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Putting your best fish forward: Investigating distance decay and relative preferences for fish conservation

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Running title: Best Fish Forward

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Acknowledgements: The authors wish to acknowledge the funding provided by the EU INTERREG IIIA Programme for Ireland/Northern Ireland for data collection. Brian Danley acknowledges funding from the Seth M Kempes' Stipend Fund. Erlend Dancke Sandorf acknowledges funding from the Jan Wallander and Tom Hedelius foundation, and the Tore Browaldh foundation grant no. B2015-0490:1; and funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 793163. Erlend Dancke Sandorf did the much of his work on earlier versions of this manuscript while at the Swedish University of Agricultural Sciences. The authors wish to acknowledge the editor, Fredrik Carlsson, as well as two anonymous reviewers for their comments and suggestions, which substantially improved the quality of this manuscript. The authors also wish to thank Lars Persson for his comments on an earlier version of this manuscript.

Accepted refereed manuscript of: Danley B, Sandorf ED & Campbell D (2021) Putting your best fish forward: Investigating distance decay and relative preferences for fish conservation. Journal of Environmental Economics and Management, 108, Art. No.: 102475. https://doi.org/10.1016/j.jeem.2021.102475

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Abstract: Easily recognizable species are often used as so-called 'flagship' species to raise awareness and funding for conservation action, but this practice has been criticized for neglecting low-profile species. One component of biodiversity is the geographic distribution of where species live, with species that live in only one habitat being endemic to that particular habitat. This study investigates how respondents to a discrete choice experiment ascribe value to the conservation of five different fish species with one species being non-endemic to the study area and familiar to most respondents while another, much lesser-known species, is endemic to the study area. We use a latent class model to investigate possible distance decay effects in which species respondents prioritize for economic valuation. Results suggest individuals who live relatively close to unfamiliar species may be among those who are more likely to value such species higher relative to more familiar substitute species.
Keywords: flagship species, endemic species, latent class multinomial logit model, discrete choice experiment
JEL codes: C25, H41, Q51, Q57

1 Introduction

Species with biodiversity importance, often candidates for non-market valuation, are important not just for their scarcity, but for their role in ecosystem functioning at both local and global scales (MESAB, 2005). Since the Convention on Biological Diversity in 1993, the public profile of biodiversity and species in sensitive habitats have risen to prominence as a policy issue (Novacek, 2008). Stated preference methods are often employed to capture the non-market values the general public ascribes to species of biological importance. Despite the public's general interest in biodiversity conservation, some scientists contend that the public's occasionally limited prior scientific knowledge makes the use of stated preferences methods problematic for policy guidance (e.g. Sagoff, 1988).

One illustration of the dilemma posed by the public's interest in conservation but often limited scientific knowledge of ecosystems and biodiversity is the use of familiar 'flagship' species as easily recognizable symbols to "increase public awareness of conservation issues and rally support for the protection of [specific] species" (Favreau et al., 2006, p 3,951). The most commonly chosen flagship species are mammals with large body sizes such as iconic predators or primates, as well as large birds (Ward et al., 1999; Dietz et al., 1994; White et al., 2001; Anderson et al., 2007). Perhaps most famously, the giant panda is the symbol of the World Wildlife Foundation and is arguably one of the most recognizable symbols of conservation in the world (Williams, 2006). However, some seemingly unlikely species have also been chosen as flagship species for various purposes, such as cold-blooded vertebrates, invertebrates, and plants (Walpole and Leader-williams, 2002; Samways, 1994; Farjon et al., 2004). Despite their potential to inform the public and gather conservation support, important yet esoteric species are not frequently selected for use as flagship species (see review in Caro and Girling, 2010). For example, SAVE Brazil selected the Orange-bellied Antwren as a flagship species due to its endangered status, restricted distribution and the similarity between its Portuguese common name and the Portuguese word for conserving. Despite indications the educational program was successful, the Antwren was subsequently replaced as the flagship species due to concerns that it was still poorly known to the target audience even after several years (Veríssimo et al., 2013b).

How the public ascribes economic value to species with important scientific characteristics but are previously unknown to them given the presence of familiar substitute species is important since much of the world's important biodiversity is often unknown to the public (MESAB, 2005). Many stated preferences studies investigate species that have iconic, cultural, or charismatic appeal (e.g. Favreau et al., 2006; Martín-López et al., 2008; Wallmo and Lew, 2016); however, non-charismatic but still widely recognized species have occasionally been successful as flagship species for education and awareness purposes (Caro and Girling, 2010). Particularly for marine threatened species, Lew (2015) reviews the stated preferences literature to find "the majority of species valued can be classified as charismatic megafauna- seals and sea lions, whales and sea turtles- in addition to well-known species, like salmon" (p 13). Given the criticism that flagship species selection should diversify to include more species than the traditionally charismatic (e.g. Bennett et al., 2015), more exploration of non-charismatic potential flagship species is needed. Therefore, non-charismatic species, including but not limited to those that are simply familiar to many individuals, are important to consider as potential flagship species as well.

In addition to considering unfamiliar species for conservation marketing, some in the conservation community have suggested using multiple flagship species akin to a market segmentation approach, but investigations into possible spatial dimensions of such market segmentation are currently lacking (e.g. Wright et al., 2015; Root-Bernstein and Armesto, 2013). A potential spatial strategy for segmented conservation marketing could be to use previously unknown species with important biodiversity characteristics as flagship species in areas near their habitats. In the economic valuation literature, sometimes the value of certain environmental goods and services is higher relatively close to where those goods and services are located; an effect called distance decay.

Distance effects for conservation of carnivores or species that have negative impacts on people living in close proximity to them can be expected to differ from non-predatory or otherwise non-nuisance species (e.g. Johansson et al., 2012). For valuation of generally benign species conservation, the subject of this investigation, studies frequently find little or no decrease in

WTP with increasing distance between the species habitat and where respondents live (Pate and Loomis, 1997; Rudd, 2009; Wallmo and Lew, 2016; Glenk et al., 2019). It is even common for respondents to state significantly positive willingness-to-pay for conservation of both familiar and previously unfamiliar endemic species if they live on different continents than the species being valued (e.g. Horton et al., 2003; Morse-jones et al., 2012). Although some between country studies of differences in WTP indicate foreign respondents to state higher WTP for conservation compared to domestic respondents, others find the opposite result (e.g. Ressurreição et al., 2011; Richardson and Loomis, 2008; Botzen and Beukering, 2018). Such distance effects across countries can be confounded by differences in sociodemographic factors between countries with differing levels of industrialization and biodiversity.

To the authors' knowledge, no study has specifically investigated if the frequent lack of distance decay in stated preferences valuation of species conservation also applies to relative values for unfamiliar species with important biodiversity characteristics compared to species of greater familiarity. The main purpose of this study is therefore to investigate if the absence of distance decay, a common finding about little-known species with important biodiversity characteristics from the stated preferences literature, also applies to *relative* preferences for previously unknown endemic species. We use data from a stated preferences study conducted in The Republic of Ireland and Northern Ireland aimed at eliciting people's preferences for the existence of five different fish species in the Lough Melvin catchment. Because the options presented to respondents in the study described the conservation status of each fish species as either 'conserved' or 'extinct' after implementation of each respective choice, resulting values can be interpreted as the value of each species' existence in the Lough Melvin catchment.

Following suggestions that different species may have appeal as flagship species to different subgroups of the public (e.g. Veríssimo et al., 2013a; Bennett et al., 2015), we use a latent class model to identify distinct subgroups of respondent preferences and focus our analysis on the relative preferences of each latent class (i.e. which species each latent class values higher than all other species). Our main focus in latent class identification is exploring how the Euclidean distance, in kilometers, between Lough Melvin and the location of each respondent's primary residence relates to their relative valuation of two potential flagship species.

