Recreational anglers' preferences for regulatory measures – Insights from meta-regression analysis

Fathallah KEROUAZ[1],
UR ETBX- Irstea Bordeaux
50 avenue de Verdun
33612 Gazinet-Cestas
fathallah.kerouaz@irstea.fr

Tina RAMBONILAZA
UR ETBX- Irstea Bordeaux
50 avenue de Verdun
33612 Gazinet-Cestas
tina.rambonilaza@irstea.fr

Abstract

Growing attractiveness of recreational angling has increased the need for reinforced regulatory measures. Successful implementation of such measures is driven by the use of relevant ecological knowledge toward biological conservation, but is also dependent on support from anglers' community. This study aims to identify which regulatory measures are most favoured by recreational anglers. One source of information regarding such preferences is the recent empirical literature that has applied the choice experiment method to examine fishermen's valuation of change in fishing conditions, including the imposition of specific technical-biological measures. We collated the results of 21 studies, and make use of meta-regressions to assess how different regulatory instruments explain the variation in the marginal willingness to pay estimates for one additional fishing trip and recreational angler's welfare. We also examine the potential effects of the context of the studies from which data are taken. Results suggest that anglers tend to perceive higher expected benefit from fishing experience taking place in sites where fish catch and harvest regulation are applied. However, they continue to avoid "fishing sites" where size limits are more restrictive, or where limits on numbers of fish caught are strengthened. The significance of these results for future research is discussed.

Keywords: Recreational fishing, Meta-regression, Choice Experiment method, Willingness-to-pay, Welfare variation, Bag limits, Size limits, Catch-and-release.

JEL code: Q22, Q57

[1] Corresponding author: Fathallah Kerouaz, Irstea- Bordeaux.
fathallah.kerouaz@irstea.fr, T: +33 5 57 89 26 91.

INTRODUCTION

Recreational fishing is widely practised in developed countries. In Europe alone, there are some 25 million recreational fishermen, of whom 20 million fish in freshwater. This figure is closer to 45 million in the USA. Fishing enthusiasts catch fish for fun, for sport, and for their personal consumption. The money they spend on equipment and travel contributes greatly to both local and national economies (Steinback, 1999; Curtis et *al*., 2017). While there are relatively few statistics, it is estimated that recreational fishing accounts for 12% of all fish caught across the globe (Cooke and Cowx, 2006). For certain freshwater (Cowx et *al*., 2010) and saltwater (Stage and Kirchner, 2005, McPhee et *al*., 2002) species, recreational fishermen catch a greater volume than their professional counterparts.

It is clear that recreational fishing is placing ever-growing pressure on stocks of certain fish species. In some areas, there is a real risk of exhausting supplies entirely. The effects of these phenomena are clearly highlighted by the fact that efforts to avoid depletion of certain types of fish – by stopping commercial fishing – have proved less successful than expected (Cook and Cowx, 2004). Limiting the volumes of fish caught by recreational fishermen has become a key objective in sustainable management of marine and inland aquatic ecosystems. In recent years, a number of European countries have introduced more stringent regulations covering recreational fishing of certain species. Such measures have been applied to eels in Europe since 2007, seabass in Ireland since 2015, and seabass in France since 2017.

The growing attractiveness of recreational fishing has increased the need for acceptable and sustainable regulatory policies.There are four main ways in which fishing regulators can apply harvest restrictions: an increase in the fishing licence fee, fishing quotas or “reduced daily bag limits” for certain species, increasing minimum catch size, and banning fishing in certain areas and/or at certain times. Successful implementation of such measures is driven by biological issues, but is also dependent on support from the recreational fishing community at large. In previous studies, recreational anglers reported a positive attitude towards recreational fishing management measures. However, they did not consider bag and size limits to be effective (Veiga et *al*., 2013). At the same time, the management option that was least favored but considered to be the most effective was that of catch-and-release (Cardona and Morales-Nin, 2013). Experience has shown that the most restrictive regulatory measures, i.e. banning fishing entirely, tend to be the least effective, as in the case of European eels in Germany (Beardmore et *al*. , 2011), where the lack of a replacement species meant that the reduction in recreational fishing pressure was offset by an increase in illegal fishing.

Since the early 2000s, numerous empirical studies have investigated recreational anglers’ preferences for fishing conditions and experience. In these studies, the Choice Experiment Method (CEM) (pioneered by Aas et *al*. (2000) among others) has typically been used to examine individual fishermen’s preference for a hypothetical change in fishing conditions, including the imposition of regulatory measures to limit catches of protected species (Hunt, 2005). The variety of contexts and survey protocols used in such studies mean that it is not possible to obtain a clear picture of the results obtained, particularly the degree of impact of different regulatory measures on fishermen’s satisfaction as provided by their willingness to pay (WTP). Indeed, variations in these empirical WTP estimates do not provide the policy maker with a useful understanding of anglers’ preferences towards biological regulatory measures.

Our aim in this study is to identify which regulatory measures are most favoured by recreational anglers, based on analysis of their willingness to pay. We collated 31 original

CEM-based studies to analyse anglers' valuation of recreational fishing regulation between 2000 and 2016. Of those 31, only 21 contained both regulatory measures and added cost burden for anglers as attributes of choice scenarios allowing us to perform an economic evaluation, either in terms of anglers' marginal WTP, or compensating surplus. Meta-regression analysis has been developed to summarize quantitatively results found in different empirical studies of the same or similar research problems in environmental economics (Van den Bergh et *al.*, 1997; Johnston et *al*., 2015). We thus use meta-regression analysis to estimate an average marginal WTP to avoid a hardening of regulatory measures and to determine which studies best explain heterogeneity in recreational anglers' preferences toward different levels of (bag and size limits) fishing regulatory instruments.

The first study using meta-analysis to examine the expected benefits of recreational fishing management from the point of view of anglers' preferences was carried out by Johnston et al (2006), who aimed to highlight the value attached by recreational fishermen to improving the quality of their fishing sites. The key indicator for this was the value of an additional fish caught each time they visited. This value is affected not only by the actual quantity of fish available, but also by the individual characteristics of the fishermen themselves. The authors of this particular study performed a meta-analysis of fishermen's (marginal) willingness to pay to catch one additional fish. Their analysis was based on 48 original case studies, using both indirect (e.g. travel costs and multiple site choice models) and stated preference methods (contingent valuation and choice experiment methods).

The difference between Johnston et *al*. (2006) and the present study is that we focus principally on studies using the choice experiment method. Our contribution to the literature is therefore twofold. We include a range of fishing regulation types as the main factors affecting variation of WTP estimates, thus providing policy makers with comprehensive picture of anglers' preferences between different types of fishing regulation measure or their combination. This information can be used by fishing managers to bring biologically founded fishing regulation measures more in line with anglers' satisfaction. Indeed, fishing regulations that will maximize anglers' satisfaction are also expected to ensure biological sustainability of protected species stock (Johnston et *al*., 2010). With respect to the application of the choice experiment method, our results show how a variety of characteristics (such as protocol design characteristics, and survey administration procedure) may influence anglers' valuation of a given fishing trip.

