Economic evaluation of catch-and-release salmon fishing: impact on anglers' willingness to pay

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Abstract

Catch-and-release (C&R) could be an interesting management tool in recreational fisheries as long as mortality remains low and the anglers' well-being does not drop. We used a choice experiment to examine the potential of C&R angling as a monitoring tool for the salmon recreational fishery in Brittany (France). Anglers were asked to choose between hypothetical fishing day trips differing in terms of their combination of relevant attributes and levels. From the analysis of respondents' trade-offs between the fishing trip's attributes, willingness-to-pay were estimated for each level of attribute. Our results show that anglers prefer unrestrictive regulations. All in all, the majority of the anglers nonetheless hold a positive valuation of a C&R fishing day, which could therefore be used to generate economic returns for the river once the TAC is reached. Lastly, the fishing season, and especially the level of river use, impact more on the value of fishing than C&R.

Keywords: recreational activity, salmon fishing, catch and release, choice experiment

JEL Classifications: C25, C9, Q26, Q22

Evaluation économique de la pêche du saumon en « no-kill » : impact sur le consentement à payer des pêcheurs

Résumé

La remise à l’eau des prises peut être une mesure de gestion intéressante dans le cas de la pêche récréative tant que la mortalité demeure faible et que le bien-être des pêcheurs ne diminue pas. Une enquête a été conduite en 2017 auprès des pêcheurs de saumons des trois départements de l'ouest breton, dans le but de leur faire révéler leur consentement à payer pour différents paramètres de gestion de la pêche : saison, total autorisé de capture (TAC), mode de pêche, no-kill, fréquentation. Il était demandé aux pêcheurs de choisir entre des destinations de pêche hypothétiques différant par la combinaison des paramètres de gestion et la distance pour s'y rendre. En moyenne, on observe que le no-kill a un effet dépressif sur la valorisation de la journée de pêche. Cependant, certaines CSP valorisent positivement le no-kill. Au total, il faut retenir que la majorité des pêcheurs conservent néanmoins une valorisation positive de la journée de pêche en no-kill, ce qui permettrait donc de valoriser la rivière après la clôture du TAC. Enfin, la saison de pêche et surtout la fréquentation impactent davantage la valeur de la pêche que le no-kill.

Mots-clés : activité récréative, pêche au saumon, no-kill, expériences de choix

Classifications JEL : C25, C9, Q26, Q22

Economic evaluation of catch-and-release salmon fishing: impact on anglers' willingness to pay

1. Background and purpose

As angling affects fish stocks as well as commercial fisheries, catch and release angling has received increasing attention recently (Arlinghaus et *al*., 2007). North America or some countries in Europe (U.K., The Netherlands) have introduced catch and release as a resource management measure for recreational fishing. But this measure has gained little, if no, traction in France. In other countries such as Germany, voluntary catch and release may lead to conflict with the Animal Protection Act (Arlinghaus et *al.*, 2007). Before it was adopted as a specific management method, the practice was initially associated with restrictions on size limits, removal and species of fish, with release required of any catch not meeting the restrictions imposed by the regulations. In addition to compulsory or regulatory catch and release, some anglers voluntarily catch and release for various personal reasons (philosophical,[1] moral, ethical, etc.). Arlinghaus et *al.* (2007) present the complex and multifaceted nature of catch and release based on historical, physical, socio-psychological, biological and management insights. Tthe practice of catch and release remains controversial, with opinions differing between anglers, biologists and fishing area managers for various reasons. Whereas catch and release is intended as a resource conservation technique, some contend that the practice has damaging biological effects, in particular with a low survival rate after release and biological stress that can affect the growth and reproduction of the fish populations. Others put forward issues of animal welfare (Aas et *al.*, 2002).

Although the practice should be evaluated in biological terms, the economic returns of extending the fishing season with catch-and-release also call for consideration. In terms of direct returns, this calls for an evaluation of the anglers' satisfaction. In terms of indirect returns, it calls for measurement of the induced tourism effects. Measurement of anglers' satisfaction brings into play the concepts of demand and willingness to pay (WTP) for recreational fishing and non-market assets in general. There are two main types of methods used to reveal anglers' WTP. Revealed preference methods examine individuals' observed behaviour ex-post. This is the case with the travel cost method, which seeks to explain the level of use of a recreational site as a function of unit travel costs. The stated preference methods study hypothetical

[1] The value placed on the resource is so high that it is a shame not to catch it once. As much pleasure is derived from the catch itself as from removal for consumption.

behaviour ex-ante and analyse the trade-off made by individuals in the choice of hypothetical situations or goods. These methods include contingent valuation, conjoint analysis and choice experiments. Stated preferences methods are commonly used to elicit angler preferences for new regulations or for fishing trip attributes when some kinds of attributes are not available (Lew and Larson, 2014).

Although the collective benefits of recreational fishing have been largely analysed by the Anglo-Saxon literature based on revealed preference or stated preference methods, very few studies valuing recreational fishing have been conducted for the case of France. Le Goffe and Salanié (2004) analyse the well-being derived from freshwater game fishing. Another study conducted by Salanié et *al.* (2004) paints a picture of salmon anglers' characteristics, their fishing effort and its components. This analysis identifies the management measures valued by recreational fishing users. Many studies establish the link between recreational anglers' well-being and resource management measures. Anglers consider stock conservation measures such as TAC and fish stocking to be beneficial, while they see fishing effort limitation regulations in a negative light. Many recreational fisheries subject to C&R through regulation or conservation-minded anglers have been studied. Lew and Larson (2015) show how certain regulatory measures (limiting individual catches) reduce anglers' satisfaction. They suggest some management policy recommendations to curb excessive pressure on the estuary, especially recreational, while maintaining the users' collective level of well-being. Olaussen (2016) considers catch and release to analyse anglers' preferences for this type of measure for Norwegian Atlantic salmon fishery management. The measure is capable of creating a win-win situation as long as mortality remains low when the fish are released and the anglers' well-being does not drop, since this type of measure could affect the very quality of the fishing experience. Olaussen (2016) concludes that catch and release reduces anglers' utility. Moving to a strict C&R regime reduces the WTP with almost 80% for the Norwegian Atlantic salmon fishery. Although this kind of measure is designed to increase salmon populations and the potential catch rate, it does not offset the loss of well-being due to the regulation's introduction. Olaussen (2016) notes a difference when the measure concerns the release of all fish as opposed to when it concerns the release of fish due to size limits or bag limits. Wilson et *al*. (2016) applied a novel bivariate model of fishing quality based on fish size and catch rates to evaluate angler preferences for C&R compared to harvest fish. They found low preferences for caught and released which modified anglers' perception of fishing quality. For Askey et *al*. (2006), C&R fisheries could exhibit poor angling quality if angler effort is sufficiently high. Their results indicates that catch rates may decline because of high effort even when the number of fish remains constant. This decrease in catch rates could be explained by learned hook avoidance and environmental factors. Johnston et *al*. (2011) studied the implementation of a mandatory C&R regulation and a bait ban on a lake in Canada. Harvest-oriented anglers moved to others lakes because of these restrictive regulation, even if catch-related fishery quality increased. They found a decline in angler effort by 90% suggesting that these regulations may have impacted some anglers' perception about the quality of the lake. As mentioned by Johnston et al. (2011), harvest regulations may alter the attractiveness of a fishery if they are perceived to constrain anglers' opportunity to harvest fish. Only anglers interested in catching trophy-size fish favoured restrictive harvest regulations. Lew and Larson (2015) show that anglers value the possibility of keeping one fish and then releasing subsequent catches. Lew and Larson (2014) estimate separate economic values for catch which is kept and which is released using a choice experiment. They exploited the interaction between catch and bag limit attributes in the CE to construct variables for catch and keep fish, catch and release fish and potential catch as a fish released may be caught again and generate additional value. Their estimates indicate that anglers value much more the fish they keep and less those they are required to release and potential catch, but these last values are still positive. Carter and Liese (2012) found also that keeping a fish was worth more than the value of releasing the fish due to a bag limit. For most of the studied species, angler WTP did not differ much between a fish released due to a bag limit and a fish released due to size limit. However, for fishing tournament, anglers strongly favour tournaments where catch-and-release behaviour is promoted and where there is no bait restrictions (Chi-Ok et *al*., 2006).

