angler take as many trips to Garadice as a novice angler, all else being equal. The dummy variable *online* indicates where the respondent completed the survey, either online or at one of the five survey sites. This is negative and significant, indicating that the onsite cohort takes more trips to Garadice than their online counterparts. This may be due, in part, to a portion of the onsite sample being collected at Garadice, resulting in oversampling of avid users of Garadice.

Unlike other analysis of angler participation (Curtis and Breen, 2017; Curtis and Stanley, 2016; Grilli et al., 2017) whether or not an angler is retired (often proxied by being 65 years or older) does not seems to play a significant role in their decision of how many days they spend fishing at Garadice. However, the analysis used elsewhere (Curtis and Breen, 2017; Curtis and Stanley, 2016; Grilli et al., 2017) did not include an age or years fishing variable, which one would expect is correlated with retirement.

Both the dummies *match* and *specimen* are positive and significant indicating that these anglers tend to spend more days fishing at Garadice than the pleasure anglers. *Income* was not statistically significant for any of the model results; a not uncommon result in travel cost modelling (Hynes et al., 2015, 2017; Curtis and Breen 2016). The variable *targets 3 or more species* is positive and significant. It may be the case that, as targeting multiple species of fish is a much more costly endeavour than just targeting one species, these individuals are willing to spend more on fishing experiences more generally. This may result in more days spent at Garadice. The final variable, *Ireland,* is a dummy indicating whether the respondent is a resident of the island of Ireland. This is positive and significant showing that, as expected, Irish anglers take more trips to Garadice than their overseas counterparts.

The per-day CS is estimated at €93, with 95% confidence intervals ranging from €50.75 to €135.25 (Table 4). The estimated average consumer surplus for the overseas anglers is much larger at €296.42 per day. A number of factors may have influenced the large difference between the mean CS of the Irish anglers in comparison to the overseas anglers. The Irish angling product may offer a unique experience to the overseas angler as fishing in Ireland is known for its natural state, scenery and fishing quality, all of which are ranked as important factors for overseas anglers visiting Ireland (TDI, 2013). There may also be an overestimation of the overseas CS if some of the visits to Ireland were for multiple purposes (Kuosmanen et al., 2004).

The predicted number of days spent at Garadice is somewhat larger than the actual frequency of 10.21. The estimate predicts 11.52 days would be taken by the sample over a year long period, 1.31 days more than the actual number of trips. For the Irish anglers this estimate is 16.76 days, 2.49 days more than the actual figure but for the overseas anglers, the estimate of 3.05 days is lower than the actual trips of 3.64 days.

5.2 Contingent behaviour Analysis

Using Stata 15's xtnberg[6] command, a random effects panel negative binomial model was estimated for the sample of coarse anglers (Table 5). For each model presented, every respondent contributes three observations; current trips, future trips and trips taken after the specified contingent behaviour change. The current trips are the number of trips they took in the 12 months prior to completing the survey, the future trips are the trips they intend to take in the next 12 months under status quo conditions, and the final observation is the stated number of trips the respondent would take if one of the contingent scenarios were to occur.

For the CB model, the travel cost coefficient is negative and significant, the interaction term *travel cost * overseas* is positive, but only significant for a change in the quantity of fish, the dummy for current trips is negative and significant indicating that the respondents, on average, took fewer trips in the current period than they intend to take in the next 12 months without any change to Garadice. Finally, all four contingent behaviour dummies are positive and significant indicating that, on average, anglers declared that they would take more trips next year, under each of the proposed scenarios, than they had otherwise intended to. In both cases, the magnitude of the CB dummies reveals that a 50% increase in either the number of specimen fish or the quantity of fish results in extra trips than a 25% increase.

Table 6 shows the marginal effect of each of the CB scenarios. The 95% confidence intervals were calculated using the Krinsky-Robb method (1986) with 5,000 draws.

All the CB scenarios add additional CS when compared to the status quo. The associated confidence intervals indicate that all estimated CS are statistically different from zero. The marginal change in days spent at Garadice ranges from 3.78 extra days for a 25% increase in the number of specimen fish to 6.56 days for a 50% increase in the quantity of fish. As would be expected, the Irish anglers are much more likely to increase the number of fishing days at Garadice as a result of one the CB changes, than the overseas anglers. The Irish anglers would

[6]As pointed out by one of the anonymous referees of this paper, the xtnbreg command, in Stata, estimates random effects with respect to the dispersion parameter, not to Xβ, so that over-dispersion is assumed to follow a beta distribution B(r,s), where r and s are the rate and scale of the beta distribution respectively. By using this command, one has a distribution of the dispersion parameter across respondents, which is very similar to what a correction for endogenous stratification does in a cross-section negative binomial model.

increase the number of days fishing at Garadice by approximately four times that of the overseas anglers, after one of the CB changes.