The remainder of the article will be organised as follows. The next section will present the general framework for an economic welfare analysis of the regulation of recreational fishing. We will then explain how the data were collected and the way in which we developed our meta-analysis. Following that, we will present the main results and discuss how they can be applied in a wider range of contexts. The fourth and final section will summarise the main implications of our work, as well as highlighting its limitations and possible future avenues of research to be explored.

1- AN ECONOMIC WELFARE APPROACH TO MANAGEMENT OF RECREATIONAL FISHING

From an economic standpoint, recreational fishing can be framed as a trip demand into a specific natural environment whose characteristics lend themselves to that particular activity. The satisfaction gleaned by each individual angler from such a fishing trip as a leisure experience depends on parameters relating to fishing effort, such as the amount of catches per unit of effort, and the average size of fish caught. The extent to which recreational fishermen will use a particular site generally reflects the difference between the satisfaction they feel when doing so (in terms of the full leisure experience) and the cost of travelling to that site (e.g. travel expenses, hotels, and other ancillary expenses, as well as opportunity cost). This "net benefit" derived from recreational fishing expeditions can be translated into monetary terms based on anglers' willingness to pay for a fishing trip. On the basis that recreational fishermen will be subject to time and money budget constraints, willingness to pay will decrease as the frequency of visits increases. In other words, they stop fishing when they are no longer prepared to pay any more money to do so.

However, given the impact of individual fishing effort on the status of fish stocks and probability of catching fish, it is necessary to strike a balance between allowing recreational fishermen to continue practising their chosen hobby, and the need to periodically replenish fish stocks (Anderson, 1983). Managing recreational fishing therefore calls for regulation of total visitor numbers within a given site, in order to limit overall fishing effort, thus limiting mortality by hook and its subsequent effect on fish stocks. The aim is to limit individual fishing effort, which has a positive effect, provided that repeat visits enhance individual welfare that anglers derive from recreational fishing. On this basis, Anderson (1993) suggests combining two types of regulatory instrument. This first one gives specific focus on regulations that restrict harvest by individual anglers, in order to raise their awareness of the mortality resulting from their activities. The other one is centred on the regulation of angler effort and total harvest by controlling the number of fishing trips undertaken. Anderson's study highlighted in particular the advantages to be gained from introducing single-day fishing licences along with restrictions on the number of fish from a certain species that are allowed to be caught.

Limiting fish catches is designed to shield specific species by protecting their ability to reproduce. These kinds of limits can be imposed in one of two ways: "bag limits" whereby recreational anglers are limited to a certain number of catches per trip, in order to keep stocks at sustainable levels, and size limits, which aim to prevent excessive numbers of juveniles being removed from the aquatic environment. Bag limits are preferable to size limits from an ecological point of view, because they are more effective in limiting per-catch mortality due to the fact that recreational fishermen are less likely to keep fish out of the water for a long time before throwing them back (Woodward and Griffin, 2003). Thus, it is on the basis of their socio-economic performance that the two regulatory instruments will tend to have differing effects.

When size limits are imposed, there is a reduction in the number of fish caught, thus leading to less benefit being derived from fishing trips (Homans and Ruliffson, 1999; Woodward and Griffin, 2003). On the flipside, anglers can compensate for their reduced catches by fishing more regularly, provided that travel expenses remain affordable. In other words, size limits tend to penalise recreational anglers who live further away from their chosen fishing sites. On the other hand, bag limits will not necessarily have an adverse effect on the benefit derived from a fishing trip. When a recreational angler is confronted with a limit on the amount of fish he is allowed to catch, he can do one of two things: comply with the measure (i.e. stop fishing when that limit is reached), or release smaller fish in the hope of catching larger individuals while remaining within the limit.

Regulations enter the recreationist's utility function both directly, as site characteristics, and indirectly, through expectations of fishing experience improvement, such as the quantities of large fish expected to be caught and harvested. The effect of regulatory instruments on the benefit derived from a fishing trip is therefore positive in terms of the satisfaction obtained from catching and keeping fish, but negative in terms of fishermen being obliged to release fish they have caught. However, variations in welfare generated by stricter enforcement of measures such as those described above reflect the way in which recreational fishermen sort their catch, deciding which fish to keep and which to throw back (Jarvis, 2011), in other words their techniques, fishing behaviour, and experience. More experienced anglers, (i.e. sports fishermen) tend to be placed at a greater disadvantage by the introduction of bag limits at their most frequently visited sites.

In practice, combining both bag and size limits can lead to significant reductions in fish mortality as a result of fishing (Woodward and Griffin, 2003). At sites where bag limits have already been imposed, introducing a size limit on top of these would mean that fishermen would need to apply more effort to catch the maximum permitted number of fish. Managers responsible for regulation therefore need to choose between different combinations of measures to achieve the desired biological results. When making this decision, they need to understand two key issues (1) the relative impact of each specific measure on the marginal WTP for additional fishes harvested with each trip as associated to a lower bag or size limit and (2) the impact of different combinations of these regulatory instruments on the economic value of recreational fishing trip, based on anglers' welfare variation assessment in terms of compensating surplus estimates.

Since the 2000s, the Choice Experiment Method (CEM) has made it possible to use recreational fishermen's preferences to explore the effects of fishing regulation measures (Hunt, 2005). The empirical analysis provided in this paper aims to develop a form of meta-analysis, to collate and make use of the findings of existing studies, relating to the effect of regulatory instruments on the marginal WTP for one additional fishing trip and recreational anglers' welfare variation. We make use of meta-regression (Johnston et *al.*, 2015) which will allow us to model how regulatory instruments affect anglers' benefit estimates, while controlling for the effects of "moderator" variables based purely on the context of the primary studies from which data are taken, to account for differences in the choice set design, questionnaire administration, or sampling strategy.

2- MATERIALS AND METHOD

2.1- Data collection and description of the sample

For a meta-analysis to yield robust results, it is essential to obtain all the relevant literature relating to the specific scientific question being addressed, which will provide the sum of empirical knowledge obtained during a given period. Once these data have been obtained, the quality of the studies needs to be examined, and their content needs to be correctly recorded in a database. As a minimum, such a database must include the following elements:

- Information relating to the documents themselves (exact reference numbers, year of publication, type of publication, the domain in which the relevant scientific review is specialised)
- The evaluations carried out in each study, and the characteristics of those evaluations (method used, number of observations, scenarios, etc.)
- The conditions in which each study took place (place, date, management method)

The aim of the meta-analysis is to find results that are common to all studies. For this to be achieved, those studies need to focus on similar effects, and, in our case, using similar survey protocols. We obtained our samples of empirical studies from the four key academic search engines relating to economics: Google Scholar, Scopus, Web Of Science, ScienceDirect.