In France, few recreational river fisheries have introduced compulsory catch and release as a resource management measure. The River Léguer, one of the most highly frequented game fishing rivers in Brittany (France), is also one of the rare rivers with a significant population of Atlantic salmon. The fishing management method used for the River Léguer is a TAC of spring salmon and one of grilse.[2] Fishing stops as soon as this TAC is reached (set at 49 spring salmon for the River Léguer in 2017). Although the fishing season extends from March to June, this TAC is quickly reached and the salmon fishing area closed early to prevent free access to the resource. This in turn reduces the value of the river's use for fishing. Yet although the fish resource is not affected by this drop in value, there is a risk that the river's different interests

[2] A grilse is a young salmon that has only spent one year at sea and is returning to freshwater for the first time in the summer.

are not being protected. However, the TAC is a necessary measure. One solution to optimise the river's fishing value could be to introduce a compulsory catch-and-release measure once the TAC is reached. The Côtes d'Armor Fishing Federation[3] argues that this early closure is a source of frustration for keen salmon anglers. Moreover, compulsory catch declarations show that the majority of the TAC is caught exclusively by local anglers. Closure once the TAC has been reached also limits the development of the area's fishing tourism. This situation and the will to develop fishing tourism in the area are behind this joint experiment by the accredited fishing and aquatic environment protection associations (AAPPMAs) present on the River Léguer and others decision-making authorities[4]. The ambition is to develop the River Léguer's aquatic heritage without impacting on the salmon resource. It has therefore been proposed to introduce a salmon fishing extension once the quota (TAC) is reached, with this extension being in the form of catch and release.

Therefore in 2017, the Côtes d'Armor Fishing Federation conducted a catch-and-release experiment on salmon fishing. Anglers who wanted to limit the catch they kept or fish past the date when the total allowable catch (TAC) was reached were asked to join a fishing experiment, whereby the salmon caught were released back into the water. The experimental sector concerned the River Léguer from the Louars Bridge between Trégrom and Plounévez-Moëdec (upstream limit) to the Sainte Anne Bridge in Lannion (downstream limit). The scheme was available to anglers holding a fishing permit and who had paid the "highly migratory fish angling" fee. Enrolment was free of charge and on a voluntary basis for the anglers, who could join the experiment whenever they wanted as of the start of the fishing season (11 March 2017). Enrolment was compulsory once the TAC was reached if anglers wanted to continue to fish through to the end of the fishing season (14 June 2017). Anglers who enrolled for the experiment had to sign a commitment to good practices charter.[5]

[3] The "Fédération Nationale de la pêche en France et de la Protection des milieux aquatiques » (FNPF) is the institution representing freshwater fishing and the protection of the French aquatic environment. It coordinates the actions of more than 3700 Accredited Fishing and Aquatic Environment Protection Associations (AAPPMA), gathered in 94 departmental federations of fisheries and aquatic protection (FDDAPPMA). The Côtes d'Armor Fishing Federation is one of these 94 departmental federations.

[4] The Côtes d'Armor Fishing Federation, the Bretagne Grands Migrateurs observatory, the Lannion-Trégor district committee and the Vallée du Léguer watershed committee.

[5] Commitment to good catch-and-release practices charter: release salmon catches; fly fishing, a single barbless hook, the strongest line possible, a rubber mesh or knotless mesh landing net; hook removal using pliers; no handling the fish out of the water, sufficient time for the fish to recover before releasing it back into the water; catch declaration; cooperate with experiment monitoring; and inform the coordinator/officer in the event of problems.

As mentioned by Arlinghaus et *al.* (2007), much of research on catch and release has focused on North America fisheries but attitudes concerning catch and release may differ in other countries. Therefore, parallel to this conducted experience and not directly related to it, we wanted to understand how anglers respond in France, especially in Brittany, to catch and release angling opportunities, and question about anglers' perceptions of catch and release across angler subpopulation. Then, the purpose of this article is to assess whether the recreational anglers in Brittany valued catch and release. For this, we chose to use the choice experiment (CE) method for our study. We were unable to obtain enough observations of angler behaviour from the catch-and-release experiment in progress on the River Léguer to statistically measure anglers' satisfaction with management measure such as catch and release and, in particular, analyse their preference for catch and release. We therefore felt this method to be more suitable, and it enabled us to look beyond the experiment on this river and collect more data.

This article presents the theoretical model to reveal anglers' preferences, the design of the questionnaire, the survey and sample description, the results of the estimates, including the willingness-to-pay estimates, and the conclusion.

2. The choice experiment method to reveal anglers' preferences

2.1. The theoretical model

In CEs, each surveyed individual is offered several choice sets so that the dataset forms a panel. For each choice set, an individual faces three mutually exclusive alternatives. Based on the consumer theory of Lancaster (1966), we assume that the individual utility gained from choosing alternative *j* in choice set *t* can be divided into two components. The first is a linear function of parameters and observed variables (the attributes of the alternatives). The second is a random error term. Individual *i* prefers alternative *j* to alternative *j'* in choice set *t*, if the utility entailed by alternative *j* is greater than that entailed by alternative *j'*.

Assuming the random term to be independent and identically distributed (IID) with an extreme value, distribution type I leads to the standard conditional logit model. This assumption leads to the particular property of independence from irrelevant alternatives (IIA). It means that the relative probabilities of two alternatives are independent of the introduction or the removal of another alternative. This property is relevant only if alternatives are all very different or all very similar. When the degree of similarity between alternatives is different, the probabilities to choose some alternatives are not independent and the IIA property is violated. A random parameter logit model (RPLM) enables this limitation of a standard logit model to be avoided and allows for random taste variation. We account for unobserved preference heterogeneity between individuals for all attributes (Revelt and Train 1998; Train 2003). These models lead to improvements compared to standard logit models or models with interaction terms containing socio-demographic characteristics.

We assume a sample of N individuals with the choice of J alternatives on T choice sets. The utility that individual *i* ($i = 1, \dots, N$) derives from choosing alternative *j* on choice set *t* is given by:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \beta_i' x_{ijt} + \varepsilon_{ijt}, \tag{1}$$

where β_i is a vector of individual *i* specific parameters, x_{ijt} is a vector of observed attributes related to individual *i* and alternative *j* on choice set *t*. Error terms, ε_{ijt}, are supposed to be IID extreme value distributed. $f(\beta|\theta)$ is the density function for β, where θ are the parameters of distribution. The probability (conditional on knowing β_i) of individual *i* choosing alternative *j* on choice set *t* is written:

$$L_{ijt}(\beta_i) = \frac{\exp(\beta_i' x_{ijt})}{\sum_{j=1}^{J} \exp(\beta_i' x_{ijt})} \tag{2}$$

This is the logit formula. The probability of the observed sequence of choices conditional to knowing of β_i is given by:

$$S_i(\beta_i) = \prod_{t=1}^{T} L_{ij(i,t)t}(\beta_i), \tag{3}$$

where $j(i,t)$ corresponds to alternative *j* chosen by individual *i* on choice set *t*. The probability (unconditional on knowing β_i) to observe the sequences of choice is the conditional probability integrated over the distribution of β:

$$P_i(\theta) = \int S_i(\beta)\, f(\beta|\theta) d\beta. \tag{4}$$

When the distribution of β is continuous, models are random parameter models (which belong to mixed logit models). The log likelihood for these models, $LL(\theta) = \sum_{i=1}^{N} \ln\, P_i(\theta)$, is approximated using simulation methods (Train 2003).