Of the two species that emerge as the relatively most preferred among respondents with high willingness-to-pay (WTP) for conservation, one of the species is the Atlantic salmon, familiar to most respondents but existing in catchments across Ireland, while another species, the Sonaghan, is known to few respondents but is endemic to Lough Melvin. We calculate unconditional and conditional (i.e. individual-specific) marginal rates of substitution between these two species and use this measure to explore potential distance decay in relative preferences. Possible decay effects in the marginal rate of substitution between likely choices for flagship species implies a geographic dimension in the relative non-use value of esoteric biodiversity. This approach may be relevant for conservation marketing by implying a geographic dimension in how to target different members of the public using different flagship species.

Our results provide novel insight on the distance decay effect of unfamiliar yet endemic species, which are often overlooked in favor of more familiar or popular species. Specifically, this study suggests that individuals who live relatively close to unfamiliar species may be among those who are more likely to value such species higher relative to more familiar species. In this study, we consider a familiar species to be a species with a name that stated preferences survey respondents recognize prior to taking the survey, not requiring any further specific knowledge.

The remainder of this paper is organized as follows: a brief background of the issue of familiarity and valuation is discussed before a pre the study area is presented to explain the context of the species being valued and their habitat. A methods section presents the data used for analysis as well as the econometric model and specification used. Next, results are presented followed by a discussion section and concluding remarks.

2 Background

Some evidence suggests the public should not be expected to give consideration to scientific information in stated preferences valuation surveys and may, for example, ignore species' endangered status for attributes such as how much respondents expressed a like or dislike for species being valued (Metrick and Weitzman, 1996). Established findings also show that people tend to profess more positive attitudes toward species that are biologically similar to human beings (e.g. Kellert, 1984) which is why respondents to stated preferences surveys tend to state willingness-to-pay (WTP) for species protection in accordance with how similar species are to humans (Gunnthorsdottir, 2001; Caro and Girling, 2010). Similar to how respondents to stated preferences surveys may search for ways to simplify their decision-making (Vatn and Bromley, 1994; Scarpa et al., 2009) respondents may be prone to simply prioritize the species most familiar to them when faced with valuation tasks that include multiple species with various scientific attributes.

Other evidence suggests a more optimistic assessment of the public's capabilities to appreciate nuanced aspects of ecosystem and biodiversity conservation. For example, Tisdell et al. (2007) and Martín-López et al. (2008) find that, when presented with relevant scientific information about the species being valued, respondents stated higher WTP for species with higher threatened status relative to species with lower threatened status. Others have found WTP for ecologically important yet less familiar species to be significantly positive, although frequently lower than WTP for mammals and birds (Yao et al., 2014; Veisten et al., 2004). Charismatic species, those which are immediately recognizable by name and often associated with well-known habitats (Kontoleon and Swanson, 2003), may be expected to attract higher WTP, although Morse-jones et al. (2012) find no significant differences in WTP for charismatic and unique species and WTP for unique and non-charismatic species. They conclude that "people are not solely reacting to charismatic or 'flagship' species, but that other more scientific and economic characteristics have a bearing on preferences" (Morse-jones et al., 2012, ,p 15).

Biodiversity is often approached in the stated preferences literature by investigating rare or endangered species (e.g. Johnston et al., 2015; Lew, 2015; Choi and Fielding, 2013), but species do not have to be endangered to have biodiversity value. One biodiversity attribute that may be valued heterogeneously among conservation-minded members of the public is the geographic distribution of species habitats. Species that live exclusively in a single geographic area are endemic to that particular location and are ecologically important because they are found nowhere else (Lamoreux et al., 2006). Endemism is a component of biodiversity in its own right, with endemic species contributing to the diversity of the ecosystems in which they live (i.e. ecosystem diversity) even if such species are not of a particularly threatened status (Rawat and Agarwal, 2015). There are at least two reasons respondents would value species endemism *per se*. First, respondents' valuation of endemic species may exhibit distance decay at increasing distances away from the species' habitat, as discussed in the introduction. Second, endemic species are of particular importance because the scope of their habitats is smaller than other species, which has received limited direct attention in the stated preferences literature (Morse-jones et al., 2012). Investigating species characteristics directly instead of actual species, Meuser et al. (2009) find endemism to be the most influential factor in explaining WTP even when the characteristics of cultural and traditional importance are included. Suggesting latent class analysis can reveal heterogeneous preferences for endemism, Veríssimo et al. (2013b) find almost half of respondents belong to a subgroup with significantly positive preferences for species endemic to geographically smaller areas.

3 Materials and Methods

3.1 The species being valued

Lough Melvin is a lake in the North West of Ireland that straddles the border between Northern Ireland and the Republic of Ireland. Due to the importance of Lough Melvin as an oligo-mesotrophic (low-medium nutrient) lake that supports a unique assemblage of fish species and diversity of habitats, flora and fauna, it has been designated as a Special Area of Conservation under the EU Habitats Directive (Kelly et al., 2012). Unlike other relatively large lakes in Ireland that have suffered from eutrophication and hydrological manipulation, Lough Melvin is in relatively pristine condition. However, the health and status of Lough Melvin is particularly vulnerable to human activities, with the most significant threat being an increase in phosphorus loadings from housing, forestry and agriculture within the surrounding catchment. Around the time the survey was administered, phosphorus concentrations in the lake had increased by over 40 percent in little more than a decade and monitoring of the catchment rivers indicated that phosphorus loadings were continuing to increase (Campbell and Foy, 2008). Lough Melvin and its associated river system supports the only remaining population of Arctic char (*Salvelinus alpinus* L.) in Northern Ireland and contains Atlantic salmon (*Salmo salar* L.) and three distinct populations of brown trout (*Salmo trutta* L.), known as Ferox (*Salmo ferox* L.), Gillaroo (*Salmo stomachicus* L.) and Sonaghan (*Salmo nigripinnis* L.).

(Figure 1 about here)

Globally, Brown trout, Arctic char, and Atlantic salmon are currently listed as species of least concern (IUCN, 2018). In the Republic of Ireland, Atlantic salmon and Arctic char are listed as vulnerable with Brown trout listed as a species of least concern (King et al., 2011, appendix 2). In the United Kingdom, Arctic char, Brown trout and Atlantic salmon are priority species (BRIG, 2007) and all have importance for protection as part of the UK Post 2010 Biodiversity Framework. The fish investigated in this study therefore have similar conservation importance at the species level, but are of importance for conservation because of the sensitivity of their habitat. In addition, the conservation importance of the three Brown trout species in Lough Melvin is worth mentioning. Based on a number of criteria, including their genetic diversity compared to other populations of Brown trout in the UK and Ireland, the Ferox, Gillaroo and Sonaghan in Lough Melvin are one of the most distinct populations of Brown trout in the UK and Ireland (McKeown et al., 2010). In a review of the research on the Brown trout in Lough Melvin, Ferguson (2004) found sufficient evidence of diversity between the Ferox, Gillaroo, and Sonaghan in Lough Melvin to regard these specific populations as three separate species.

The populations of Ferox, Gillaroo, and Sonaghan in Lough Melvin are considered to be of special conservation concern based on the notion that "conservation measures should be based on local populations rather than solely on evolutionary lineages or defined taxa, with other local characteristics being used to determine conservation priority" (McKeown et al., 2010, , p 343).

3.2 Data

Stated preference data was gathered to estimate the value of the five selected fish species existing in the Lough Melvin Catchment in Ireland. The survey was conducted via in-person interviews in 2007. While preferences may have changed since the data were collected, Lough Melvin remains a Special Area of Conservation whose continued pristine environmental condition is a subject of some public interest. Furthermore, the five selected fish species are still present in the catchment and the Arctic char in Lough Melvin are still the only remaining population of Arctic char in Northern Ireland. Despite their age, these data are likely still relevant for conservation policy in Lough Melvin and, more importantly, are useful for making wider generalizations about how little known species with important biodiversity characteristics can be used in conservation marketing.