Table 1: Summary of the 21 studies included in the meta-regressions

Authors (Year)	**Publication/Journal Title**	**Country/Region coverage**	**Fishing site type**	**Target Species**	**Regulatory instruments**	**Survey year**	**Sample Respondents**	**Sample size** (*) Application of Dillman's method
Anderson and Lee (2013)	Marine Resource Economics	USA/ Northwest	Saltwater	King salmon and pink salmon	Bag limits, Temporary closures	2007	Sport fishermen (Non-resident and resident)	1889*
Anderson et *al.* (2013)	Land Economics	USA/ Puget Sound	Saltwater	Rockfish	Bag limits, Size limits	2007	Recreational anglers	1309*
Beardmore et *al.* (2011)	Fisheries Research	Germany	Freshwater	European eel	Bag limits, Rod limits, Temporary Fishery Closures	2007	Resident anglers	398*
Beardmore et *al.* (2013)	Leisure Sciences	Germany	Freshwater	European eel	Bag limits, Rod limits, Temporary Fishery Closures	2008	Resident fishermen	816*
Beville and Kerr (2009)	Australian Agricultural and Resource Economics Society conference	New Zealand	Freshwater	Trout	Bag limits, Size limits, Temporary fishery closures	2008	Resident fishermen	1436
Carter and Liese (2012)	North American Journal of Fisheries Management	USA/South East	Freshwater	Epinephelus, Mycteroperca, Snapper, Dolphinfish, King Mackerel	Bag limits, Size limits, Catch-and-release	2003/ 2004	Sport fishermen	5677
Dorow et *al.* (2010)	Fisheries Management and Ecology	Germany	Freshwater	European eel	Bag limits, Size limits, Temporary fishery closures	2007	Recreational anglers	381
Gentner (2004)	Proceedings of the Conference of the International Institute of Fisheries Economics & Trade	USA/ South East	Freshwater	King mackerel, dolphinfish, Epinephelinae and red snapper	Bag limits, Size limits	2004	Non-resident fishermen	200*
Hutt et *al.* (2013)	North American Journal of Fisheries Management	USA/Texas	Freshwater/ River	Catfish	Bag limits, Size limits	2009	Recreational anglers	462*

Laitila and Paulrud (2008)	Tourism Economics	Sweden	Freshwater / Lake	Salmon	Bag limits, Size limits	2004	Resident fishermen	1097
Lawrence (2005)	Fisheries Management and Ecology	UK	Freshwater	Bar, Cod, Mackerel, Ray, Conger, Pollack	Bag limits, Size limits	2004	Recreational anglers	358
Lew and Seung (2010)	North American Journal of Fisheries Management	Alaska	Saltwater	Halibut, Salmon	Bag limits, Size limits	2006	Non-resident fishermen	1991*
Lew and Larson (2012)	North American Journal of Fisheries Management	Alaska	Saltwater	Pacific halibut, king salmon, and silver salmon	Bag limits, Size limits	2007	Sport fishermen (Non-resident and resident)	2066*
Lew and Larson (2014)	Fisheries Research	Alaska	Saltwater	Pacific halibut, king salmon, and silver salmon	Bag limits, Catch–and-Release	2007	Sport fishermen (Non-resident and resident)	2066*
Lew and Larson (2015)	Marine Policy	Alaska	Saltwater	Pacific halibut, king salmon, and silver salmon	Bag limits, Size limits	2012	Sport fishermen (Non-resident)	825*
Oh et *al.* (2005)	Human Dimensions of Wildlife	USA/Texas	Saltwater	Red drum	Bag limits, Size limits	2003	Recreational anglers	771*
Oh et *al.* (2007)	Environmental Management	USA/Texas	Freshwater	Not specified	Catch-and-release, Restrictions on bait	2004	Sport fishermen	648*
Oh and Ditton (2006)	Leisure Sciences	USA/ Texas	Saltwater	Red drum	Bag limits, Size limits	2003	Recreational anglers	522*
Paulrud and Laitila (2004)	Journal of Environmental Planning and Management	Sweden/North	Freshwater/ River	Grayling and common trout	Bag limits, Size limits, Catch-and-release,	2002	Recreational anglers	569*
Paulrud and Laitila (2013)	Applied Economics	Sweden/North	Freshwater/ River	Trout and salmon	Bag limits, Size limits	2008	Recreational anglers	633
Whitehead et *al.* (2011)	Marine Resource Economics	USA / North Carolina	Freshwater	King mackerel and snapper	Bag limits	2007	Recreational Anglers	244

The keywords used were: Willingness-to-pay, Choice experiment, recreational fishing, angling, angler, fishing regulation, bag limits, size limits, catch-and-release. We found a total of 31 studies that had made use of CEM to study the impacts of regulation of recreational fishing on the satisfaction of fishermen. The time period used was from 2000 to 2016. Of those, we considered that only 21 contained the regulatory instruments and monetary aspects necessary to obtain a useful economic evaluation.

We constructed our meta-analysis database using 21 existing usable studies (see details in Table 1). These studies were based on surveys carried out between 2002 and 2012 and published between 2004 and 2015 respectively. Some of these studies were carried out by the same authors, using the same survey campaigns, but, crucially, not the same protocols and econometric methods, meaning that there are no "repeated" tests as such.

Because they are drawn from works already published in scientific journals, the majority of the values used in our analysis have already been subject to comments, suggestions, and reviews. Only two of the studies were taken from presentations given at conferences. This situation could possibly lead to a phenomenon known as publication bias, whereby only studies that are statistically significant are presented.

Our sample contains a larger number of studies carried out in the USA (13) than in Europe (7), including 3 in Sweden, 3 in Germany, and 1 in the UK). The other study of the 21 was carried out in New Zealand. Despite the greater number of studies carried out in the USA, the size of that country means that there is as much difference between different US states as there is between the US and other countries, in terms of ecological characteristics, fishermen's practices, and the way in which fishing as an activity is regulated by local authorities.

Thirteen out of the 21 studies were carried out in saltwater areas (offshore or in coastal zones). This shows that regulation of seaborne recreational fishing has been studied to a greater extent than that practiced in inland freshwater. However, recreational fishing is much more popular in freshwater areas. Migratory fish (trout and eels) tended to be the species focused on in freshwater-specific studies. Salmon was studied both in fresh and saltwater. The fishermen surveyed were both sports fishermen and those who fished simply "for fun". They were both resident and non-resident in the areas studied.