Estimates of consumer surplus associated with attribute changes can be derived from the estimated model following Adamowicz, Louviere and Williams (1994). The specification of the utility function is usually linear in the alternative attributes:

$$V_{ijt} = \beta_{0i} + \beta_{1i}.x_{1ijt} + \dots + \beta_{Ki}.x_{Kijt} + \beta_{pi}.x_{pijt}, \tag{5}$$

where β_{ki} is the parameter for attribute k, and β_{pi} is the parameter for the price attribute. The parameter β_{pi} represents the marginal utility of income for i as the parameter β_{ki} is the marginal utility of attribute k. The WTP for a marginal change in the level of attribute k can be calculated as the negative ratio of parameter β_k to parameter β_p:

$$WTP_k = -\frac{\beta_k}{\beta_p} \tag{6}$$

Normal distribution is frequently used for the parameters. Then, WTP is the ratio of two normal random parameters, and we cannot calculate moments for the distribution of WTP. Fixing the price parameter and assuming homogeneous preferences for this attribute solves this problem. It implies that the distribution of the WTP for attribute k follows the same distribution as the attribute parameter (Revelt and Train, 1998).

2.2. Questionnaire design

The purpose of the study is to measure the satisfaction of salmon fishing anglers. The choice experiment method was chosen to identify the determinants of respondent anglers' preferences for salmon fishing and their relative weight. To do this, respondent anglers were placed in a situation of choosing between salmon fishing day trips. The experiment's design was therefore vital, since it would steer the development of hypothetical scenarios. These scenarios were built from the different combinations of chosen attributes and attribute levels. The choice of attributes was hence crucial and needed to lead us to propose sufficiently realistic, albeit hypothetical, choice alternatives if respondents were to answer coherently. The number of attributes could not be too high, since that would have prevented respondents from really making a choice. They needed to be sufficiently understandable and relevant to avoid confusing respondents (Sanko, 2001). And they needed to be representative of salmon fishing day trips to be realistic and meaningful to respondents (Ryan and Wordsworth, 2000; Bennett and Adamowicz, 2001).

The attributes we chose needed to reflect the relevant characteristics of a fishing destination while including the possibility of introducing a new regulation such as catch and release. Salmon anglers' satisfaction depends, among others, on the regulations in place to manage fishing (level of access to the public, quota, size limit on fish caught, constraint on fishing methods, etc.), the state of the fished resource, the period of the year, the fishing area and access to that area (level of congestion on the river, quality of the environment and the water, and distance from place of residence). Discussions with salmon anglers in focus groups led us to select the attributes associated with salmon fishing regulations or regulation such as authorised fishing method, total allowable catch of salmon for the river and compulsory release of catches back into the water, since this is the area of particular interest to us. The fishing season during which the fishing trip is made and the level of river use were also selected as attributes that could affect the quality of the fishing experience. We did not introduce a monetary attribute, as is often the case in recreational activity valuation methods, since anglers in France do not usually pay an entrance fee for a day's fishing on a river. Access to the resource is virtually free of charge aside from the payment of an annual fishing permit and the "highly migratory fish" angling fee. Yet we did need a monetary attribute to measure the anglers' valuation of the other attributes characteristic of the fishing trip. In keeping with Hanley et *al.* (2002), Boxall and Macnab (2000), Rulleau et *al*. (2011) and Ropars-Collet et *al*. (2014, 2017), the choice was made to use the distance by car to the river for the fishing trip. The distance attribute was then converted into a travel cost to estimate willingness to pay for each of the attributes. This attribute's categories had to be balanced (same deviation between the different categories), and the deviations between categories had to be large enough to be explanatory. Following discussions and consultations, three categories were selected at 30-kilometre intervals (10 km, 40 km and 70 km). Table 1 presents the chosen attributes, their description and the levels chosen. All these attributes were selected following discussions (focus group) with the Côtes d'Armor Fishing Federation and recreational anglers.

Table 1: Chosen fishing trip attributes

Attributes	Description	Levels
Season	Fishing season during which the fishing trip is made	▪ Spring (mid-March to mid-June) ▪ Summer (mid-June to July) ▪ Autumn (September-October)
TAC	Total allowable catch of spring salmon and grilses for the river	▪ 80 spring salmon and 640 grilses ▪ 30 spring salmon and 240 grilses
Fishing method	Fishing method authorised on the river	▪ Fly ▪ Fly and spin ▪ Fly, spin and bait
Distance	Travel distance to the river	▪ 10 km ▪ 40 km ▪ 70 km
Compulsory catch and release	Fishing with compulsory release of catches back into the water	▪ Yes ▪ No
Level of river use	Level of river use	▪ High ▪ Low

For each proposed set of choices, the respondent angler could choose fishing trip A or fishing trip B, with each of these fictitious fishing trips defined by different attribute levels. A third alternative was also introduced in the form of the possibility of choosing neither of the proposed trips, an alternative subsequently called status quo, which mean that they would not go fishing.

A factorial design was used to construct the sets of choices proposed to respondents. A full factorial design comprises all the possible combinations of the categories of the different attributes describing the choice alternatives. Such a design has the advantage of being orthogonal, i.e. the attributes are not intercorrelated. In the case of three attributes with two categories and three attributes with three categories, (2^3x3^3) combinations are possible, *i.e*. 216 choice sets for a full factorial design. However, it is not possible to propose that many choices in turn to an individual. We therefore used an orthogonal fractional factorial design in order to reduce the number of possible choices. The final design contained 36 choice sets (split into six blocks), excluding the dominant alternatives and otherwise impossible or unrealistic alternatives (Sanko, 2001). Lastly, to make the survey easily practicable and acceptable, six sets of salmon fishing trip choices were presented to each respondent angler. Six versions of the questionnaire were created. Table 2 presents a choice set proposed to respondents.

For each choice set, we asked respondent anglers which fishing trip they preferred of the two or whether they preferred none. For all the trips presented, they were told that the proposed TAC for spring salmon and grilses was considered to not yet have been reached on the river. The status quo alternative avoided the issue of respondents having to choose a scenario they did not actually prefer and/or not finishing the questionnaire (Lee et *al*., 2014).

Table 2: Example of a choice set proposed to respondent anglers

	Trip A	**Trip B**	**None**
Fishing season	Spring	Spring	
Salmon TAC	30 spring salmon 240 grilses	80 spring salmon 640 grilses	
Authorised fishing method	Fly	Fly and spin	
Distance	40 km	10 km	
Compulsory catch and release	No	Yes	
Level of river use	High	Low	
Which trip do you prefer?	☐	☐	☐

The questionnaire contained other parts than the choice experiment section. Following the presentation of the choice sets, we asked respondents to assess how hard they found it to choose their preferred fishing trip (from 1 for "not at all hard" to 10 for "very hard). Additional questions were asked to gain an idea of the respondent anglers' profiles in terms of salmon fishing and other recreational activities. Lastly, we collected their socioeconomic characteristics. We used this additional information to refine the interpretation of the choices made by respondents and elucidate our results on the anglers' valuation of the attributes.