Table 6 also displays the marginal effect, in terms of increased fishing days, associated with the CB changes for specimen anglers, match anglers and pleasure anglers. A priori expectations are that for a change in the number of specimen fish the marginal effect will be largest for specimen anglers, whereas a change in the quantity of fish will have the greatest impact on match anglers. However, the results do not fully meet expectations.

A 50% increase in the quantity of fish results in the match anglers' spending approximately 8 more days fishing; many more than either the pleasure or specimen anglers. Although the estimated change for the specimen anglers is larger for an increase in specimen fish rather than an increase in quantity of fish, it is a comparatively small value; smaller than for match or pleasure anglers. The estimates imply that match anglers are the most responsive to a change in fish quality followed by pleasure anglers, whereas specimen anglers do not react strongly to any of the CB scenarios. However, specimen anglers are the least well represented amongst the sample which may make the sample less representative of specimen anglers than either match or pleasure anglers.

6. Discussion and conclusion

Fish quality is considered to be the most important aspect of Irish recreational fishing (TDI, 2013). However, little is known about how anglers respond to an increase in either the number of specimen fish or the quantity of fish. The literature has given somewhat conflicting results but, generally, suggests that size or number of specimen fish is an important aspect of angler participation whereas quantity seems to play a less dominant role. However, no attempt has been made to directly estimate how changes to fish quality would affect angler participation in Ireland.

The current study employed contingent behaviour analysis to estimate the changes associated with a 25% and 50% increase in either the number of specimen fish or the quantity of fish at Lake Garadice. The results indicate that both the number of specimen fish and the quantity of fish play a significant role in angler participation. The results also indicate that anglers are almost equally well off from an increase in the number of specimen fish as an increase in the quantity of fish. The difference between the mean estimates is approximately €4 for a 25% and €8 for a 50% increase. The marginal change in the number of days spent fishing is also similar; a 25% increase in either the number of specimen fish or the quantity of fish results in approximately 3.80 more days fishing at Garadice and a 50% increase in quantity of fish results in 6.56 more days, whereas a 50% increase in the number of specimen fish induces anglers to take 5.25 more days fishing at Garadice.

These results imply that recreational users of Irish coarse fishing sites may benefit from stocking practices as an increase in fish stock may result in Irish anglers spending more days angling during the year while also enticing overseas anglers to holiday in Ireland for longer periods of time. However, stocking for coarse fish is seldom practised in Ireland, particularly for natural waters (IFI 2015). In part, this may be because Irish waters are seen as natural and wild, and its fish robust and challenging. Hatchery fish, as reported by Inland Fisheries Ireland (IFI), the state agency responsible for the protection, management and conservation of inland fisheries, are genetically inferior and provide less of a challenge to catch (IFI 2015). This, in itself, poses a question on the trade-off anglers are willing to make for an increase in fish abundance. Anglers may want more fish but be unwilling to substitute natural fish for hatchery fish.

At present, IFI has undertaken a policy of trying to keep and restore Irish recreational fishing waters in a natural state. This includes the improvement and preservation of water quality, protection of nurseries, and legislation over the size and quantity of fish that are allowed to be kept. It may be possible to extend these practices to increase the number of specimen fish and the quantity of fish at Garadice. By altering the legislation on what fish can be kept an increase in fish abundance and possibly fish size may be achieved without the need to stock lakes. However, this may be a delicate balancing act, as anglers may want an increase in fish quality but may not be willing to release more caught fish than is currently legislated. It could, in fact, be the case that anglers may be, on average, worse off from an increase in fish quality if it is brought about by a change in legislation. Careful consideration would need to be given not only to the trade-off between fish quality and the amount of fish an angler can keep but also to the time horizon over which a change in fish quality might occur and to anglers' discounting of future utilities.