This study involved numerous rounds of design and testing to confirm that respondents could meaningfully interpret the attribute levels. A series of six focus group discussions were held consisting of meetings in the Lough Melvin Catchment area and four discussion meetings in other areas of Northern Ireland and the Republic of Ireland. Focus group participants included several stakeholder groups such as farmers, foresters, anglers, and members of the general public. Input from the focus groups and subject matter experts was used to refine the wording, options and layout of the choice experiment. A pilot survey of over 100 respondents was conducted to gather further information and test the survey design. Feedback from the focus groups, pilot study, and expert opinions indicated that people found the experiment to be meaningful and credible.

Respondents were informed the following information about the fish species in the discrete choice experiment: Sonaghan only exists in Lough Melvin and will go completely extinct if they disappear from the catchment; the population of Arctic char is the last such population in Northern Ireland, with populations of Arctic char in decline across catchments in the Republic of Ireland as well; Atlantic salmon, Gillaroo and Ferox are present in other catchments across both Northern Ireland and the Republic of Ireland. Finally, respondents were told that all species except the Arctic char have angling potential. Because respondents were told to consider the Sonaghan, Ferox, and Gilleroo as a separate species, they will be considered as such for the purposes of this study. We argue that the individual fish species therefore have three dimensions of uniqueness by which respondents can distinguish them from each other: first, the Sonaghan is endemic to the study area, making the scope of its habitat smaller than the other four. The Arctic char may also be of importance for the smaller scope of its habitat since the lakes where it can be found are more numerous compared to the Sonaghan, but less numerous than the remaining three species. Second, all species except for the Arctic char have use value for recreational fishing due to their angling potential. Finally, the uniqueness of a species' public profile is of critical importance, with Atlantic salmon being the most recognizable of the five fish species by the sample and the Sonaghan being known to fewer respondents. Approximately 89 percent of the sample had previously heard of Atlantic salmon, whereas only 9 percent had heard of the Sonaghan beforehand. Respondents were presented a visual prompt with a picture of the five fish species, but no other framing devices were used.

The discrete choice experiment was structured as a panel of sixteen repeated non-labeled choice tasks. Each choice task outlined three possible outcomes. The first two choice options, 'option A' and 'option B', described the conservation status of each of the fish species as either 'conserved' or 'extinct' in the catchment after implementation of each respective conservation project (see Morse-jones et al., 2012; Cerda et al., 2013, for similar conserved/ extinct attribute descriptions). Both 'option A' and 'option B' conserved at least some or all of the fish species while respondents were informed that the third outcome, labeled as 'do nothing', meant that all five fish species would become extinct. Options 'A' and 'B' had a positive cost associated with their conservation outcomes, using one of the following cost levels: €3, €6, €12, €24 or €48. The 'do nothing' alternative entailed a zero cost to the respondent. An example choice card is shown in Figure 2. The full text of the choice experiment script is included in the appendix.

(Figure 2 about here)

The payment mechanism used was a one time increase in the Income Tax and/or Value Added Tax contributions that respondents alone, not their household, would personally have to pay. Prior to completing the choice experiment, a standard cheap talk script was read to respondents explaining that people may overstate their willingness-to-pay and requested they consider the impact of the additional cost on their budgets. Before each task respondents were reminded to consider whether they felt the outcomes were worth it and if they could realistically afford it. Also prior to starting the choice experiment, respondents were asked if they had heard of each of the five fish species prior to the interview. The experimental design was obtained using an algorithm that minimized the variance of the sum of the marginal willingness to pays (Scarpa and Rose, 2008) and invoked Bayesian assumptions informed on estimates from pilot studies (Vermeulen et al., 2011). Specifically, a search process was automated using Visual Basic macros constructed in Microsoft Excel with the asymptotic variance covariance matrices of the designs constructed using matrix algebra manipulation formulas in Microsoft Excel.[1]

The population of interest was the adult population of the Republic of Ireland and Northern Ireland. The study adopted a stratified random sample to reflect the geographic distribution of the adult population; the approximate rural/urban split; the approximate socio-economic status of the regional population; and the approximate gender and age profile of the populations within both jurisdictions. Interviewers collected the sociodemographic information mentioned in the previous sentence from each potential respondent prior to each interview to make sure the sample was representative of the target population. If the potential respondent did not fit the required quotas, the interviewer would thank them and move on to another potential respondent who did fit the quota requirements. Including respondents who answered the required socio-demographic questions, a sample of 516 usable interviews was obtained which, with each respondent answering sixteen choice tasks, resulted in 8,256 choice observations for analysis. For further analysis on this data interested readers are referred to Campbell et al. (2010, 2012, 2015).

3.3 Econometric analysis

Discrete choice data can be analyzed in a random utility framework. We assume that respondents are maximizing utility and that their choices can be described by a random utility model. Let

[1] We thank John Rose for sharing his code.

respondents be indexed by n, the chosen alternative by i and the choice occasion by t. We assume a linear-in-the-parameters additive utility function on the form:

$$U_{nit} = C_i + \beta X_{nit} + \varepsilon_{nit} \tag{1}$$

where C_i is an alternative specific constant, X_{nit} a vector of attribute levels for alternative i, β a vector of parameters to be estimated and ε_{nit} an *i.i.d.* type I extreme value distributed error term with constant variance $\pi^2/6$. Under these assumptions, the probability that individual n chooses alternative i in choice occasion t can be described by the multinomial logit model (McFadden, 1973) in Equation 2.

$$\Pr(i_{nt}|C,\beta,X_{nit}) = \frac{\exp(C_i + \beta X_{nit})}{\sum_{j \in J} \exp(C_j + \beta X_{njt})} \tag{2}$$

where J is the set of alternatives available at choice occasion t. We can write the probability of the sequence of choices for individual n, $y_n =< i_{n1}, i_{n2}, \ldots, i_{nT} >$ where T is the total number of choice occasions, using Equation 3:

$$\Pr(y_n|C,\beta,X_n) = \prod_{t=1}^{T} \Pr(i_{nt}|C,\beta,X_{nit}) \tag{3}$$

To allow for preference heterogeneity and to understand better how different respondents might value the species under consideration we use a latent class model. In a latent class model, respondents are assumed to belong to one of several preference classes where preference homogeneity exists within classes and heterogeneity exists between classes. Which class any given respondent belongs to is unobservable by the analyst, but we can make probabilistic statements about class membership. Let the unconditional probability that individual n belongs to class $q \in Q$ be described by Equation 4:

$$\pi_q = \frac{\exp(\alpha_q + \psi_q Z_n)}{\sum\limits_{q \in Q} \exp(\alpha_q + \psi_q Z_n)} \quad \text{with} \quad \sum_{q \in Q} \pi_q = 1 \tag{4}$$

where α_q is a class specific constant, Z_n a vector of individual specific covariates (e.g., socio-demographic variables) and ψ_q a vector of class specific parameters to be estimated. For identification purposes, α and ψ are fixed to zero for one class. We can write the joint unconditional probability of being in a given class and their sequence of choices by multiplying the class probability function in Equation 4 with the class specific sequence of choices as shown in Equation 5:

$$\Pr(y_n | C, \beta, X_n, \alpha, \psi) = \sum_{q \in Q} \pi_q \prod_{t=1}^{T} \frac{\exp(C_{iq} + \beta_q X_{nit})}{\sum_{j \in J} \exp(C_{jq} + \beta_q X_{njt})} \tag{5}$$

where C_q and β_q are class specific preference parameters to be estimated.