3. Survey administration and sample description

One of the difficulties with the choice experiment method can be found in the administration of the survey questionnaire. In the case of recreational fishing, some surveys may be conducted in the field, at the fishing spot or in angling competitions (Hanley et *al*., 1998; Lee et *al*., 2014; Lawrence, 2005), or otherwise by approaching anglers in specialised shops without any particular sampling. Time and resource constraints prompt some studies to use postal surveys (Carson et *al*., 2009; Olaussen, 2016; Arlinghaus et *al*., 2014; Carter and Liese, 2012), telephone surveys (Mkwara et *al*., 2015), e-mail surveys (Beville and Kerr, 2009) or a combination of these (Adamowicz et *al*., 1994; Lew and Larson, 2015). For reasons of geographic scale and time and budget constraints, we chose to conduct our survey by e-mail with an online questionnaire and by post when we did not have the anglers' e-mail address. The online questionnaire was put together using the "Lime Survey" software program, the rights to which were obtained for us by INRA Rennes. We built six online questionnaires representing the six versions of our choice sets. We sent two reminders to the e-mail survey anglers at two-week intervals. For the postal survey, a stamped addressed envelope was enclosed with the questionnaire to facilitate returns and hence increase the response rate. The online and postal surveys had the advantage of being able to survey a maximum number of salmon anglers in the départements of Côtes d'Armor, Finistère and Morbihan. However, the disadvantage was that there was no possibility of assisting respondents in the event of difficulties answering or understanding the choice experiment method. Some anglers started filling in the questionnaire, but did not finish, possibly for this reason. However, respondents did have the possibility of contacting us, which some did, mainly by e-mail regarding the online survey.

Our sample comprises all angler members of the AAPPMAs affiliated with the Département Fishing Federations of Morbihan, Côtes d'Armor and Finistère who have paid the "highly migratory fish" angling fee to be able to fish salmon Then, there was a total of 859 anglers were surveyed (351 in Morbihan, 265 in Côtes d'Armor and 343 in Finistère). We contacted 290 anglers by e-mail, the others by mail. The six versions of the questionnaire were distributed randomly to respondents.

Of the 859 anglers contacted by e-mail and post, 220 anglers responded to the questionnaire, for a response rate of 25.61%. The online response rate was higher than the postal response rate (41% versus 15%). Beville and Kerr (2009) obtained a much lower online response rate (12.7%) to their online survey of anglers, whereas Olaussen (2016) achieved a response rate of 62% to a postal survey, but after sending two reminders. Tables 3 and 4 present our sample's descriptive statistics. Some anglers did not fully complete the questionnaire, especially the question on the household's net monthly income to which we only obtained 188 answers.

The vast majority of the respondent anglers were men with an average age of 53 years. Over 40% of respondents were over 60 years old and less than 8% were under 30 years old. Over 60% of the sample was made up of working individuals, with over one-third retired. One-quarter were company heads, executives, or in a higher intellectual or self-employed profession. These socioeconomic groups, especially the company heads (22.14% versus 7.32% in the French working-age population), are overrepresented in our sample compared with the French population.[6] Conversely, manual and non-manual employees are underrepresented in our sample. Over half of the respondents had a higher education qualification, while nearly one-third had an occupational proficiency certificate or vocational certificate (CAP/BEP). Over half of the respondent anglers had a net monthly household income of over €3,000 (average monthly income per household in France), while just 10% had less than €1,500.

The respondent anglers had an average 20 years of salmon fishing experience. Over 40% had been fishing salmon for less than ten years, while nearly 40% had been fishing salmon for over 20 years. Nearly 10% had only been fishing salmon for one year. Lastly, nearly 8% started fishing salmon in 2017.

In 2016, nearly 17% of respondents went on a salmon fishing trip abroad. The length of these trips was just over two weeks on average and over half of the trips were to Ireland.

The respondents were members of 42 AAPPMAs. Seven of these AAPPMAs accounted for over half of the respondent memberships. Nearly 80% of respondents fished in seven rivers in the main. Over half frequented mainly the rivers Ellé, Léguer and Blavet for salmon fishing.

[6] INSEE statistics (https://www.insee.fr/fr/statistiques/2569937?sommaire=2569957)

Nearly 13% of respondents had signed the commitment to good catch-and-release practices charter.

In 2016, half of the salmon fishing trips were in the spring. Irrespective of the fishing season, the average number of salmon caught in 2016 was 0.5 per respondent angler. Over 40% of respondents said they practised mainly or exclusively fly fishing. Over one-quarter did not practise this fishing method. The respondents fished other types of fish than salmon. Over 80% targeted trout and over 40% targeted carnivorous fish. Nearly 60% also practised sea angling. Lastly, among the other outdoor recreational activities, nearly 40% hunted and over half hiked.

Table 3: Socioeconomic characteristics of the sample

Variable		Average	Standard deviation	Median
Household size		**2.51**	**1.26**	
Number of dependent children		**0.69**	**1.03**	
Age		**53.33**	**15.36**	
Variable			**Proportion**	
Gender (male %)			**99.03**	
Age (%)	Less than 20 years		**0.97**	
	20-29 years		**6.32**	
	30-39 years		**16.04**	
	40-49 years		**15.55**	
	50-59 years		**19.41**	
	60-69 years		**26.21**	
	Over 70 years		**15.50**	
Status (%)	Company head or self-employed profession		**14.22**	
	Executive or higher intellectual profession		**10.29**	
	Intermediate profession		**15.20**	
	Non-manual employee		**9.80**	
	Manual employee		**9.80**	
	Retired		**34.31**	
	Student		**1.47**	
	Unemployed		**2.45**	
	Other (inclusion benefit recipient, freelance entrepreneur. etc.)		**2.45**	
Net monthly household income (%)	< €1,000		**2.20**	
	€1,000 - €1,499		**8.79**	
	€1,500 - €1,999		**14.29**	
	€2,000 - €2,999		**21.98**	
	€3,000 - €3,999		**23.63**	
	€4,000 - €4,999		**14.84**	
	> €5,000		**14.29**	
Level of education (%)	No qualifications		**4.02**	
	CAP/BEP		**31.66**	
	Baccalauréat		**14.57**	
	Bac +2. +3. +4		**30.65**	
	Bac +5 and more		**19.10**	
Number of observations			**188 or 220**	

Table 4: Descriptive statistics on the sample's salmon fishing activity

Variable		Average	Standard deviation
Number of years of salmon fishing experience		20.49	12.29
Length of fishing trips abroad (days)		16.02	15.40
Number of salmon fishing trips in 2016	In spring	14.86	15.00
	In summer	9.16	12.85
	In autumn	5.10	7.87
Number of salmon caught in 2016	In spring	0.5	0.89
	In summer	0.56	2.17
	In autumn	0.49	1.24

Variable		Proportion
Signed the River Léguer catch-and-release charter (%)		12.68
Fished salmon for the first time in 2017 (%)		7.77
Fishing trip abroad in 2016 (%)		16.91
Destination of fishing trips abroad in 2016 (%)	Ireland	57.50
	Norway	17.50
	Scotland	10.00
	Others	12.50
Main river for salmon fishing (%)	Ellé	18.83
	Léguer	18.83
	Blavet	14.35
	Trieux	10.76
	Scorff	7.62
	Aulne	5.83
	Elorn	5.83
Main membership AAPPMAs (%)	Lannion	10.89
	Quimper	8.91
	Lorient	7.41
	Pontrieux-La Roche Derrien	7.43
	Elorn	6.93
	Plouay	6.44
	Guingamp	5.94
	Morlaix	3.96
	Ellé	3.96
Salmon fishing methods (%)	Fly	63.46
	Spin	68.75
	Bait	50.48

Table 4: Descriptive statistics on the sample's salmon fishing activity (cont.)

Fly salmon fishing (%)	Exclusively	18.45
	Mainly	24.27
	Occasionally	29.13
	Not at all	28.16
Means of transport used (%)	Own car	94.23
	Car pooling	15.87
	Other	4.46
Owns a craft (%)	Boat	22.34
	Kayak	9.14
	Other (float tube, paddle board)	4.57
	None	63.96
Other fishing practised? (%)	River trout	80.77
	Reservoir trout	14.42
	Carnivorous	43.27
	Sea angling	58.17
	Other (shore fishing, etc.)	5.79
	None	3.85
Other outdoor recreational activities? (%)	Hunting	38.42
	Hiking	53.20
	Canoe-kayak	10.84
	Cycling	26.11
	Other (gardening, etc.)	22.73
	None	10.84
Number of observations		188

There is a possibility that not all of the results are representative of the population of recreational anglers in France. The way our survey was administered may have induced a self-selection bias. This is often the case when survey participants are contacted online or by post. Certain recreational angler profiles may be overrepresented. Some socioeconomic groups or younger anglers might be less apprehensive of or find it easier to answer the online questionnaire. Some more concerned about the state of the resource or with experience of catch-and-release fishing were probably more inclined to take part in the survey than others.