The study also highlighted several characteristics of angler participation that may be of interest to managers of fisheries outside of Ireland. Firstly, it is clear that tourist anglers are impacted differently by travel cost than Irish anglers. This may indicate higher WTP for a day spent coarse angling, or alternatively, that the trips are multipurpose. Consequently, models from any region that encompasses both Irish and tourist anglers should consider the differences highlighted in this paper. Secondly, the number of extra days that tourist anglers are willing to spend fishing due to any of the purposed changes was about a quarter of the size of the Irish anglers. It may be the case that if managers aim to increase tourist angling by increasing fish quality the change may be much less dramatic than for local anglers. Finally, as a consequence of the previous two points, analysts of data such as this may need to consider the demographics of the sample as data sets overrepresented by tourist anglers may undervalue CB changes in terms of extra days spent fishing but overvalue associated CS.

With respect to the international literature, reviewed in section 2, there are a number of reasons that this study may result in different estimates than previous papers. The first and most obvious being the populations that the samples are drawn from are different. Secondly, as the source of the extra days spent at Garadice is uncertain, it may be the case that anglers will substitute fishing days at other sites for days at Garadice. If this were the case and if respondents of other analysis did not have this opportunity one may expect a larger estimate for this analysis than others as substituting one fishing day for another may be easier than non-fishing days for fishing days. Also, this paper is the first, with respect to size and quantity changes in CB analysis, to incorporate current non-users of the site of interest into the sample as well as being the first to combine an onsite and online sample which may result in different estimate than previous studies. As the normal issue of endogenous stratification and avidity bias should have been greatly reduced, the results may be more generalizable to the population of interest than previous estimates and, consequently, different CB estimates.

This paper also presented a traditional travel cost model. The estimates imply that the CS is €93 per day spent fishing in Garadice. However, no accurate information exists on the total number of visitors or the compositions of the users of Garadice. As such, the values cannot be extrapolated to all user and potential users of Garadice but reveal important information on the CS associated with a day spent coarse angling.

With respect to both the TCM and CB, the different treatment of the Irish anglers' and the overseas anglers' travel expenditure also merits some discussion. It is assumed that the travel expenditure of overseas anglers, who are on multiday visit to Ireland, can be conveniently parcelled into a number of single day costs. This implies that all the expenditure the overseas anglers spent in Ireland can be attributable to fishing and that each fishing day is of equal value. This may not be the case. Some anglers may see these multi-day trips as multipurpose and, as such, a portion of the expenditure may rightly be attributable to other activities. This may, in fact, account for some of the difference between the Irish and overseas anglers with respect to their disutility from additional costs. There is a growing literature on the incorporation of multipurpose/ multidestination trips into travel cost models (Hill et al., 2014; Saengavut, 2018).

However, the required information was not available to address this issue here. Although it is common amongst the recreational angling literature to combine overseas and native anglers into one travel cost model due care must be taken when extrapolating result from this paper given this uncertainty.

Acknowledgements

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.

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Table 1: Contingent Behaviour Questions Posed to the Respondents

How many days have you spent fishing at Garadice in the previous 12 months?
How many days do you intend on spending fishing at Garadice in the next 12 months?
If there were a 25% increase in the quantity of fish at Garadice how many days would you spend fishing there?
If there were a 50% increase in the quantity of fish at Garadice how many days would you spend fishing there?
If there were a 25% increase in the number of specimen sized fish at Garadice how many days would you spend fishing there?
If there were a 50% increase in the number of specimen sized fish at Garadice how many days would you spend fishing there?

Table 2: Sample descriptive statistics

	Irish and Overseas Respondents (n =123)	Irish Respondents (n = 76)	Overseas Respondents (n = 47)
Variable	Mean	Mean	Mean
Average one-way distance (km)	287.45 (293.55)	81.19 (70.83)	620.98 (190.84)
Average expenditure per day (€)	76.75 (71.40) 10.21 (18.88)	65.01 (56.32) 14.28 (22.37)	95.74 (88.07) 3.64 (7.69)
Mean number of days spent at Garadice			
Years fishing	37.75 (14.55)	34.80 (14.00)	34.80 (14.00)
Number of species Targeted	1.71 (1.13)	1.99 (1.29)	1.26 (0.57)
Age	52.88 (11.73)	49.11 (12.60)	59.32 (6.25)
Income (€)	44,684 (33,579)	43,975 (29,073)	43,214 (37,302)
Survey online	0.37 (0.48)	0.57 (0.50)	0.04 (0.20)
Ireland	0.62 (0.49)	N/A	N/A
Match	0.42 (0.50)	0.43 (0.50)	0.40 (0.50)
Specimen	0.13 (0.34)	0.20 (0.40)	0.02 (0.15)
Pleasure	0.45 (0.50)	0.37 (0.49)	0.57 (0.50)
Ability level	2.34 (0.66)	2.46 (0.64)	2.15 (0.66)
Retired	0.24 (0.43)	0.22 (0.42)	0.28 (0.45)

Standard deviation presented in parenthesis.