2.2- Dependent variables

In meta-regression analyses, the dependent variable is called 'effect size'. The effect size standardises findings across studies such that they can be directly compared. In this study, we focused on choice experiment studies based on scenarios describing fishing conditions and access to fishing sites. We used two dependent variables. Marginal willingness to pay (WTP) was chosen as the first dependent variable because this allows reported values for regulatory instrument attributes to be compared. Using our 21 studies, we were able to create a database of values relating to marginal WTP from 17 studies. These values were extracted from 12 out of the 21 works. In a way similar to that used by Johnston et *al*. (2006) for calculating marginal WTP, we can added a further 5 studies, which gave us a first data set composed of 262 individual observations relating to estimated marginal WTP obtained from 17 different studies. The effect size is thus defined in terms of willingness to pay to benefit from additional fish as associated to more or less restrictive fishing regulation. This can be calculated for a specific fish, or for a group of Target species. We standardised WTP estimates into one currency: euros (€) at the 2017 exchange rate. The relevant rates were obtained for each national currency from world Table (http://fxtop.com).

WTP values for different combinations of regulatory instruments also need to be specified. As such, using compensating surplus estimates as the dependent variable was identified as important in establishing future regulation scenarios. Regulations affect the recreationist's utility function directly as site characteristics and indirectly through expectations of fishing experience improvement. There are two advantages in exploring the welfare effects of changes in fishing regulations. The first is the ability to measure the welfare effects of regulated sites in general. The second is the possibility to quantify the benefits of combining size and bag limits. We thus constructed a second database of compensating surplus estimates using 9 out of our 21 studies. From those 9 studies, we were able to obtain a total of 92 individual observations.

2.3- Explanatory factors of differences in WTP estimates

It is important to make a distinction between WTP estimates relating to resident and non-resident populations. The monetary attributes used to infer WTP can relate to the costs involved in travelling to local fishing areas, the cost of a day's fishing (including travel and food costs in some cases) for resident anglers, and the cost of visiting a particular site, which may include accommodation costs for studies focused on non-resident anglers.

WTP estimates can also change over time due to different natural climatic conditions. The survey year was included in the analysis to capture this effect. Cultural differences may be important drivers of difference in public valuation of natural recreation. We created a dummy variable to indicate studies conducted in Europe.

In the majority of cases, bag limits are tested at the same time as size limits, either with or without other types of regulatory instruments. Only one of the studies we examined contained neither a bag limit nor a size limit, opting instead for a "catch & release" approach. One other study looked at the introduction of bag limits in comparison with a scenario in which there is no regulation whatsoever. However, although, our 21 studies analysed the same regulatory instruments, they displayed a wide range of levels for these variables as attributes of choice scenarios, and tested very different levels of constraints imposed on recreational fishermen's catches and travel.

Target fishes vary with catchment characteristics and unobservable factors such as river quality, site location and type (inland versus coastal) which may influence how respondents view tradeoffs. We thus make a distinction relating to whether migratory fish species are presented as target fish or not.

The studies varied widely in the characteristics of the survey used to obtain responses (e.g; survey protocol, administration procedure, sample size). A number of moderator variables were included to explain differences between WTP values. The choice experiment protocol presents between 3 and 50 sets of choices to respondents, divided into three scenarios. These choice sets can involve a status quo scenario (actual fishing conditions), or an opt-out option, whereby if a fisherman feels that none of the scenarios put forward are acceptable, he can opt to practice an alternative leisure activity, or simply fish in a different place. As such, respondents making choices where survey protocols display a status-quo scenario are likely to have lower WTP values than those who have the choice to opt-out. We thus identify whether a status-quo option was presented or not.

One constraint that is common to all surveys relating to recreational fishermen is that such surveys cannot be carried out on site. All surveys of this type are therefore carried out either by telephone or by return of post. Some of the studies followed the method adopted by Dillman (2000), while others did not. Dillman's approach, known as the "Total Design Method" is designed to increase the response rate to surveys carried out by telephone or by post. It follows that the WTP estimates obtained from studies applying the Dillman method are supposed to be statistically more efficient than a simple random sample.

A well-known issue with meta-analysis is publication bias. Authors often submit for publication manuscripts that have theoretically consistent or conceptually expected results. In the environmental valuation literature, we assume that researchers do not necessarily confine themselves to significant results, because estimated WTP values may well be zero or even negative. However, we cannot rule out the fact that WTP values reported in biology journals (when compared to those appeared in economic journals) were potentially biased towards lower WTP values which relate to higher expected benefits from reinforced fishing regulation.

2.4- The Meta-regression model

The relationships between WTP values and their potential explanatory variables are explored using mixed-effects meta-regression to help correct for well-known issues with meta-analysis data, such as collinearity and heteroscedasticity (Nelson and Kennedy, 2009) using the following equation:

$$LogY_{in} = \alpha + \beta_1 X_{i1} + \beta_2 X_{in2} + u_i + \varepsilon_{in}, \text{ avec } u_i \sim N(0.\tau^2);\ \varepsilon_i \sim N(0.\sigma^2{}_i) \quad (1)$$

$LogY_{in}$ represents the log value of the marginal WTP or compensating surplus estimate for observation n belonging to the same study i; α represents the constant of the regression and corresponds to the true average value of the marginal WTP or compensating surplus estimate. X_{i1} are the variables describing the context of the study in question. X_{in2} are the regulatory instruments tested (including Target species and site types). β_1 and β_2 are the parameters to be estimated, and describes the mean effect of the different variables of interest. The variable u_i accounts for variations due to the study effect, following a normal distribution with zero mean and variance τ^2 . The term ε_{in} is the residual of the regression, it follows a normal distribution with zero mean and a differing variance $\sigma^2{}_i$ for each study.

3 - RESULTS

3.1- Meta-regression of marginal WTP values

A brief statistical summary of the relevant dataset showed that the marginal WTP values for less restrictive fish catch regulations were between 0 € and 2,426 € per trip. 74% of these values were expressed by resident fishermen. 31% of these observations relate to the effect of size limits, 40% to bag limits, 24% to catch and release, and the rest to other types of measures such as temporary closure. 70% of these values concerned migratory fish. The large majority (83% of observations) are related to deep-sea and coastal fishing. Only, 10% of observations are related to European sites. 80% came from studies which used the Dillman method, meaning that they provided a relatively clear picture of the population in question. Only 28% of observations came from a choice protocol that provided a status quo scenario. Finally, 58% of observations came from publications in fish biology journals.

The equation (1) was estimated in three steps: an estimation using only the constant (model 1), an estimation using characteristic variables from the primary study (model 2), and an estimation using – alongside the previous variables – variables relating to the relevant regulatory instruments (model 3). The results of these three models are presented in Table 2.