4. What are the determinants of the salmon anglers' fishing trip choices?

The chosen methodology was to propose choice alternatives to survey respondents. We drew on the anglers' answers to estimate their indirect utility function parameters. In the proposed choice experiments, respondent anglers were asked to choose between different fictitious fishing trips defined by different attributes and their levels. After presenting the choice sets, we then asked anglers how hard they found it to choose their preferred fishing trip (1 for "not at all hard" and 10 for "very hard"). The perceived average level of difficulty equals 4.9 with no significant differences between respondent anglers answers (socioeconomic group or other). Statistical analysis of respondents' trade-offs between the different fishing trip attributes reveals how they value these attributes of interest. For this, we estimated discrete choice models. If an attribute's estimated parameter is positive, then the presence of that attribute increases the probability of choosing a fishing trip presenting that attribute, and inversely.

4.1. Results of the discrete choice model estimations

The chosen statistical model estimates the probability of an individual choosing a fishing trip based on the attributes of these trips. We therefore estimated a conditional Logit model entering the fishing trip attributes in the regression, including the distance attribute, as model explanatory variables. We also introduced a constant specific to the status quo alternative as an explanatory variable in order to capture the effect of the unobserved variables on the choice of status quo. The results were then examined in greater detail, looking into whether any valuation differences by individual characteristics were identified by introducing interactions between attributes and individual characteristics. We also assumed that the unobserved preferences relating to the different attributes were heterogeneous across respondents by estimating a random parameter Logit model.

With the exception of the distance attribute, all the attributes included in a fishing trip were qualitative. They had to be transformed and coded. An attribute with *L* levels is transformed into *L-1* dummy variables. A simple way of proceeding for each of these dummy variables is to assign the value *1* if the level is present and *0* otherwise (these variables are called *Dummy*). The L^{th} level is excluded to avoid collinearity problems with the regression. This level then serves as the reference. However, the effect of the L^{th} level can then be identified, since it is captured by the constant b_0 in the following model: $Y_j = b_0 + b_1 D_{j1} + b_2 D_{j2} + \cdots + b_{L-1} D_{jL-1}$. The constant describes the utility of the omitted attribute, with the other coefficients interpreted as the variation in the other attribute levels' utility compared with the utility associated with the L^{th} level. All the estimated parameters are correlated with the constant b_0. This way of coding can create a parameter identification problem, since the utility associated with the attribute's L^{th} level cannot be separated out from other elements of utility that may also be found in the constant. Such is the case if the model contains other discrete variables transformed in the same way. The effect of the level omitted for this variable would also be found in the constant b_0. To prevent coefficient identification and interpretation problems, we used *coding effects* to code the discrete variables (Bech and Gyrd-Hansen, 2005; Daly et *al*., 2016). Each of the *L-1* variables created takes the value *1* if the level is present, *-1* for the level corresponding to the reference level and *0* otherwise. The effect of the reference level on utility is no longer found in the constant. The parameter associated with each reference level for each attribute is not estimated directly by the model. Reference level *L*'s contribution to utility is equal to the opposite of the sum of the *L-1* parameters. Consequently, our model's alternative specific constant (ASC) captures solely the effect of the status quo alternative on the individual's utility. Table 5 presents the coding used (*coding effects*) for each of our attributes.

Table 5: Effects coding for qualitative attributes

Saison	**Season1**	**Season2**	**Season3**	
Spring	1	0	0	α_1
Summer	0	1	0	α_2
Autumn	-1	-1	1	$-\alpha_1 - \alpha_2$
Associate parameter	α_1	α_2	$\alpha_3 = 0$	
TAC	**TAC1**	**TAC2**		
30 Spring salmon and 240 grilses	1	0		β_1
80 Spring salmon and 640 grils	-1	-1		$-\beta_1$
Associate parameter	β_1	$\beta_2 = 0$		
Fishing methods	**Method1**	**Method2**	**Method3**	
Fly	1	0	0	γ_1
Fly and spin	0	1	0	γ_2
Fly, spin and bait	-1	-1	1	$-\gamma_1 - \gamma_2$
Associate parameter	γ_1	γ_2	$\gamma_3 = 0$	
Compulsory C&R	**C&R1**	**C&R2**		
Yes	1	0		δ_1
No	-1	-1		$-\delta_1$
Associate parameter	δ_1	$\delta_2 = 0$		
Level of river use	**RiverUse1**	**RiverUse2**		
Low	1	0		η_1
High	-1	-1		$-\eta_1$
Associate parameter	η_1	$\eta_2 = 0$		

Reference's level in grey

In view of the coding, the equation to be estimated is formalised as follows:

$$U_{ijt} = ASC_{jt} + \alpha_{1i}.Season1_{jt} + \alpha_{2i}.Season2_{jt} + \beta_{1i}.TAC1_{jt} + \gamma_{1i}.Method1_{jt} + \gamma_{2i}.Method2_{jt} + \delta_{1i}.C\&R1_{jt} + \eta_{1i}.RiverUse1_{jt} + \theta_i.Distance_{jt} + \varepsilon_{ijt}$$

We estimated both a conditional Logit model and a random parameter Logit model. The conditional Logit model assumes that the IIA hypothesis holds. This hypothesis was tested using the Hausman-McFadden test (Hausman and McFadden, 1984). The "Trip A", "Trip B" and "Status Quo" choices were removed in turn from the sample. The results of the test are presented in the table in Appendix 1. They show that the IIA hypothesis does indeed hold, which results in consistent estimations.

The results of the model estimations based on the data collected are presented in Table 6. The parameters calculated for the attributes' reference levels are given in Table 7. The models present a sound goodness-of-fit. The likelihood ratio tests (LR test) indicate that the models are significant overall.

The status quo alternative specific constant is significant and negative whatever the model, which suggests that, for the respondent anglers, choosing any fishing trip provides more utility than the no-choice option of status quo. They hence prefer going on a fishing trip to doing nothing. All the estimated coefficients of the CL models are significant (at the 1% and 5% error levels), except the "Season2" and "Method2" variable coefficients. A fishing trip in the summer and authorisation of both fly and spin fishing have no impact on the respondent anglers' well-being. However, the other parameters estimated and calculated suggest that respondents prefer to go on fishing trips in spring, whereas their well-being decreases in the case of autumn trips. Moreover, respondents prefer fishing trips on less frequented rivers with a low TAC. They also prefer it when all the fishing methods are authorised and there are no compulsory catch-and-release regulations. However, perceived congestion on a river reduces the respondent anglers' satisfaction. This is also the case when the only fishing method authorised is fly fishing and when C&R is compulsory. Lastly, as expected, the anglers surveyed prefer trips to rivers nearby, other things being equal.