Table 3: Travel cost model with negative binomial specification

Variables	Coefficients
Travel cost	-0.011 (0.002)***
Travel cost * Overseas	0.007 (0.003)**
Years fishing	0.015 (0.009)*
Ability level	-0.094 (0.176)
Online	-1.628 (0.288)***
Retired	0.139 (0.314)
Match	0.525 (0.225)**
Specimen	0.971 (0.436)**
Income	0.085 (0.057)
Targets 3 or more fish species	1.267 (0.315)***
Ireland	2.154 (0.326)***
Constant	0.266 (0.591)
Alpha	0.920 (0.142)***
Observations	123
Pseudo R2	0.124
Log-likelihood	-345
AIC	717
BIC	753

*Figures in parenthesis are standard errors. *** indicates significant at 1% ** indicates significant at 5% * indicates significant at 10%*

Table 4: Estimated consumer surplus per ay

	Value
Consumer surplus €	93.00
Confidence Intervals €	50.75 – 135.25
Willingness to pay €	158.02
Predicted Number of Days	11.52

Table 5: Contingent Behaviour Models

	25% increase in quantity fish	50% increase in quantity fish	25% increase in specimen fish	50% increase in specimen fish
Travel cost	-0.006 (0.002)***	-0.005 (0.002)***	-0.005 (0.002)***	-0.005 (0.002)**
Travel cost * overseas	0.005 (0.003)*	0.004 (0.003)*	0.004 (0.003)	0.004 (0.003)
Dummy current	-0.222 (0.071)***	-0.225 (0.077)***	-0.221 (0.073)***	-0.218 (0.079)***
25% increase in quantity fish	0.292 (0.062)***			
50% increase in quantity fish		0.474 (0.065)***		
25% increase in specimen fish			0.292 (0.064)***	
50% increase in specimen fish				0.384 (0.068)***
Years Fishing	0.016 (0.007)**	0.012 (0.006)*	0.014 (0.007)**	0.014 (0.007)**
Ability Level	-0.117 (0.147)	-0.087 (0.139)	-0.089 (0.149)	-0.073 (0.144)
Online	-1.134 (0.261)***	-1.050 (0.249)***	-1.074 (0.264)***	-1.035 (0.257)***
Retired	0.073 (0.245)	0.106 (0.230)	0.076 (0.246)	0.051 (0.236)
Match	0.466 (0.188)**	0.471 (0.177)***	0.423 (0.189)**	0.382 (0.182)**
Specimen	-0.169 (0.334)	-0.256 (0.316)	-0.060 (0.332)	-0.073 (0.322)
Income	0.075 (0.047)	0.061 (0.044)	0.079 (0.047)*	0.072 (0.045)
Target 3 or more fish species	0.374 (0.253)	0.370 (0.237)	0.319 (0.253)	0.348 (0.242)
Constant	0.460 (0.472)	0.384 (0.445)	0.378 (0.478)	0.219 (0.459)
r	2.470 (0.404)	2.461 (0.396)	2.280 (0.3720	2.191 (0.352)
s	2.466 (0.487)	3.087 (0.637)	2.391 (0.485)	2.850 (0.600)
Observations	369	369	369	369
Log-likelihood	-1043	-1075	-1048	-1077
AIC	2118	2183	2128	2185
BIC	2180	2245	2191	2248

*Figures in parenthesis are standard errors. *** indicates significant at 1% ** indicates significant at 5% * indicates significant at 10%*

Table 6: Marginal effect of contingent behaviour scenarios

Irish only cohort	25% increase in quantity fish	50% increase in quantity fish	25% increase in specimen fish	50% increase in specimen fish
Marginal Effect, €, per day	50.86	89.01	54.97	81.09
95% confidence intervals	24.25 – 163.87	48.28-300.72	24.72 – 204.08	37.96 – 349.13
Marginal change in days fishing	3.8	6.56	3.78	5.25
Change for Irish anglers	6.53	10.69	6.34	8.59
Change for overseas anglers	1.49	2.75	1.52	2.21
Change for specimen anglers	2.47	3.92	2.8	3.96
Change for Match anglers	4.66	8.12	4.55	6.25
Change for pleasure angler	2.93	5.07	2.98	4.26