To help with interpretation, we derive both unconditional class membership probabilities and conditional class membership probabilities to use for obtaining unconditional and conditional marginal rates of substitution estimates, respectively. Unconditional class membership probabilities are calculated exclusively as per the coefficients of the latent class specification outlined in the following subsection, while conditional probabilities also take into consideration the series of choices each respondent made in calculating their probabilistic latent class membership. As such, the conditional marginal rate of substitution estimates, derived using conditional class membership probabilities, can be interpreted as individual-specific. We obtain the conditional probabilities using Bayes rule (Train, 2009), as shown in Equation 6:

$$\pi_{q|y_n} = \frac{\pi_q \Pr(y_n|X_n, C_q, \beta_q)}{\sum_{q=1}^{Q} \pi_q \Pr(y_n|X_n, C_q, \beta_q)}. \tag{6}$$

To facilitate interpretation of how distance influences the unconditional marginal rate of substitution, we extrapolate them to the map of Ireland using the regression Kriging prediction. Kriging, which has been used by (Campbell et al., 2009) and (Czajkowski et al., 2017) in similar contexts, is a geostatistical technique that is based on the assumption that nearby values contribute more to the interpolated values than do distant observations. In Kriging, the surrounding measured values are weighted to derive a prediction for an unmeasured location. Our rationale for using Kriging is that it is considered an optimal spatial interpolation technique since will provide the best linear unbiased estimate of the value of marginal rate of substitution at any point in the coverage. For further discussion on the theory of Kriging and its implementation see (Cressie, 1993).

3.4 Model specification

The non-cost attributes are the respective fish species in the Lough Melvin Catchment that were included in the discrete choice experiment and the cost attribute is a lump sum one-time payment for a conservation program with no explicit time horizon. We show the utility specification for class q in Equation 7.

$$\beta_q X_{nit} = \beta_{q_1}\text{Arctic char} + \beta_{q_2}\text{Atlantic salmon} + \beta_{q_3}\text{Ferox} + \beta_{q_4}\text{Gillaroo} + \beta_{q_5}\text{Sonaghan} + \beta_{q_6}\frac{\text{Cost}}{R_n}, \tag{7}$$

where R_n is respondent n's personal (not household) weekly income. Scaling the cost attribute by weekly income allows us to express the cost of each scenario as a share of weekly income and estimate the marginal utilities in terms of this cost share. Respondents reported their weekly income as belonging to one of nine intervals, and we used the midpoint of each interval as a proxy. Since individuals with lower incomes may be more concerned about costs than those with higher incomes (Train, 2009, page 73), the weekly income share allows us to directly consider income in the estimation of the utility functions without estimating additional parameters (Giergiczny et al., 2012; Kassahun et al., 2021; Ben-Akiva and Lerman, 1985, page 160).

The significance of the income share becomes clear when we consider WTP. The assumptions inherent in our models mean that everyone in the same latent class is willing to pay the same share of their weekly income, but because weekly income differs between respondents, WTP differs even within latent classes.[2] We acknowledge that using an income share requires the use of self-reported income in this case, and could possibly introduce some measurement error. Although survey respondents tend to under-report their actual household income (Davern et al., 2005), this survey asked respondents for their personal income, which provides a more reliable income measure and lower item non-response rates compared to when respondents are asked to estimate the combined income of other members of the household (Micklewright and Schnepf, 2010). So, the particular way in which income is gathered and incorporated into our models is likely less problematic than other survey data.[3]

Expressing WTP as an income share allows for the marginal utility of money to differ along the income distribution. Specifically, WTP estimates are derived in terms of the proportion of weekly income a respondent would be willing to give up in a one-time payment for species conservation. From our specification, one can multiply the income share WTP estimates (presented in the tables) with the respondent's income and weight by the unconditional or conditional class membership probability to derive the unconditional or conditional marginal willingness-to-pay, respectively. For example, the conditional marginal willingness-to-pay for the Arctic char species

[2] We justify our decision based on the ability of our specification to account for differences in marginal utility of income and the possibility that respondents may relate the costs of the conservation program to their weekly budgets, thus easing mental accounting (Thaler, 1990). To confirm that our specification accurately identifies respondents who said they prioritized the Sonaghan in the valuation task, we refer to Table IV to confirm that, on average, respondents who said the Sonaghan was "very important" in the valuation tasks have a higher conditional marginal rate of substitution.

[3] Another possible challenge is potential endogeneity between the respondent-specific covariates entering the latent class equations and respondent income, which enters into the utility functions. To explore the potential endogeneity issue, we ran a series of Monte Carlo simulations with over 50,000 simulated data sets in which correlations between individual-specific covariates were varied from very low (almost 0) to very high (maximum 0.71). Simulations revealed that endogeneity concerns emerge as the correlation between income and the covariate in the latent class equation becomes large (above 0.5) or if the covariate in question is the main driver of latent class membership. Neither of these conditions are the case here, which alleviates any endogeneity concerns arising from our approach for these specific data. Furthermore, the Appendix presents results from a latent class specification with cost, not income share, in the utility function to confirm our main results are not dependent on this particular utility specification.

would be:

$$\text{WTP}_{\text{Arctic char},n} = -R_n \sum_{q \in Q} \pi_{q|y_n} \frac{\beta_{q_1}}{\beta_{q_6}}. \tag{8}$$

More important for this paper is to compare respondent preferences for an esoteric, endemic species with a familiar yet non-endemic species. For this reason, we concentrate our analysis on the marginal rates of substitution between the two main species of interest. We obtain both an unconditional and a conditional marginal rate of substitution value as an estimate of how much conservation of Atlantic salmon each respondent would be willing to forgo in order to increase conservation of Sonaghan. The conditional marginal rate of substitution we calculate is shown below:

$$\text{MRS}_n = \left| \sum_{q \in Q} \pi_{q|y_n} \frac{\beta_{q_5}}{\beta_{q_2}} \right| \tag{9}$$

while the unconditional estimates are instead obtained using unconditional class membership probabilities. In cases where this relative measure is greater than 1, it means that respondents have a higher marginal utility for Sonaghan conservation compared to Atlantic Salmon conservation, equal to 1 means that respondents are indifferent between the species, and less than 1 means that respondents have a higher marginal utility for conserving Atlantic salmon relative to Sonaghan.

In this paper, we are particularly interested in the distance decay of the marginal rate of substitution between Sonaghan and Atlantic salmon, which makes geographical information about respondents' primary residences critical for investigation. Therefore, where respondents live in relation to Lough Melvin, if they reside in Northern Ireland or the Republic of Ireland, and if they live in a rural area are important geographic factors to include in latent class identification. In addition to the geographic characteristics of respondents' primary residences, whether or not they are recreational anglers (i.e., if we can say they have actual or potential use value for four of the five choice attributes) is also important to consider. Specifically, the covariates entering the class membership probability function are as follows:

$$\psi_q Z_n = \psi_{1,q}\text{Distance} + \psi_{2,q}\text{RoI} + \psi_{3,q}\text{Rural} + \psi_{4,q}\text{Angler}. \tag{10}$$

Distance from the Lough Melvin catchment is a continuous variable based on the Euclidean distance, in kilometers, between the study site and the location of each respondent's primary residence (Glenk et al., 2019). For environmental goods that have clear use value, distance is occasionally treated as a choice attribute in the utility function (e.g. Hanley et al., 2003); however, we can only be certain that anglers have actual or potential use value for this application. Due to the low number of anglers in this sample, around 8 percent of usable responses, anglers are not treated differently for distance effects but instead assigned a 1 in the 'Angler' indicator variable. Particularly since the Arctic char in Lough Melvin are the last remaining population in Northern Ireland, the 'RoI' indicator variable is included with 1 for respondents who reside in the Republic and 0 for those in Northern Ireland. The 'Rural' indicator variable is coded as 0 for respondents who live in a city or town and 1 for those who live in more sparsely populated areas. The purpose of this indicator variable is to allow for preference heterogeneity based on the degree of urbanization where respondents live.