Table 6: Estimate results of condition logit model and random parameter logit model

	CL	CL with interactions	RPLM
Variable	**Parameters**		**Mean of Random Parameters**
ASC (*statu quo*)	-0.175* (0.100)	-0.202** (0.104)	-0.613*** (0.240)
Season1 (*Spring*)	0.349*** (0.066)	0.377*** (0.069)	0.569*** (0.109)
Season2 (Summer)	-0.081 (0.066)	-0.105 (0.069)	-0.136 (0.113)
TAC1 (*30 Spring salmon, 240 grilses*)	0.111** (0.049)	0.101** (0.051)	0.140* (0.078)
Method1 (*Fly*)	-0.217** (0.073)	-0.188** (0.076)	-0.500*** (0.149)
Method2 (*Fly and spin*)	-0,001 (0.066)	0.011 (0.069)	0.104 (0.126)
RiverUse1 (*Low level*)	0.372*** (0.048)	0.401*** (0.050)	0.689*** (0.102)
Distance	-0.009*** (0.002)	-0.009*** (0.002)	-0.016*** (0.004)
C&R1 (*Yes*)	-0.223*** (0.048)	-0.678** (0.289)	-0.453*** (0.107)
C&R1 (*Yes*) ## Retired		0.399 (0.302)	
C&R1 (*Yes*) ## Manual Employee		0.313 (0.329)	
C&R1 (*Yes*) ## Intermediate Profession		0.507* (0.314)	
C&R1 (*Yes*) ## Employee		0.381 (0.323)	
C&R1 (*Yes*) ## Unemployed		-0.382 (0.451)	
C&R1 (*Yes*) ## Student		-0.193 (0.494)	
C&R1 (*Yes*) ## Executive or Higher Intellectual Profession		0.840*** (0.324)	
C&R1 (*Yes*) ## Company Head or Self-Employed Profession		0.791*** (0.315)	
			Standard Deviation of Parameters
ASC (*statu quo*)			2.656*** (0.280)
Season1 (*Spring*)			0.460** (0.195)
Season2 (*Summer*)			0.575*** (0.173)
TAC1 (*30 Spring salmon, 240 grilses*)			0.274* (0.165)
Method1 (*Fly*)			1.467*** (0.193)
Method2 (*Fly and spin*)			0.841*** (0.200)
C&R (*Yes*)			0.978*** (0.141)
RiverUse1 (*Low level*)			0.486*** (0.166)
N (Nb. Ind. X **3 alt** X **6 choice sets)**	3384	3204	3384
Log Likelihood	-1166.86	-1093.44	-995.18
Test LR	144.75 (0.00)	159.75 (0.00)	**LR (8)** 343.49 (0.00)

***, **, * denote significance at the 1%, 5% and 10 % levels respectively. Estimated standard errors are in parentheses. Number of Halton draws for the maximum likelihood for the RPLM: 100.

Table 7: Parameters calculated from table 6 for the attributes' reference levels

Variable	CL	CL with interactions	RPLM
	Parameters		Mean of Random Parameters
Season3 (*Autumn*)	-0.268***(0.071)	-0.272*** (0.069)	-0.433*** (0.122)
TAC2 (8*0 Spring salmon, 640 grilses*)	-0.111** (0.049)	-0.10** (0.051)	-0.140* (0.078)
Method3 (*Fly, spin and bait*)	0.218*** (0.066)	0.177*** (0.073)	0.396*** (0.154)
C&R (*No*)	0.223*** (0.048)	0.678** (0.289)	0.453*** (0.107)
RiverUse2 (*High level*)	-0.372*** (0.048)	-0.401*** (0.050)	-0.689*** (0.102)
			Standard Deviation of Parameters
Season3 (*Autumn*)			1.035*** (0.287)
TAC2 (8*0 Spring salmon, 640 grilses*)			0.460** (0.195)
Method3 (*Fly, spin and bait*)			2.308*** (0.291)
C&R (*No*)			0.978*** (0.141)
RiverUse2 (*High level*)			0.486*** (0.166)

***, **, * denote significance at the 1%, 5% and 10 % levels respectively. Estimated standard errors are in parentheses.

Preferences for the attributes describing the fishing trips are not necessarily homogeneous across all respondent individuals. We therefore subsequently considered the surveyed anglers' individual characteristics – such as socioeconomic group, income, qualifications and fishing practices – and interacted them with the fishing trip attributes in the regression, on the assumption that they could have an influence on the choice of trips. Not all of these interactions were significant for all the attributes. They were significant mainly for the compulsory catch-and-release attribute and the authorised fishing method, especially fly fishing. This suggests that the surveyed anglers' preferences are heterogeneous with respect to this type of regulation. We also tested interactions with age, the number of years of salmon fishing experience, etc. As they did not appear to be significant, we did not retain them. Significant differences are hence found for the alternative specific constant depending on the respondent angler's socioeconomic group (Appendix 2) with, in particular, much higher values for company heads and executives and higher intellectual professions (in absolute value).

On average, the probability of the angler choosing a trip decreases when C&R is compulsory on the river. However, we observe differences by respondent socioeconomic group, as this probability increases for company heads, for intermediate profession and for executives and higher intellectual professions (table 6). Moreover, the higher the surveyed anglers' level of education, the more they will choose a fishing trip on a river where catches are required to be released (Appendix 4). On average, a river on which only fly fishing is authorised attracts fewer anglers. But, an angler practising exclusively fly fishing has a greater probability of choosing a trip on a river where C&R is compulsory (Appendix 4). Anglers who have signed the River Léguer catch-and-release charter have also a greater probability of choosing a trip on a river where C&R is compulsory (Appendix 4). Differences are also found in the valuation of C&R by respondent angler qualifications (Figure 5), with a gain in well-being from catch-and-release regulations for the most qualified anglers (Baccalauréat + two or more years of higher education), other things being equal. The anglers practising exclusively fly fishing value the catch-and-release regulations, while those who never or occasionally practise fly fishing do not value them at all. This makes sense because the release of catches is compatible solely with this type of fishing. Lastly, a low value is placed on fly fishing for the "authorised fishing method" attribute, except by those anglers with the highest incomes.

As there is some unobserved preference heterogeneity between anglers for all attributes, we estimate a RPLM using a normal distribution function for the random parameters. Parameters of all attributes have a random component, except the distance attribute. Indeed, we estimate a RPLM with the distance coefficient random but the standard deviation was not significant implying homogenous preference for this attribute. The model we retained is estimated by maximum likelihood using 100 Halton draws. Estimate results are presented in Tables 6 and 7. The estimated means of the attributes random parameter are significant at 1% and 10% levels, except for summer and the fishing method "fly and spin". Standard deviation of the random parameters are all significant at 1% or 5% levels. The mean ASC is significant and negative meaning that choosing a fishing trip provides utility for the respondents but this standard deviation indicates that this is not the case for some part of the sample. The great value of the standard deviation compared to the mean of the random parameter for the authorised fishing methods, for the TAC, for compulsory C&R, for summer and spring seasons indicate that these attributes' levels do not have the same effect on the probability to choose a trip among the anglers of the sample. But based on the parameter distribution, a fishing trip in spring provides utility for all anglers of our sample, in the same way as fishing in a less frequented river.

4.2. What is the willingness to pay for a fishing trip?

The estimations of the parameters associated with the attributes, including the distance attribute, can be used to calculate the willingness to pay for each attribute level, and then, working back up, to calculate the willingness to pay for a fishing trip (irrespective of the trip's characteristics) and the value of standard fishing days combining a number of attributes. In our model, the price attribute is a distance attribute in reality. Yet the distance used as a cost dummy variable is subsequently converted into a cost as in Hanley et *al.* (2002), Timmins and Murdoch (2007), Ropars-Collet et *al*. (2015, 2017), and Rulleau et al. (2011). The WTP results are contingent on the hypotheses selected to measure the anglers' travel cost. A number of possibilities are put forward in the literature to convert distance into cost. Here, solely the fuel cost was used, excluding the cost of vehicle wear-and-tear, assuming that anglers place importance solely on the fuel costs when choosing a fishing day trip, especially when the distances are relatively short as is the case with the proposed choices. A cost of €0.103 per kilometre was used as the average fuel outlay per kilometre for 5 to 7 horsepower vehicles,[7] considering that 75% of French vehicles on the road run on diesel. This value is similar to that used by Rulleau et *al*. (2011) and Ropars-Collet et *al*. (2015, 2017) and the Anglo-Saxon literature. The distance attribute was converted into a return trip travel cost by the following formula: Distance in kilometres x 2 x €0.103. We could have included the vehicle's depreciation and the opportunity cost of time (€0.10 per km if time is valued at the minimum wage) in the vehicle cost in addition to the fuel cost. We chose to set "floor" values, considering that anglers who car pool share the fuel and that travel time is not necessarily seen as a cost when relating to a leisure activity. The WTP calculation formulae for each attribute level are presented in Table 8. The WTP estimate from the CL and RPLM are presented in table 9.