Table 2: Mixed effect regression analysis of marginal WTP values

Variable	Model 1 (Full sample)	Model 2 (Full sample)	Model 3 (Full sample)	Model 4 (Restricted sample)
Constant	4.13 *** (0.13)	2.54 *** (0.58)	3.35 *** (0.6252)	4.08 *** (0.67)
Year of study		-0.03 (0.05)	0.003 (0.06)	-0.15 ** (0.05)
Migratory fish Species		0.49 ** (0.21)	0.52 ** (0.21)	0.61 * (0.34)
Coastal sites		0.63* (0.33)	0.21 (0.35)	-0.73** (0.34)
Residents		-1,94 *** (0.20)	-1.90 *** (0.19)	-1.22 *** (0.26)
Europe		1,01 *** (0.31)	0.71 ** (0.33)	0.17 (0.30)
Dillman method		2,23 *** (0.24)	2,06 *** (0.25)	1,77 *** (0.15)
Status quo		-0.91 ** (0.29)	-1.06 *** (0.30)	-1.40 *** (0.30)
Fish biology review		1,34 *** (0.19)	1,09 *** (0.21)	-0.04 (0.26)
Size limits			-0.62 ** (0.19)	0.35 ** (0.1603)
Catch-and-Release			-0.38 * (0.20)	-0.61 *** (0.22)
Other instruments			-1.19 ** (0.46)	-0.27 (0.23)
τ^2	4.57	1.22	1.18	0.39
${\sigma^2}_i$	99%	97%	96%	96%
Adjusted R²		0.73	0.74	0.78
Number of observations	262	262	262	151

Note: Standard-error in () ; *** significant at 1%, ** significant at 5% and * significant at 10%.

The estimations in Model 1 show that marginal WTP values differ greatly between studies (${\sigma^2}_i$= 99%). This heterogeneity can be explained by differences in study characteristics: the τ^2 indicator reduced from 4.57 in Model 1 to 1.22 in Model 2. The differences between models 2 and 3 show that introducing regulatory instruments as moderator variables allows this heterogeneity to be reduced. $\tau^2$is reduced from 1.22 to 1.18 and the adjusted value of R² is increased from 0.73 to 0.74.

Our last meta-regression estimation (column 4) show that Year of study had no notable impact on results, i.e. marginal WTP does not change over time. Marginal WTP from surveys applying the Dillman method tended to be higher, as did that from studies published in fish biology reviews. Values from choice experiment survey that displayed a status quo scenario were lower. Values obtained from residents were lower, while marginal WTP for Europeans was higher.

All of the regulatory measures serving as explanatory variables are significant, meaning that marginal WTP for relaxing regulatory instruments tends to be lower when size limits and other such measures are applied than when bag limits are used. There is no significant difference between marginal WTP values for sea fishing compared with freshwater fishing. On the other hand, less value is attached to the regulation of migratory fish. This result is surprising when compared with that of Johnston et *al*. (2006), who found that salmon had varying levels of influence on marginal WTP.

3.2- Meta-regression of marginal WTP values without Alaska data

We decided to test the sensitivity of these results in relation to certain studies. To do this, we tested the impact on the statistical inference of mean effects when one study was removed. Studies removed were those with large numbers of observations: Lew and Larson (2012) (14 observations), Lew and Larson (2014) (90 observations), Anderson and Lee (2013) (69 observations), Hutt et *al*. (2013) (16 observations), Gentner et *al*. (2004) (11 observations). The results of these meta-regressions from Model 3 are detailed in the appendix (Table A-1).

It is important to point out here that our meta-regression shows no less dispersion of the values within this new sample than in the full original one, except for Lew and Larson (2012) and Lew and Larson (2014). Values for indicator τ^2 are less than 1: 0.58 and 0.75 respectively. On this basis, it is preferable to keep the same statistical inference without the Lew and Larson studies, because τ^2 values influence the effects of moderator variables (Borenstein et *al*., 2009). In view of this, we decided to exclude results from the studies by Lew and Larson (2012, and 2014). It is our belief that the conditions in which these results were collected (in Alaska) were excessively specific to that region, which pushed up the heterogeneity in our marginal WTP valuation database. This specificity derives from the fact that all fishing in Alaska is a long-distance affair, even for residents, given the vast open spaces to be found there.

When compared with the full sample, the number of observations per study is now between 2 and 69. Only 28% of data were obtained from fish biology reviews. 71% of observations related to value attached to deep sea and coastal fishing. Marginal WTP values were between 0 € and 326 €. 64% (as opposed to 80% previously) were obtained from surveys using the Dillman method. The proportion of data obtained from status quo scenarios is higher at 44%. There is no detectable difference for migratory fish (72%). 75% are marginal WTP values for an additional fishing trip to fish a particular kind of species. Over 85% are values expressed by resident fishermen. More marginal WTP is attached to size limits (40%), while less is attached to bag limits (21%). The value for catch and release remains unchanged at 21%. The Column 5 of Table 2 provides estimation with this subsample.

Our comments of this last regression (Model 4) relate only to results which changed either in terms of sign or significance. This means that Year of Study is significant and has a negative influence. Recent marginal WTP values appear to be lower. The type of publication used has no effect on the values observed. The influence of fishing site becomes both significant and negative, meaning that marginal WTP for less restrictive harvest regulation in freshwater sites appears to be higher. There is no difference between that obtained in studies conducted in Europe and the rest (US excluding Alaska and New Zealand). Fishermen's marginal WTP for lowering size limits is 1.41 times higher at sites where size limits are imposed (when compared with sites where bag limits are used). These results are consistent with the theoretical predictions of Woodward and Woodward and Griffin (2003) and Jarvis (2011). Our results also show that marginal WTP to reduce fishing regulation is 1.84 times higher when fishing for migratory fish, and 1.52 times higher when fishing in freshwater.

The results obtained from this last meta-regression, confirm that there is a positive marginal WTP value for fishing sites where regulatory measures are loosely applied. In other words, fishermen are willing to pay (up to 59€ per fishing trip) to fish in sites where such measures are applied but not in force. That being said, there are considerable differences from one study to another. These variations are primarily due to the heterogeneous nature of the conditions of each study. In cases where the Dillman approach is used, values are 4.87 % higher, and where a "status quo" scenario is included, there is a drop of 75%[2]. In other words, for survey protocols where the baseline scenario is the status quo (actual fishing conditions) rather than an "opt out" option (other fishing sites, or activities), respondents are more likely to express lower marginal WTP value.

3.3- Meta-regression analysis of compensating surplus estimates

This particular meta-regression is based on the results of 9 studies, 2 of which were carried out in Europe, with a total of 92 observations. The meta-regression applied to this sample aimed to study effects on the compensating surplus of one additional visit, once fishing conditions have been changed by the introduction of a combination of different regulatory instruments. The equation (1) for this sample is calculated based on all the variables which indicates the characteristics of our primary studies, and the variables relating to the different (minimum, medium, maximum) levels at which different regulatory instruments (bag limit and size limit) were applied in the choice experiment scenarios across studies. The results of this model are presented in column 2 of Table 3.