Latent class multinomial logit models were programmed by the authors using the open source software R (R Core Team, 2018). Models were optimized with the maxLik package (Henningsen and Toomet, 2011) using multiple vectors of starting values to check for local optima. Figures 2 and 3 are created using ggplot2 (Wickham, 2016).

4 Results

The appropriate number of latent classes was selected based on extensive testing that gave consideration to both model fit as well as behavioral interpretability (Keane and Wasi, 2013). The Bayesian Information Criteria for a model with five latent classes (11,643.6222 and Log Likelihood -5,573.7970) indicates a worse fit to the data compared to the Bayesian Information Criteria for the model with four latent classes (11,555.3134 and Log Likelihood -5,583.7547). Furthermore, models with five or more latent classes lead to a positive estimate of the cost paramater for some classes. Given a positive estimate of the cost parameter implies a negative marginal utility of money, we selected the best fitting model that is also consistent with economic theory. Consequently, the model with four latent classes was chosen for analysis.[4]

Using four latent classes reveals heterogeneity between respondents who have a relatively high willingness to pay for conservation overall, which facilitates easily interpretable preference types.

[4]We acknowledge that attribute non-attendance is present in these data and may become apparent when accounting for additional heterogeneity beyond the four latent classes we present. Readers who are interested in attribute non-attendance aspects of these data are referred to Campbell et al. (2010, 2012, 2015).

Results from the model with four classes are presented in Table I and class specific willingness-to-pay estimates in terms of weekly income proportions and marginal rates of substitution are presented in Table II. The term “ASC” in Table I stands for “alternative specific constant.” The reported WTP figures in Table II are directly interpretable as the share of a respondent’s weekly income they are willing to pay. For example, a WTP of 0.9 means members of that latent class are willing to pay 90% of their weekly income in a *one time payment* to preserve a particular fish species from extinction.

(table I about here)

From these results, we can see that two latent classes can be identified as being relatively cost insensitive while the other two classes are extremely cost sensitive, producing classes with high and low willingness-to-pay, respectively. Justifying our focus on only two species among the possible five, we draw attention to the fact that one of the high willingness-to-pay classes is found to place the highest value on conserving the familiar, non-endemic Atlantic salmon, while the other latent class with high willingness-to-pay is found to place highest value on conserving the esoteric, endemic Sonaghan. For this reason, we label these two classes as ‘High WTP (a) *familiar*’ and ‘High WTP (b) *endemic*,’ respectively. While the two classes with low willingness-to-pay are found to be willing to contribute a very small proportion of income to conserving any of the fish species, notwithstanding statistical significance, there is, again, a distinction in these classes in the values placed on familiar and non-familiar species. One of the low WTP classes places the highest value on conserving the Ferox, also a relatively unfamiliar species, while another places the highest value on conserving the familiar Atlantic salmon. For this reason, we label these classes ‘Low WTP (a) *non-familiar*’ and ‘Low WTP (b) *familiar*,’ respectively.

At the sample level, both the unconditional and conditional class membership assignments estimate approximately 62 percent of respondents belong to one of the high willingness-to-pay classes. Table II clearly shows the importance of the Atlantic salmon in the 'High WTP (a) *familiar*' class and the Sonaghan in the 'High WTP (b) *endemic*' class with each respective species having a willingness-to-pay estimate over two orders of magnitude higher than the species with the next highest WTP. To briefly mention the marginal rates of substitution between the other species and the Atlantic salmon, the marginal rates of substitution of Arctic char, Ferox, and Gillaroo are below 1 for all classes, with the exception of the 'High WTP (b) *endemic*' class. For the 'High WTP (b) *endemic*' class, the marginal rates of substitution for Arctic char, Ferox, and Gillaroo are 1.552, 1.193, and 1.324, respectively. In accordance with expectations that familiar species attract more attention relative to non-familiar species, the estimated size of the 'High WTP (b) *endemic*' class is slightly more than half the size of the class valuing the Atlantic salmon highest, based on both conditional and unconditional estimates, (57% and 59% respectively). Most covariates in the latent class functions are not statistically significant aside from the class specific constants and distance.

(Table II about here)

Figure 3 presents a Kriging prediction of the unconditional marginal rate of substitution estimate. Also in accordance with studies finding insignificant or non-monotonic distance decay effects in WTP for species conservation, Figure 3 shows the concentration of relatively higher marginal rate of substitution exists close to Lough Melvin is not monotonically decreasing with increasing distance. There is a concentration of a relatively higher marginal rate of substitution between

Sonaghan and Atlantic Salmon (i.e. how much Atlantic Salmon conservation respondents are willing to forgo to increase Sonaghan conservation) close to Lough Melvin and in Northern Ireland. The concentration of a higher unconditional marginal rate of substitution near Lough Melvin is a result of a combination of the individual-specific variables in the latent class functions.

(Figure 3 about here)

To explain the pattern in Figure 3, we calculate which respondents have a marginal rate of substitution significantly larger than 0 (33 respondents) and present the means of those respondents' covariate values in Table III. Table III shows that while respondents with a higher unconditional marginal rate of substitution more often live in Northern Ireland, in Rural areas, and at an average of 135 kilometers from Lough Melvin, being an Angler is strongly associated with a higher marginal rate of substitution. We note that the average distance from Lough Melvin of the respondents with an unconditional marginal rate of substitution greater than 0 is closer to Lough Melvin than the sample average of about 155 kilometers.

(Table III about here)

Due to the negative and insignificant utility estimate on the Atlantic salmon for the 'Low WTP (a) *non-familiar*' class, 142 (27.5%) respondents have a negative conditional utility estimate for the Atlantic salmon. Such respondents are excluded from the following presentations of conditional MRS estimates since individual-specific estimates imply these respondents do not in fact face a trade-off between the Sonaghan and Atlantic salmon, which is the main focus of our analysis. Furthermore, given the low proportion of weekly income this class is willing to pay for conservation overall and our focus on identifying heterogeneity among conservation-minded individuals, their exclusion from conditional MRS results does not hinder the main aim of this study.

Figure 4 shows the distribution of conditional marginal rates of substitution between the Sonaghan and Atlantic salmon. This distribution further illustrates the relative appeal of an unlikely choice for a flagship species, one which is endemic yet unknown to most respondents, to a sub-section of respondents with high WTP for conservation. As for the geographic dimension of the distribution, Figure 5 shows the average conditional MRS (i.e. the individual-specific estimate of how much conservation of Atlantic salmon respondents are willing to forgo to increase Sonaghan conservation) based on 50 kilometer distance increments from Lough Melvin. While respondents living within a 50 kilometer radius of Lough Melvin tend to have a higher conditional MRS estimate, the effect of distance is not monotonic. In particular, respondents living 150 – 200 kilometers from the catchment also have a stronger preference for Sonaghan conservation relative to Atlantic salmon conservation, on average. In other words, respondents with a relatively stronger preference for unfamiliar, endemic species relative to familiar, non-endemic species are distributed nationally, but one such concentration exists within 50km of the endemic species' habitat. Conversely, respondents living 200 – 250km and 250+km from Lough Melvin tend to have a stronger relative preference for the familiar yet non-endemic species, on average.