[7] Source: French tax scale: http://bofip.impots.gouv.fr/bofip/2095-PGP.html

Table 8: WTP for each level of attribute

Attribute	Level	WTP
Season		
	Spring	$-2 * 0{,}103 * \alpha_1/\theta$
	Summer	$-2 * 0{,}103 * \alpha_2/\theta$
	Autumn	$2 * 0{,}103 * (\alpha_1 + \alpha_2)/\theta$
TAC		
	30 Spring salmon and 240 grilses	$-2 * 0{,}103 * \beta_1/\theta$
	80 Spring salmon and 640 grilses	$2 * 0{,}103 * \beta_1/\theta$
Fishing methods		
	Fly	$-2 * 0{,}103 * \gamma_1/\theta$
	Fly and spin	$-2 * 0{,}103 * \gamma_2/\theta$
	Fly, spin and bait	$2 * 0{,}103 * (\gamma_1 + \gamma_2)/\theta$
Compulsory Catch&Release		
	Yes	$-2 * 0{,}103 * \delta_1/\theta$
	No	$2 * 0{,}103 * \delta_1/\theta$
Level of river use		
	Low	$-2 * 0{,}103 * \eta_1/\theta$
	High	$2 * 0{,}103 * \eta_1/\theta$

Table 9: Estimate WTP from CL model and estimate moments of the distribution of the WTP from RPLM

WTP (€ per fishing trip and per angler)	CLM	CLM with interactions	RPLM	
			Mean	Standard deviation
Based value of a fishing trip	4.01	4.82	8.23***	34.26***
Spring	8.00	9.01	7.42***	6.00**
Summer	-1.86	-2.51	-1.77	7.50***
Autumn	-6.14	-6.50	-5.64***	13.50***
Low TAC	2.55	2.40	1.83*	3.58*
High TAC	-2.55	-2.40	-1.83*	3.58*
Fly	-4.98	-4.48	-6.52***	19.14***
Fly and spin	-0.02	0.26	1.35	10.97***
Fly, spin and bait	5.00	4.22	5.17**	-30.11***
Low level of river use	8.55	9.58	8.98***	6.34***
High level of river use	-8.55	-9.58	-8.98***	6.34***
Compulsory C&R	-5.12	-16.19	-5.91***	12.76***
Compulsory C&R for Retired		-6.66		
Compulsory C&R for Manual Employee		-8.72		
Compulsory C&R for Intermediate Profession		-4.09		
Compulsory C&R for Employee		-7.09		
Compulsory C&R for Unemployed		-25.31		
Compulsory C&R for Student		-20.79		
Compulsory C&R for Executive or Higher Intellectual Profession		3.85		
Compulsory C&R for Company Head or Self-Employed Profession		2.69		

, * denotes significance at the 5 and 1% levels respectively.

Based on these formulae (Table 8) and on the estimate results (Tables 6 and 7), we can estimate the anglers' average valuation of the different characteristics of a fishing day trip (Table 9). From the RPLM, we calculate some moments of the WTP distribution of each attribute level. The ASC captures the loss of utility resulting from choosing the status quo alternative. Based on the ASC, we can then calculate the value of the option to go on a "fishing trip", of any sort, which we can consider as a basic value that can rise or fall depending on the level of the attributes and their valuation. On average from the CL model, this basic value is less than €5, but significant differences are found by respondent angler socioeconomic group (Appendix 2). For example, the basic value of a fishing trip for company heads and self-employed professions, and executives and higher intellectual professions is relatively high (at around €17 and €23 respectively), while it is very low for student and negative for retirees and manual employees. From the RPLM, the mean basic value of a fishing trip is around €8 but we observe a great dispersion as it varies, starting at €-26 and rising to over €40 for some anglers of our sample.

With respect to the valuation of the characteristics of the fishing trip, the surveyed anglers place a high value on fishing in spring compared with autumn (deviation in mean of approximately €13). They also place a high value on fishing in less frequented rivers (deviation in mean of €18). This brings into play the hypothesis of a congestion externality that reduces the anglers' satisfaction. Other things being equal, a very low value is placed on a highly frequented river around €0). Overcrowded fishing spots is moreover the main argument put forward by anglers who no longer want to go salmon fishing in France and who make the choice to go abroad to fish at a price per day. In France, once the annual fishing permit has been purchased, river access is not regulated. Turning to the fishing methods, the anglers' satisfaction decreases when only fly fishing is authorised. The anglers also prefer rivers on which it is not compulsory to release the catch back into the water. The deviation in mean well-being between a compulsory catch-and-release regulation and authorised removal is over €12 per fishing trip. We found a great dispersion in well-being for compulsory C&R between anglers as 25% of the WTP for this attribute are on the positive part. Lastly, a low TAC on a river is valued more highly than a high TAC. This result is not the expected finding, but it may reflect the anglers' concerns about the state of the resource, which moreover prompted comments on some questionnaire returns. It could also be due to a poor interpretation or misunderstanding of the definition of TAC.

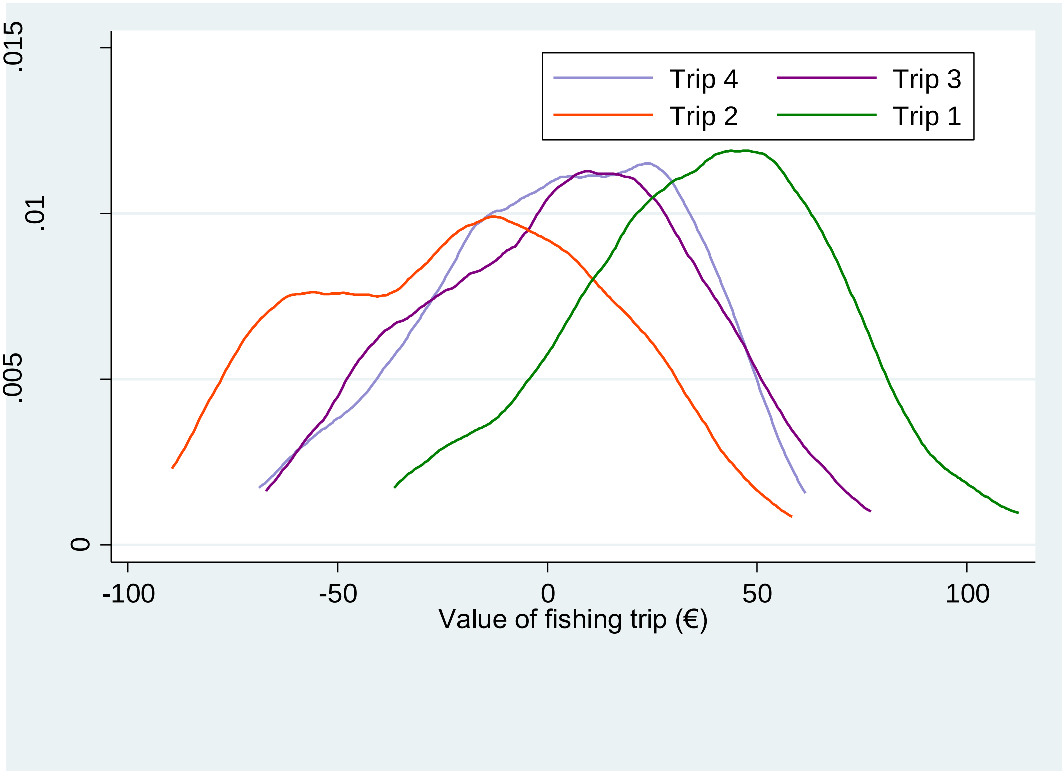
There are significant differences between the anglers' valuations of a fishing trip's characteristics, especially for compulsory C&R. Such regulations decrease the anglers' well-being on average. Yet this loss of well-being is highest for the unemployed, and is also relatively high for retirees and manual workers. Conversely, company heads and self-employed professions, and executives and higher intellectual professions value more these regulations.