On the basis of the results shown above, there is clearly a positive effect associated with the application of catch and harvest limits (in comparison with status-quo or opt-out option) on recreational fishermen satisfaction from fish trip. This is illustrated by the positive, significant regression constant. However, regardless of the level at which other measures are applied, welfare variations are lower when there are restrictions on the size of fish caught (negative and significant coefficients for the three different levels). On the other hand, the introduction of bag limits appears to have a significant positive impact when applied at maximum level (i.e. at its most restrictive).

Expected compensating surplus estimates achieved by improving fishing conditions through restricting catches are lower when they concern migratory fish. This would appear to indicate that – all things being equal – fishermen who focus on these types of fish, as opposed to those who focus on other species, have a lower expectation of benefit from improvements to their fishing conditions through a mixture of biological measures. This is unsurprising, in the sense that reproduction among migratory fish depends on a very specific set of conditions.

[2] The increase of the dichotomous variable from 0 to 1 also leads to a variation in the percentage of the variable: $100 * (\exp(\beta) - 1)$.

Table 3: Mixed effect regression analysis of compensating surplus estimates

Variable	Model estimated with full sample	Model estimated with restricted sample
Constant	0.54	1.89 ***
	(0.59)	(0.35)
Year of study	0.67 ***	0.32 ***
	(0.06)	(0.05)
Migratory Fish Species	-0.97 ***	-1.86***
	(0.27)	(0.24)
Status quo	0.84 **	1.65 **
	(0.32)	(0.20)
Min-Bag-limit	0.52	-0.60
	(0.51)	(0.42)
Med-Bag-limit	0.16	-0.85 ***
	(0.41)	(0.25)
Max-Bag-limit	0.78 *	-0.41
	(0.50)	(0.29)
Min-Size-limit	-0.86 *	-0.53
	(0.40)	(0.37)
Med-Size-limit	-1.15 ***	-0.41
	(0.34)	(0.26)
Max-Size-limit	-0.55 **	-0.29
	(0.58)	(0.30)
τ^2	1,12	0.28
I^2_{res}	98%	91%
Adjusted R^2	0.75	0.87
Number of observations	92	88

Note: Standard-error in (); *** significant at 1%, ** significant at 5% and * significant at 10%.

As before, we applied a sensitivity test, excluding estimations taken from studies carried out in Alaska. In this case, we saw reduced dispersion of true variation in CS values, and a reduction in τ^2 from 1.12 to 0.28 (Column 3 of Table 3). Expected welfare variation through an improvement in fishing condition attributes is estimated to be about 6.86 € per fisherman per trip, for all scenarios. As with marginal WTP, the influence of regulatory measures was modified as a result. Variations in anglers' satisfaction from an additional visit are not sensitive to changes in size limits. On the other hand, they are lower in scenarios where the bag limit instrument is applied at medium level. Introducing management based on a bag limit (at medium level) reduces fishermen's welfare by 50%. CS estimates specific to the fishing of migratory species is 84 % lower. In other words, the benefits expected from management policies based on limiting migratory fish catches are very low.

As before, the conditions in which studies are carried out have a significant influence on results. The use of a status quo scenario as opposed to an opt-out option in the choice process provides a four-fold increase in CS estimates. This is not surprising, because it refers to the expected benefit from the form of fishing site management most likely to lead to an improvement in fishing conditions. In cases where there is an opt-out scenario, CS estimates reflect expected benefits for a site compared with that of other sites or other activities (i.e. substitutes).

4- DISCUSSION AND CONCLUSION

In this study, mixed effect meta-regressions were estimated to identify how regulatory instruments affect recreational anglers' preferences. More specifically, our meta-regression results raise two broad findings. The type of fishing sites (coastal versus fresh water), target species (or not) were significant explanatory variables of the variation in marginal WTP estimates for an additional fish. More specifically, our study shows that such WTP is higher for freshwater fishing sites, or at sites offering predominantly migratory fish species. Results show also that recreational anglers perceive higher expected benefit from fishing experience taking place in sites where fish catch regulations are applied. However, they are willing to pay additional cost to avoid "fishing sites" where size limits are severely extended or where numbers of fish caught are drastically reduced.

The results of our meta-regressions show that WTP varies significantly depending on the way in which surveys are carried out. Statistically speaking, the effects of these different methods make up a large proportion of the variation in marginal WTP between studies. When combined, these variations can have a greater effect than those linked to the species fished and the attributes of the various scenarios. The compensating surplus (CS) expected from an additional fishing trip to sites with more stringent catch and harvest regulations are positive. As for marginal willingness-to-pay values, the choice set design and the degree of severity of catch and harvest limitations and target species were significant explanatory variables for compensatory surplus estimates.

This study has several limitations. First, as most samples are from a few countries in Europe and the US, the meta-regression analysis could not test the effects of detailed location variables, nor could it reflect meteorological and natural conditions. Second, most studies did not provide welfare variation estimates. Therefore, we cannot use the findings of our meta-regression of compensating surplus estimates to compare the welfare effects of different degrees of bag limits and size limits. Future studies should calculate compensating variation surpluses that examine the effects of combining different levels of technical-biological measures.

In fishing resource economics, there is a tradition of employing a bioeconomic approach, which provides concepts and methods to understand the mechanisms through which more sustainable fishing may be achieved (Cox and Walters 2002; Kulmala et *al*., 2008 to cite a few). While the fishing management options put forward by such approaches are undoubtedly effective when applied to purely biological questions, they are less so when dealing with anglers' behaviour, specifically the wide range of practices they exhibit and the way in which the number of their catch can vary (Johnston et *al*., 2010; Fenichel and Abbott, 2014). This is because bioeconomic models often use a simplified representation of anglers' behaviour, in order to simulate the impact of management measures on the development of fish stocks. One of the aims of the more recent bioeconomic models has been to obtain a clearer picture of the complex range of behaviours exhibited by recreational anglers (Johnston et *al.*, 2015). This has typically been achieved through attempts to combine fishermen's satisfaction analysis with the biological dynamics of specific fish populations. The welfare effects of fishing regulatory measures were obtained through non-market valuation which applies the choice experiment method to scenarios with different fishing conditions (Dabrowska et *al.*, 2017). A critical area for future research concerns the design of choice experiment studies and surveys to identifying the welfare effects of regulatory instruments applied to recreational fishing, and their potential implications for benefit transfer.