(Table III about here)

To confirm results from our latent class model specification, we compare conditional marginal rates of substitution to the importance respondents said they gave to the Sonaghan in the valuation task using a Likert scale. The Likert scale questions asked respondents to express the importance they ascribed to each species in the valuation task with 1 indicating 'not important' and 5 indicating 'very important.' Respondents were asked to perform this ranking after the valuation task. Table IV shows the average marginal rate of substitution for respondents based on how important respondents thought it was to prioritize Sonaghan in the valuation task. Respondents who said they thought Sonaghan were 'very important' in the valuation task have, on average, a marginal rate of substitution estimate more than twice that of respondents who said the Sonaghan was less than 'very important.' The substantially higher average conditional marginal rate of substitution among respondents who said they thought it was 'very important' to prioritize the Sonaghan illustrates that our model specification produces results that are consistent with how relatively important respondents considered the previously unknown but endemic species.

(Table IV about here)

As another check to confirm results from our latent class model specification, we ran a model with cost, not income share, in the utility function and present results in the Appendix. A model with four latent classes produces two classes that are qualitatively similar to our two main classes of interest (i.e. a 'High WTP (a) *familiar*' class and a 'High WTP (b) *endemic*' class), with each class being of similar size compared to our model with income share in the utility function. Key results concerning the conditional and unconditional marginal rate of substitution are qualitatively similar, as seen in Table VI, which replicates Table IV, and Figure 6, which replicates the Kriging predictions from Figure 3. Due to the insignificant coefficients on the cost parameter for our two main classes of interest in the model with cost in the utility function, see Table V, the model with income share is preferred since it is compatible with Random Utility Theory.

Taken together, our results show respondents who place high importance on the esoteric yet endemic species are distributed throughout Ireland, but one geographic concentration of such respondents exists close to the endemic species' habitat. These results suggest there may be a localization effect of which species respondents prioritize even if relative preferences for species with different familiarity and biodiversity attributes do not exhibit monotonic distance decay. Finally, respondents who report they had not previously heard of the Sonaghan actually had a higher conditional MRS estimate, on average, than those who had prior knowledge of the species, at 1.357 and 1.102, respectively. This difference based on prior species knowledge indicates respondents who ascribe a higher relative value to the Sonaghan compared to the Atlantic Salmon tend to do so despite a lack of familiarity with the Sonaghan.

5 Discussion and Conclusion

Easily recognizable wildlife tend to be chosen as flagship species to represent a range of biodiversity that often includes esoteric species. While familiar species may have a widespread appeal for conservation education and outreach, some environmentally conscious individuals may have a relatively stronger preference for species with biodiversity attributes even if substitute species are better known to them. This paper has investigated relative preferences for a little-known Brown trout called the Sonaghan, which is endemic to the Lough Melvin catchment in Ireland, with the widely familiar Atlantic salmon, which lives in catchments across Ireland and the UK. Findings show that while the Atlantic salmon may have the strongest relative appeal to the greatest number of respondents with high marginal WTP for conservation, a distinct group of respondents with high marginal WTP for conservation prioritize the endemic Sonaghan. While respondents with stronger relative preferences for the Sonaghan compared to the Atlantic salmon are distributed throughout Ireland, one concentration of such respondents exists close to Lough Melvin, the Sonaghan's only habitat.

These results contribute to the stated preferences valuation literature on species conservation by suggesting distance decay in relative preferences for species with different familiarity and biodiversity characteristics, separate from the frequent absence of distance decay in absolute WTP found in other studies (e.g. Lew, 2015; Richardson and Loomis, 2008). It is possible to imagine similar results for other species that are not a clear nuisance to humans living in close proximity to them, although more research is needed to make generalizations. Additionally, these results may be more common in stated preferences surveys in which all species have the same or similar phylogenetic relationship to humans, have use value for no or only a small proportion of respondents, and do not contain a species with obvious iconic, cultural, or national status.

Some limitations of the study are important to note. With such a small percentage of recreational anglers in the sample (8%) who have actual or potential use value for four of the five species, it was not feasible to investigate different distance decay effects for respondents with use value and those who presumably have primarily non-use value for the species investigated. Conversely, we note that this study did not explore the possibility that non-angler respondents may have considered the option value of recreational angling for four of the five fish species when completing choice tasks. In general, use value can be expected to decrease with increasing distance from the object of valuation due to implicit travel or search costs and the proximity of substitutes (e.g. Hanley et al., 2003; Campbell et al., 2009). Glenk et al. (2019) note that when the value in question is primarily non-use value, there is no clear guidance for economic theory on how distance should affect valuation. Our results should be interpreted as largely applying to the distance decay effects of non-use value, which generally tends to exhibit little or no decrease with increasing distance from the object of valuation in empirical studies (Concu, 2007; Glenk et al., 2019). Future studies could investigate if the distance decay of relative non-use values for species conservation is influenced by the geographic distribution of substitute species with varying familiarity and biodiversity attributes which were not included in this study (e.g. Johnston et al., 2015; Schaafsma et al., 2013).

As conservation programs attempt to diversify the number and kinds of species used for outreach efforts (Barua et al., 2011), this study lends further support to the idea that different kinds of species can appeal to different segments of the public (Veríssimo et al., 2013b; Bennett et al., 2015). Although familiar species may appeal to relatively more members of the public who are willing to pay for conservation, unfamiliar species with particular biodiversity characteristics may be relatively preferred by a distinct group of conservation-minded individuals. These results suggest the geographic distribution of the public that responds to species with biodiversity attributes, despite their lack of familiarity, is likely widespread but could include locations relatively close to those particular species' habitats.

Although all biodiversity is important, lesser-known biota must often compete with familiar, charismatic, or even iconic species for public and private conservation funding. Investigating the kinds of trade-offs the public is willing to make between unfamiliar species with unique biodiversity characteristics and familiar species can have important applications since much of the world's biodiversity is often unknown to the public. Similar to findings of absolute willingness to pay from other stated preferences literature, this study shows relative preferences for the existence of a species with an important biodiversity characteristic is not limited by geographic location. Adding novelty to the literature, this study shows individuals who live relatively close to unfamiliar species may be among those who are more likely to value such species higher relative to more familiar substitute species.

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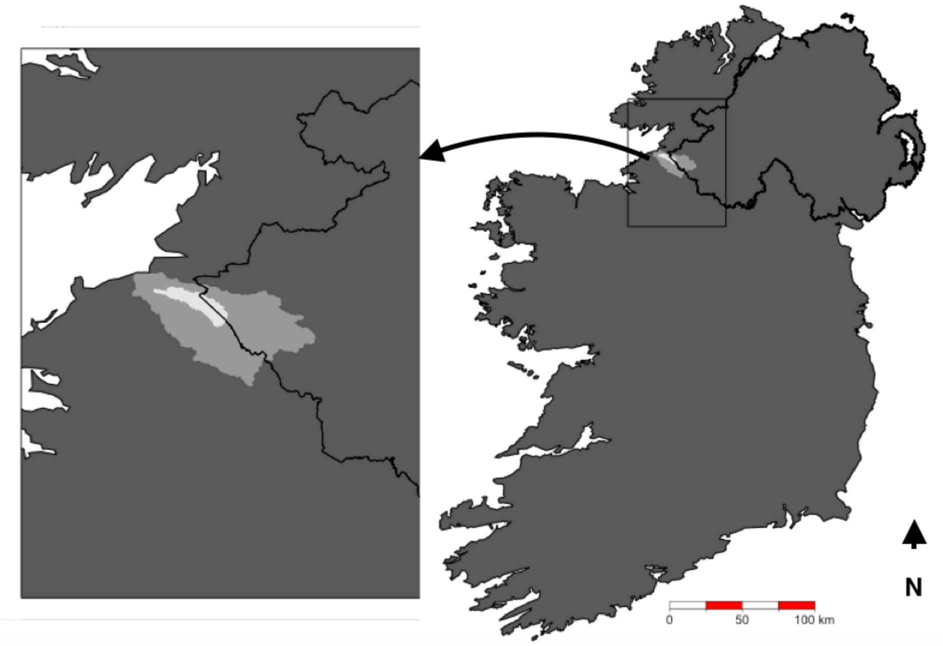

Figure 1 - Map of study area. The Lough Melvin catchment is colored in medium gray and the lake itself in light gray. The border between Northern Ireland and the Republic of Ireland is indicated with a dark

Which outcome would you most prefer?