The WTP calculated for each attribute level can be used to estimate the mean and the standard deviation of standard fishing trips' value (Table 10). The value of Trip 1, which could be called ideal for the angler since it presents the most highly valued levels for each attribute, is around €38 in mean excluding travel. Conversely and regarding the mean of the distribution, Trip 2 presenting the lowest valued levels for each attribute does not have a positive value. Figure 1 shows Kernel density plots of the distribution of the individual value of the four fishing trips, derived from our model, following Greene and Hensher (2003), which approximates the density function from observations on our sample. For trip 1, almost 90% of the value are positive whereas less than 30% are positive for trip 2. However, the anglers value more highly and consequently prefer a fishing trip in spring (Trip 3), even if the regulations require the compulsory release of catches, to a fishing trip in autumn when removals are authorised (Trip 4), other things being equal. As we can see on Figure 1, kernel density plots of the distribution of the value of the fishing trip 3 and 4 are quite similar.

Table 10: Value of standard fishing trip per day per angler (from RPLM estimates)

	Trip 1	**Trip 2**	**Trip 3**	**Trip 4**
Season	Spring	Autumn	Spring	Autumn
Level of river use	Low level of river use	High level of river use	High level of river use	High level of river use
TAC	Low TAC	High TAC	Low TAC	Low TAC
Fishing method	Fly, spin and bait	Fly	Fly and spin	Fly and spin
Catch	Authorised removal	Compulsory C&R	Compulsory C&R	Authorised removal
Mean (€)	**37.6**	**-20.7**	**3.9**	**2.7**
Standard Deviation (€)	68.37	-18.6	-14.4	-14.4

Figure 1: Kernel density functions of standard fishing trips' value



5. Discussion of the results and conclusion

Our results show that a salmon fishing trip (irrespective of the trip's characteristics) provides well-being to the surveyed anglers. However, we observe a wide variation in the value of the fishing trip by socioeconomic group and income. The choice of a fishing destination depends on all the attributes and the levels used to define the fishing trip. Yet not all of them have the same weight in the angler's decision to choose a trip. The fishing season and especially the level of river use have a strong impact on the angler's satisfaction. For example, the gain in well-being is approximately €13 between a fishing trip in spring and one in autumn, and €18 if the river is less frequented (other things being equal). On average, the anglers prefer unrestrictive regulations, where C&R is not compulsory and fly fishing is not the only fishing method authorised. In our sample, C&R reduces the angler's well-being per fishing day. On average, we observe that C&R has a depressive effect on the valuation of a day's fishing, at €14 per day if removal is authorised and €2 per day if C&R is compulsory. However, we observe a heterogeneity of preferences between anglers for a compulsory C&R regulation. Here, the valuation of C&R increases with qualifications and the practice of fly fishing, and can even become positive. It is moreover a characteristic valued by certain socioeconomic groups, such as company heads and self-employed professions, or executives and higher intellectual professions. We also show that a fishing trip in spring where C&R is compulsory is worth more than a fishing trip in autumn with authorised removal. Compared with closing fishing areas once the TAC has been reached, extending the fishing period in the form of C&R increases the number of fishing days and the anglers' overall well-being. For a constant TAC (provided there is zero mortality), C&R increases the value of the river's fish resource. C&R is therefore one of the parameters that could be brought into play to manage the resource. Yet C&R does not prevent a certain level of congestion, whereas regulating the level of river use appears to be a decisive element in recreational anglers' well-being, especially in terms of salmon fishing.

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Appendix 1: Results of the Hausman-Mc Fadden test for the IIA hypothesis

The IIA assumption requires that the inclusion or exclusion of alternatives does not affect the relative risks associated with the regressors in the remaining alternatives. The IIA Hausman-Mc Faden test compares the estimated parameters of the model including all alternatives with models excluding each alternative.

	Khi^2	**p-value**
Exclusion of « Trip A »	11.13	0.267
Exclusion of « Trip B »	9.95	0.354
Exclusion of « Status Quo »	14.59	0.068

The tests say that excluding the alternatives “Trip A”, “Trip B” or “Status Quo” does not affect the relative risks of the remaining alternatives. The IIA assumption has not been violated.

Appendix 2: Estimate results of the CL model containing interactions between ASC and socioeconomic group

Variable	Parameter
ASC (*statu quo*)	0.566** (0.230)
ASC (*statu quo*) ## Retired	-0.321 (0.244)
ASC (*statu quo*) ## Manual Employee	-0.440 (0.300)
ASC (*statu quo*) ## Intermediate Profession	-1.102*** (0.275)
ASC (*statu quo*) ## Employee	-0.708** (0.293)
ASC (*statu quo*) ## Unemployed	-1.145** (0.502)
ASC (*statu quo*) ## Student	-0.538 (0.548)
ASC (*statu quo*) ## Executive or Higher Intellectual Profession	-1.324*** (0.305)
ASC (*statu quo*) ## Company Head or Self-Employed Profession	-1592*** (0.294)
Season1 (*spring*)	0.349*** (0.067)
Season2 (*summer*)	-0.086 (0.067)
TAC1 (*30 spring salmon and 240* grilses)	0,114** (0.050)
Method1 (*Fly*)	-0.223** (0.074)
Method2 (*Fly and spin*)	0.004 (0.067)
C&R1 (*Yes*)	-0.229*** (0.048)
RiverUse1 (*Low level*)	0.378*** (0.049)
Distance	-0.009***(0.002)
N (Nb. Ind. X **3 alt** X **6 choice sets)**	3384
Log Likelihood	-1135.78
Test LR	206.91 (0.00)

***, ** denote significance at the 1% and 5% levels respectively.
Estimated standard errors are in parentheses

Appendix 3: Based value of fishing trip depending on the respondent angler's socioeconomic group (from estimate results in Appendix 2)

Socioeconomic group	Based value in €
Retired	-5.58**
Manual Employee	-2.88**
Intermediate Profession	12.21***
Employee	3.24**
Unemployed	13.19**
Student	-0.63**
Executive or Higher Intellectual Profession	17.24***
Company Head or Self-Employed Profession	23.35***

***, ** denote significance at the 1% and 5% levels respectively

Appendix 4: Estimate results of the CL model containing interactions between compulsory C&R and individual characteritics

Variable	**Parameter**
ASC (*statu quo*)	-0.138 (0.182)
Season1 (*spring*)	0.387*** (0.068)
Season2 (*summer*)	-0.115* (0.069)
TAC1 (*30 spring salmon and 240* grilses)	0.122** (0.051)
Method1 (*Fly*)	-0.237*** (0.076)
Method2 (*Fly and spin*)	0.010 (0.069)
C&R1 (*Yes*)	-1.145*** (0.162)
C&R1 (*Yes*) ## Signed the C&R charter	0.604*** (0.148)
C&R1 (*Yes*) ## Education level Bac+2.+3.+4.	0.291*** (0.113)
C&R1 (*Yes*) ## Education level Bac+5and more	0.424*** (0.136)
C&R1 (*Yes*) ## Fly fishing practises exclusively	0.0399*** (0.128)
RiverUse1 (*Low level*)	0.394*** (0.050)
Distance	-0.008***(0.002)
N (Nb. Ind. X **3 alt** X **6 choice sets)**	3258
Log Likelihood	-1094.73
Test LR	196.71 (0.00)

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