The findings of this study suggest that the use of the choice experiment survey is a very promising method by which to assess fishermen's preferences as they apply to different management scenarios for regulating fishing harvest and preserving species stocks. That said, to achieve reliable results, it is important that researchers pay particular attention to the methodology employed. Our findings indicate that the application of the Dillman method (when compared to simple random sampling) provides higher marginal willingness to pay estimates. In summary, future studies should employ more representative samples. Future choice experiment studies should also be cautious in the definition of the baseline scenario of their choice sets. The application of the status-quo scenario or an opt-out option has a significant impact on the marginal WTP value and the magnitude of compensating surplus estimate. Therefore, we recommend that future studies investigate recreational anglers' preferences with status-quo scenarios for direct and unbiased comparisons of the welfare effects of different fishing regulation instruments.

Acknowledgments: This work has benefited the financial support of the Nouvelle-Aquitaine Regional Council under the FAUNA project.

APPENDIX

Table A-1 Sensitivity analysis of marginal WTP estimate analysis

Variable	Model A	Model B	Model C	Model D	Model E
Constant	3.17 *** (0.56)	3.96 *** (0.82)	3.36 *** (0.68)	2.29 *** (0.49)	3.38 *** (0.64)
Year of study	0.12 ** (0.06)	-0.02 (0.06)	0.05 (0.06)	-0.002 (0.04)	-0.01 (0.06)
Fish biology review	-0.88 *** (0.26)	0.90* (0.52)	1.16 *** (0.23)	1.74 *** (0.16)	1.06 *** (0.21)
Dillman method	1.89*** (0.20)	1.86 *** (0.27)	1.85 *** (0.28)	2.22 *** (0.18)	1.94 *** (0.29)
Status quo	-1.29 *** (0.30)	-0.94 ** (0.47)	-0.97 *** (0.34)	-0.97 *** (0.23)	-0.98 *** (0.33)
Coastal Site	-0.57 * (0.33)	-0.06 (0.43)	0.03 (0.37)	0.75 *** (0.26)	0.33 (0.41)
Migratory Fish Species	-0.33 (0.35)	0.43 ** (0.21)	0.58 *** (0.22)	0.56 *** (0.16)	0.51 ** (0.21)
Residents	-0.53 * (0.30)	-1.88 *** (0.20)	-1.88 *** (0.20)	-1.87 *** (0.15)	-1.88 *** (0.20)
Europe	1,19*** (0.33)	0.84 ** (0.41)	0.40 (0.38)	0.96 *** (0.25)	0.67 ** (0.34)
Size limits	-0.19 (0.20)	-1.42 *** (0.23)	-0.60 *** (0.21)	0.02 (0.15)	-0.67 *** (0.21)
Catch-and-Release	-1.00 *** (0.28)	0.56 ** (0.24)	-0.37 * (0.22)	-0.3913 ** (0.1514)	-0.40 * (0.21)
Other Instruments	-0.21 (0.39)	-1.53 *** (0.48)	-2.40 ** (0.93)	-0.94 *** (0.34)	-1.25 *** (0.48)
τ^2	0.75	1.19	1.24	0.58	1.23
I^2_{res}	97%	94%	96%	95%	96%
Adjusted R^2	0.67	0.80	0.70	0.87	0.69
Number of observations	172	193	246	248	251

Note: Standard-error in () ; *** significant at 1%, ** significant at 5% and * significant at 10%.
Model A = meta-regression excluding results from the study by Lew and Larson (2014).
Model B = meta-regression excluding results from the study by Anderson and Lee (2013).
Model C = meta-regression excluding results from the study by Hutt et al. (2013).
Model D = meta-regression excluding results from the study by Lew and Larson (2012).
Model E = meta-regression excluding results from the study by Gentner (2004).

REFERENCE

Aas, Ø., Haider, W., Hunt, L., 2000. Angler Responses to Potential Harvest Regulations in a Norwegian Sport Fishery: A Conjoint-Based Choice Modeling Approach. North American Journal of Fisheries Management 20, 940-950.

Anderson, L.E., Lee, S.T., 2013. Untangling the Recreational Value of Wild and Hatchery Salmon. Marine Resource Economics 28, 175-197.

Anderson, L.E., Lee, S.T., Levin, P.S., 2013. Costs of Delaying Conservation: Regulations and the Recreational Values of Exploited and Co-occurring Species. Land Economics 89, 371-385.

Anderson, L.G., 1983. The Demand Curve for Recreational Fishing with an Application to Stock Enhancement Activities. Land Economics 59, 279-286.

Anderson, L.G., 1993. Toward a Complete Economic Theory of the Utilization and Management of Recreational Fisheries. Journal of Environmental Economics and Management 24, 272-295.

Beardmore, B., Dorow, M., Haider, W., Arlinghaus, R., 2011. The elasticity of fishing effort response and harvest outcomes to altered regulatory policies in eel (Anguilla anguilla) recreational angling. Fisheries Research 110, 136-148.

Beardmore, B., Haider, W., Hunt, L.M., Arlinghaus, R., 2013. Evaluating the Ability of Specialization Indicators to Explain Fishing Preferences. Leisure Sciences 35, 273-292.

Beville, S., Kerr, G., 2009. Fishing for more understanding: a mixed logit-error component model of freshwater angler site choice, The 53rd annual Australian Agricultural and Resource Economics Society conference, Cairns, Queensland.

Borenstein, M., Hedges, L.V., Higgins, J.P., Rothstein, H.R., 2009. Introduction to meta-analysis. Wiley, UK.

Cardona, F., Morales-Nin, B., 2013. Anglers' perceptions of recreational fisheries and fisheries management in Mallorca. Ocean & Coastal Management 82, 146-150.

Carter, D.W., Liese, C., 2012. The Economic Value of Catching and Keeping or Releasing Saltwater Sport Fish in the Southeast USA. North American Journal of Fisheries Management 32, 613-625.

Cooke, S.J., Cowx, I.G., 2004. The Role of Recreational Fishing in Global Fish Crises. BioScience 54, 857-859.

Cooke, S.J., Cowx, I.G., 2006. Contrasting recreational and commercial fishing: Searching for common issues to promote unified conservation of fisheries resources and aquatic environments. Biological Conservation 128, 93-108.

Cowx, I.G., Arlinghaus, R., Cooke, S.J., 2010. Harmonizing recreational fisheries and conservation objectives for aquatic biodiversity in inland waters. Journal of Fish Biology 76, 2194-2215.

Cox, S., Walters, C., 2002. Maintaining quality in recreational fisheries: how success breeds failure in management of open-access sport fisheries, in: Pitcher, T.J., Hollingworth, C.E. (Eds.), Recreational Fisheries: Ecological, Economic and Social Evaluation Blackwell Science, London, Uk.

Curtis, J., Breen, B., O'Reilly, P., O'Donoghue, C., 2017. The economic contribution of a recreational fishery in a remote rural economy. Water Resources and Rural Development 10, 14-21.