	Option A	Option B	Do Nothing
Arctic Char • Not found in other catchments in NI but found in other catchments in RoI. • Has no angling potential.	Conserved	Extinct	Extinct
Atlantic Salmon • Found in other catchments in NI and RoI. • Has angling potential.	Extinct	Conserved	Extinct
Ferox • Found in other catchments in NI and RoI. • Has angling potential.	Conserved	Extinct	Extinct
Gillaroo • Found in other catchments in NI and RoI. • Has angling potential.	Extinct	Conserved	Extinct
Sonaghan • Only found in the Lough Melvin Catchment. • Has angling potential.	Extinct	Conserved	Extinct
Cost of the outcome to you	€6	€24	€0

Figure 2 - Example choice card

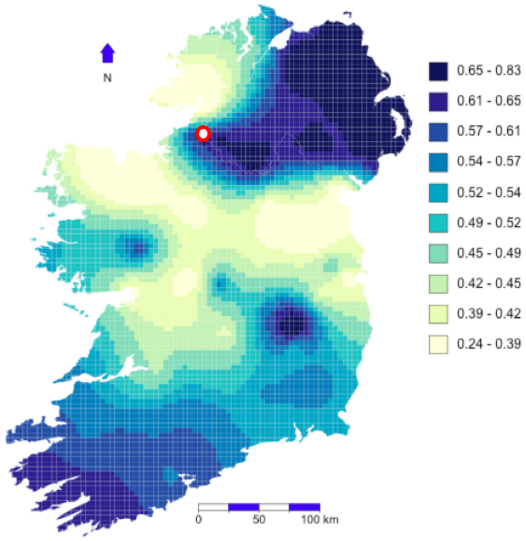

Figure 3 - Kriging predictions of the unconditional marginal rate of substitution between Sonaghan and Atlantic Salmon (i.e. how much Atlantic Salmon conservation respondents are willing to forgo to increase Sonaghan conservation.) The location of Lough Melvin is shown with a red and white dot.

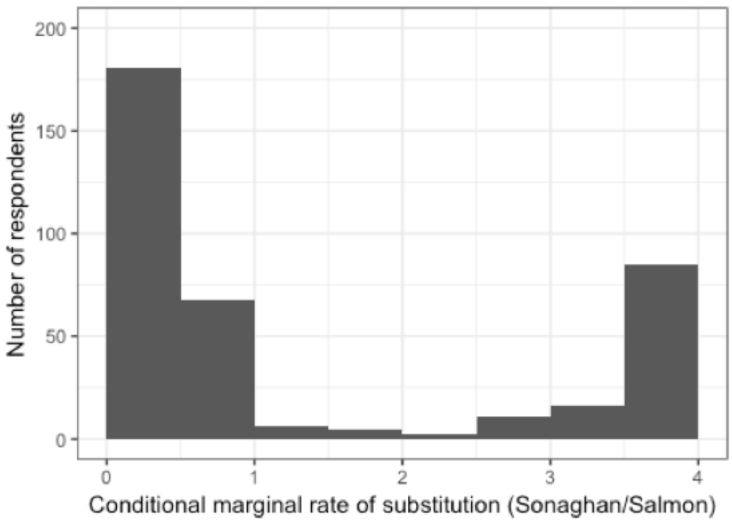

Figure 4 - Distribution of conditional marginal rate of substitution estimates (Sonaghan/Atlantic salmon). Excludes respondents with a negative conditional marginal rate of substitution estimate.

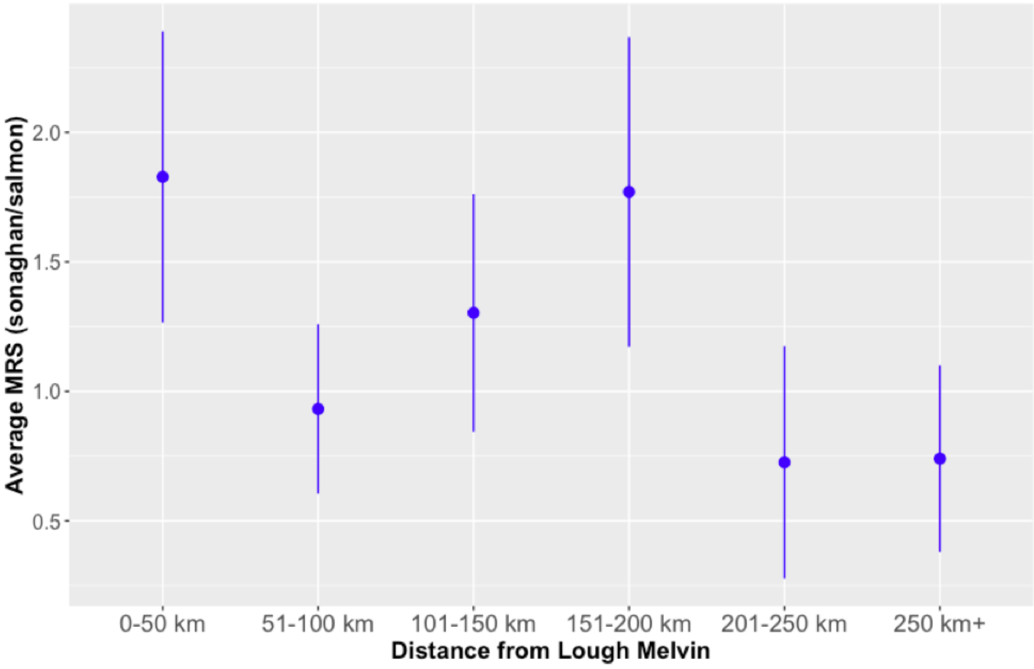

Figure 5 - Average conditional marginal rate of substitution by distance from Lough Melvin. Excludes respondents with a negative conditional marginal rate of substitution estimate.

Table I - The latent class model. Standard errors in parentheses.

	High WTP (a) *familiar*	High WTP (b) *endemic*	Low WTP (a) *non-familiar*	Low WTP (b) *familiar*
Arctic Char	0.396***	0.984***	0.045	0.208*
	(0.072)	(0.161)	(0.093)	(0.113)
Atl Salmon	1.167***	0.634***	-0.048	0.392**
	(0.104)	(0.137)	(0.106)	(0.190)
Ferox	0.321***	0.757***	0.190***	-0.090
	(0.070)	(0.110)	(0.076)	(0.115)
Gillaroo	0.517***	0.839***	0.113	0.270*
	(0.076)	(0.108)	(0.083)	(0.138)
Sonaghan	0.174**	2.427***	0.095	0.249
	(0.085)	(0.333)	(0.109)	(0.168)
Cost/ Inc	-1.020**	-1.294	-16.974***	-72.725***
	(0.471)	(0.940)	(1.109)	(2.686)
ASC	-2.163***	-2.275***	-2.530***	-1.186***
	(0.299)	(0.740)	(0.254)	(0.314)
	Class probability memberships			
Constant	2.407**	2.087**	2.427***	
	(0.735)	(0.713)	(0.727)	
Distance	-0.008*	-0.009**	-0.011***	
	(0.003)	(0.003)	(0.003)	
RoI	-0.307	-0.389	0.055	
	(0.525)	(0.604)	(0.626)	
Rural	0.314	0.167	-0.057	
	(0.432)	(0.527)	(0.570)	
Angler	0.498	0.59	-0.643	
	(0.54)	(0.613)	(0.791)	
	Average proportions of class membership (unconditional)			
	0.3983	0.2266	0.2363	0.1388
	Average proportions of class membership (conditional)*			
	0.3876	0.2287	0.2287	0.1415
LL		-5,583.8		
BIC		11555.3		
Rho. Sq. (Adj.)		0.380		
N		8,256		

'***' - 1% level, '**' - 5% level and '*' - 10% level of significance.
*Conditional class membership proportions were calculated by assigning individuals to the class for which they have a greater than 50% conditional probability of membership. 1.357% of respondents not assigned to a class.

Table II - Class specific willingness to pay in proportion of weekly income, marginal rates of substitution, and class membership proportions. Numbers in (parentheses) show willingness to pay in proportion of annual income.

	High WTP (a) *familiar*	High WTP (b) *endemic*	Low WTP (a) *non-familiar*	Low WTP (b) *familiar*
Arctic char	0.389	0.760	0.003	−0.003
	[0.197, 0.581]	[0.058, 1.463]	[−0.005, 0.011]	[−0.006, 0.000]
	(0.0075)	(0.0146)	(0.0001)	(−0.0001)
Atlantic salmon	1.144	0.490	−0.003	0.005
	[0.618, 1.670]	[0.039, 0.941]	[−0.011, 0.006]	[0.002, 0.009]
	(0.0220)	(0.0094)	(−0.0001)	(0.0001)
Ferox	0.315	0.585	0.011	−0.001
	[0.156, 0.477]	[0.050, 1.125]	[0.004, 0.018]	[−0.004, 0.002]
	(0.0061)	(0.0113)	(0.0002)	(0.0000)
Gillaroo	0.507	0.649	0.007	0.004
	[0.260, 0.754]	[0.036, 1.262]	[−0.001, 0.015]	[0.001, 0.007]
	(0.0098)	(0.0125)	(0.0001)	(0.0001)
Sonoghan	0.171	1.876	0.006	0.003
	[0.052, 0.291]	[0.176, 3.575]	[−0.003, 0.014]	[0.000, 0.006]
	(0.0033)	(0.0361)	(0.0001)	(0.0001)
Marginal rate of substitution (Sonaghan/ Atlantic salmon)				
	0.150	3.828	−1.982	0.635
	[0.057, 0.242]	[2.701, 4.954]	[−9.309, 5.344]	[0.068, 1.202]
Average proportions of class membership (unconditional)				
	0.3983	0.2266	0.2363	0.1388
Average proportions of class membership (conditional)*				
	0.3876	0.2287	0.2287	0.1415

*Conditional class membership proportions were calculated by assigning individuals to the class for which they have a greater than 50% conditional probability of membership. 1.357% of respondents not assigned to a class. Numbers in brackets show upper and lower bounds of 95% confidence intervals.

Table III - Explaining Figure 3: means of covariates for respondents with an unconditional MRS significantly greater than 0. (33 respondents have an unconditional MRS estimate significantly higher than 0.)

	Average value (MRS>0)	Sample average value
Northern Ireland	0.636	0.401
Angler	1.000	0.076
Rural	0.455	0.382
Distance	135.645	154.690

Table IV - Average MRS (sonaghan/ atlantic salmon) based on how important respondents thought it was to prioritize Sonaghan in the valuation task. Excludes respondents with a negative conditional marginal rate of substitution estimate.

		n	Avg MRS
Not important	1	68	0.865
	2	46	0.778
	3	74	0.857
	4	54	1.049
Very important	5	117	2.392
total		359	

6 Appendix

Table V - A latent class model with only cost in the utility function- Compare to Table I. Standard errors in parentheses.

	High WTP (a) *familiar*	High WTP (b) *endemic*	Low WTP (a) *Both*	Low WTP (b) *familiar & unfamiliar*
Arctic Char	0.325***	0.943***	0.133	-0.089
	(0.068)	(0.139)	(0.116)	(0.110)
Atl Salmon	0.996***	0.608***	0.380**	0.494*
	(0.102)	(0.137)	(0.142)	(0.199)
Ferox	0.257***	0.735***	0.314***	-0.131
	(0.083)	(0.102)	(0.084)	(0.112)
Gillaroo	0.456***	0.847***	0.195*	0.495**
	(0.083)	(0.108)	(0.093)	(0.166)
Sonaghan	0.123	2.398***	0.380**	0.201
	(0.079)	(0.315)	(0.121)	(0.176)
Cost	0.004	-0.006	-0.081***	-0.108***
	(0.002)	(0.008)	(1.109)	(0.019)
ASC	-2.332***	-2.170***	-2.770***	-0.348
	(0.445)	(0.594)	(0.464)	(0.372)
	Class probability memberships			
Constant	0.617		-0.500	-1.584**
	(0.467)		(0.472)	(0.515)
Distance	-0.001		0.002	0.007*
	(0.002)		(0.002)	(0.003)
RoI	0.139		0.537	-0.090
	(0.355)		(0.444)	(0.465)
Rural	-0.039		0.003	-0.220
	(0.265)		(0.293)	(0.338)
Angler	0.068		-2.389)*	-0.009
	(0.546)		(1.010)	(0.715)
	Average proportions of class membership (unconditional)			
	0.4100	0.2254	0.2387	0.1259
	Average proportions of class membership (conditional)*			
	0.4100	0.2255	0.2386	0.1259
LL		-5,436.49		
BIC		11260.78		
Rho. Sq. (Adj.)		0.396		
N		8,256		

'***' - 1% level, '**' - 5% level and '*' - 10% level of significance.

Table VI - From a latent class model with only cost in the utility function- Compare to Table IV. Average MRS (sonaghan/ atlantic salmon) based on how important respondents thought it was to prioritize Sonaghan in the valuation task. Includes more respondents compared to the model with income share since all respondents have a conditional MRS estimate greater than 0 in the model with only cost in the utility function.

		n	Avg MRS
Not important	1	98	0.892
	2	71	0.823
	3	102	0.846
	4	77	1.004
Very important	5	149	2.137
total		497	

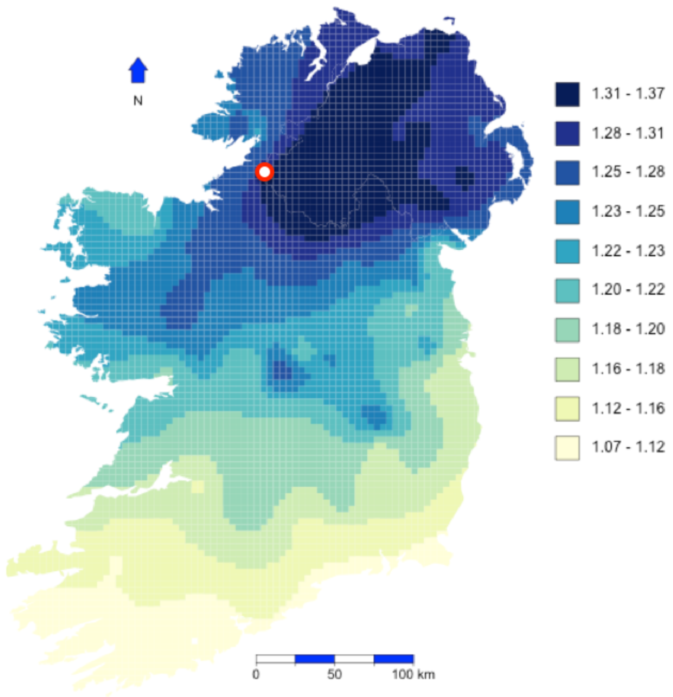

Figure 6 Appendix- Compare to Figure 3. Using a model with cost in the utility function, not income share. Kriging predictions of the unconditional marginal rate of substitution between Sonaghan and Atlantic Salmon (i.e. how much Atlantic Salmon conservation respondents are willing to forgo to increase Sonaghan conservation.) The location of Lough Melvin is shown with a red and white dot.