Dabrowksa, K., Hunt, L.M., Haider, W., 2017. Understanding How Angler Characteristics and Context Influence Angler Preferences for Fishing Sites. North American Journal of Fisheries Management 37, 1350-1361.

Dillman, D.A., 2000. Mail and Internet surveys: The tailored design method. Wiley.

Dorow, M., Beardmore, B., Haider, W., Arlinghaus, R., 2010. Winners and losers of conservation policies for European eel, Anguilla anguilla: an economic welfare analysis for differently specialised eel anglers. Fisheries Management and Ecology 17, 106-125.

Fenichel, E.P., Abbott, J.K., 2014. Heterogeneity and the fragility of the first best: Putting the "micro" in bioeconomic models of recreational resources. Resource and Energy Economics 36, 351-369.

Gentner, B., 2004. Examining target species substitution in the face of changing recreational fishing policies, in: Matsuda, Y., Yamamoto, T. (Eds.), Twelfth Biennial Conference of the International Institute of Fisheries Economics & Trade, Tokyo, Japan.

Homans, F.R., Ruliffson, J.A., 1999. The Effects of Minimum Size Limits on Recreational Fishing. Marine Resource Economics 14, 1-14.

Hunt, L.M., 2005. Recreational Fishing Site Choice Models: Insights and Future Opportunities. Human Dimensions of Wildlife 10, 153-172.

Hutt, C.P., Hunt, K.M., Schlechte, J.W., Buckmeier, D.L., 2013. Effects of Catfish Angler Catch-Related Attitudes on Fishing Trip Preferences. North American Journal of Fisheries Management 33, 965-976.

Jarvis, S.L., 2011. Stated Preference Methods and Models: Analyzing Recreational Angling in New England Ground fisheries, Department of Agricultural and Resource Economics. University of Maryland.

Johnston, F.D., Arlinghaus, R., Dieckmann, U., 2010. Diversity and complexity of angler behaviour drive socially optimal input and output regulations in a bioeconomic recreational-fisheries model. Canadian Journal of Fisheries and Aquatic Sciences 67, 1507-1531.

Johnston, R.J., Ranson, M.H., Besedin, E.Y., Helm, E.C., 2006. What Determines Willingness to Pay per Fish? A Meta-Analysis of Recreational Fishing Values. Marine Resource Economics 21, 1-32.

Johnston, R.J., Rolfe, J., Rosenberger, R.S., Brouwer, R., 2015. Benefit Transfer of Environmental and Resource Values in Meta-analysis: Rationale, Issues and Applications, in: Johnston, R.J., Rolfe, J., Rosenberger, R.S., Brouwer, R. (Eds.), Benefit Transfer of

Environmental and Resource Values : A Guide for Researchers and Practitioners. Springer, pp. 357- 418.

Kulmala, S., Laukkanen, M., Michielsens, C., 2008. Reconciling economic and biological modeling of migratory fish stocks: Optimal management of the Atlantic salmon fishery in the Baltic Sea. Ecological Economics 64, 716-728.

Laitila, T., Paulrud, A., 2008. Anglers' Valuation of Water Regulation Dam Removal for the Restoration of Angling Conditions at Storsjö-Kapell. Tourism Economics 14, 283-296.

Lawrence, K.S., 2005. Assessing the value of recreational sea angling in South West England. Fisheries Management and Ecology 12, 369-375.

Lew, D.K., Larson, D.M., 2012. Economic Values for Saltwater Sport Fishing in Alaska: A Stated Preference Analysis. North American Journal of Fisheries Management 32, 745-759.

Lew, D.K., Larson, D.M., 2014. Is a fish in hand worth two in the sea? Evidence from a stated preference study. Fisheries Research 157, 124-135.

Lew, D.K., Larson, D.M., 2015. Stated preferences for size and bag limits of Alaska charter boat anglers. Marine Policy 61, 66-76.

Lew, D.K., Seung, C.K., 2010. The Economic Impact of Saltwater Sportfishing Harvest Restrictions in Alaska: An Empirical Analysis of Nonresident Anglers. North American Journal of Fisheries Management 30, 538-551.

McPhee, D., Leadbitter, D., Skilleter, G., 2002. Swallowing the bait: is recreational fishing in Australia ecologically sustainable? Pacific Conservation Biology 8, 40-51.

Nelson, J.P., Kennedy, P.E., 2009. The Use (and Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment. Environmental and Resource Economics 42, 345-377.

Oh, C.-O., Ditton, R.B., Gentner, B., Riechers, R., 2005. A Stated Preference Choice Approach to Understanding Angler Preferences for Management Options. Human Dimensions of Wildlife 10, 173-186.

Oh, C.-O., Ditton, R.B., Riechers, R., 2007. Understanding Anglers’ Preferences for Fishing Tournament Characteristics and Policies. Environmental Management 40, 123.

Oh, C.-O., Ditton, R.B., Riechers, R., 2007. Understanding Anglers’ Preferences for Fishing Tournament Characteristics and Policies. Environmental Management 40, 123.

Paulrud, A., Laitila, T., 2004. Valuation of management policies for sport-fishing on Sweden's Kaitum river. Journal of Environmental Planning and Management 47, 863-879.

Paulrud, A., Laitila, T., 2013. A cost-benefit analysis of restoring the Em River in Sweden: valuation of angling site characteristics and visitation frequency. Applied Economics 45, 2255-2266.

Stage, J., Kirchner, C., 2005. An economic comparison of the commercial and recreational line fisheries in Namibia. African Journal of Marine Science 27, 577-584.

Steinback, S.R., 1999. Regional Economic Impact Assessments of Recreational Fisheries: An Application of the IMPLAN Modeling System to Marine Party and Charter Boat Fishing in Maine. North American Journal of Fisheries Management 19, 724-736.

Van den Bergh, J.C.J.M., Button, K.J., Nijkamp, P., Peing, G.C., 1997. Meta-analysis in environmental economics. Kluwer, Dordrecht.

Veiga, P., Pita, C., Leite, L., Ribeiro, J., Ditton, R.B., Gonçalves, J.M.S., Erzini, K., 2013. From a traditionally open access fishery to modern restrictions: Portuguese anglers' perceptions about newly implemented recreational fishing regulations. Marine Policy 40, 53-63.

Whitehead, J.C., Dumas, C.F., Landry, C.E., Herstine, J., 2011. Valuing Bag Limits in the North Carolina Charter Boat Fishery with Combined Revealed and Stated Preference Data. Marine Resource Economics 26, 233-241.

Woodward, R.T., Griffin, W.L., 2003. Size and Bag Limits in Recreational Fisheries: Theoretical and Empirical Analysis. Marine Resource Economics 18, 239-262.