Fisher's preferences and trade-offs between management options.

Alternative Title 1: A Choice Experiment of fisher's preferences and trade-offs between management options.

Alternative Title 2: A Choice Experiment of fisher's preferences and trade-offs between management options in Europe's Common Fisheries Policy.

Mike Fitzpatrick* (1), Christos D. Maravelias (2), Ole Ritzau Eigaard (3), Stephen Hynes (1), David Reid (4).

(1) Socio-Economic Marine Research Unit (SEMRU), J.E. Cairnes School of Business and Economics, National University of Ireland, Galway, Ireland; (2) Hellenic Centre for Marine Research, Greece; (3) National Institute of Aquatic Resources, DTU Aqua, Technical University of Denmark, Charlottenlund Castle, 2920 Charlottenlund, Denmark; (4) Marine Institute, Rinville, Galway, Ireland.

*Corresponding author: Mike Fitzpatrick, Socio-Economic Marine Research Unit (SEMRU), J.E. Cairnes School of Business and Economics, National University of Ireland, Galway, Ireland. Email: mike@irishobservernet.com. Phone: 00353 868584156 (mobile); 00353 21 4505256.

Running Title: Fisher's preferences and trade-offs.

Abstract

Failure to understand the potential responses of fishers to management measures creates a significant risk of revisiting the familiar scenario of perverse and unintended consequences of those measures. This paper reports on a Choice Experiment survey to evaluate fisher's preferences for various management measures proposed under the EU Common Fisheries Policy (CFP) reform process, but the conclusions have wider relevance as similar measures are used by comparable fleets in fisheries globally. The survey was conducted with fishers involved in mixed pelagic and demersal fisheries in Ireland, pelagic fisheries in Denmark and demersal fisheries in Greece. Fisheries management policies were characterised by five attributes designed both to cover the principal CFP reform proposals and to integrate ecological, social, economic and institutional factors affecting fisher's decisions. The paper uses a random utility modelling framework to reveal the preferences of the fishers across the alternative policy attributes. Results show that while there are generally preferences both for healthy stocks and for maintaining the importance of fishing to the local community, strong inter-fishery preference differences exist. These differences are most notable in relation to a discard ban and to the use of individual transferable fishing rights, favoured in Denmark, but not in Ireland for instance. The strength of these inter-fishery differences supports the assertion that there are no panaceas in fisheries management and that solutions should be tailored within the context of specific fisheries. Not doing so could create a significant risk of inappropriately managed fisheries that may lead to unsustainable outcomes.

Keywords: Behaviour of fishers, Choice Experiment, Common Fisheries Policy, fisheries governance, Random Utility Model.

Table of Contents:

Introduction

Successful governance of marine fisheries remains a difficult issue of global importance (FAO 2016). The European Common Fisheries Policy (CFP) (European Parliament and Council 2013) is a case in point (Villasante *et al*. 2011). The CFP contains a wide range of management measures intended to solve the overarching problems identified during the CFP reform process (European Commission 2009). These measures include *inter alia* changes to governance arrangements such as regionalisation, economic instruments such as the proposed mandatory use of transferable quotas and conservation measures such as a landing obligation for quota species. Fisher's relative preferences for these management measures, including those that may be positively received and could incentivise "good" behaviour, have not been systematically assessed. If we are to avoid the familiar problem, well known to those involved in fisheries management, of perverse and unintended consequences (Abbott and Haynie 2012; Degnbol and McCay 2007) then it is necessary to have a greater understanding of fisher's likely responses to these measures, following approaches taken in countries such as Australia (Fulton *et al.* 2011; Pascoe *et al.* 2009).

The central question addressed by this paper is which management measures, and at what scale, create the right incentives to tackle the main failings of fisheries management, as exhibited under the CFP. We report on an innovative approach to assessing fisher's preferences for management measures and additionally to providing insight into how fishers are prepared to trade-off between them. Choice Experiments (CE) are designed to measure the overall value of a good such as a healthy marine ecosystem while also discerning the marginal value or utility of that good's individual attributes (Hanley *et al.* 1998; Hynes *et al.* 2008). The importance of this is that management measures targeting those attributes most valued by stakeholders and which in theory will most incentivise change can be identified (Eliasen *et al.* 2014).

The CE method has been widely used in environmental and agricultural economics (Hanley *et al.* 1998; Birol and Cox 2007; Hynes and Campbell 2011; Chhun *et al.* 2013) but has seldom been applied in relation to fisher's preferences for different commercial fisheries management approaches. Oh *et al.* (2005) analysed preferences for various management options in recreational fisheries using a CE. Duffield *et al.* (2012) modelled the behaviour of recreational Marlin anglers in the Western Pacific. Eggert and Martinnson (2003) used CE to explore levels of risk tolerance in commercial fishers. Groeneveld (2011) modelled preferences in the Netherlands with regards to a specific management measure, an area closed to fishing to protect juvenile Plaice. There has also been some application of the CE approach to specific aspects of small-scale commercial fisheries in the developing world: Launio *et al.* (2009) examined the factors considered important for fishers in relation to Marine Protected Areas in the Philippines; while Kanchanaroek *et al.* (2013) modelled fisher's property rights choices in a Cambodian small scale fishery. To the best of our knowledge there has been no previous application of the CE method to model the preferences of fishers between alternative management measures in any commercial fisheries despite the fact that the method is well suited to making such an analysis. This research is also the first to use the CE methodology to compare preference structures across a number of different fisheries.

Case study fisheries

Three case study fisheries were selected in which to conduct the Choice Experiment: the Celtic Sea herring (*Clupea harengus*, Clupeidae) fishery in Ireland; the Danish pelagic fishery and the Aegean demersal trawl fishery in Greece. These fisheries were selected on the basis that they included one strictly pelagic, one strictly demersal and one mixed fishery which allows an examination of whether management preferences differ across types of European fishery. Figure 1 shows the grounds fished by each of the surveyed fleets.

The Celtic Sea herring fishery

The Celtic Sea herring fishery is conducted off the south coast of Ireland predominantly within 20 nautical miles of the coast. The fleet is highly diverse with vessels ranging from under 10m multi-purpose inshore vessels up to modern 45m refrigerated sea water (RSW) vessels. Most of the participating vessels are classed as polyvalent, i.e. they alternate between pelagic and demersal fisheries during the year. The fishery has traditionally been a very important one for both the fleet and processing sectors in the south of Ireland.

The history of the fishery over the past 50 years has been one of an alternating boom and bust cycle. Following very low stock levels from approximately 1995 to 2007 the Spawning Stock Biomass (SSB) is currently at its highest point since the 1960's while fishing mortality (F) rates are at their lowest recorded level. A long-term management plan (LTMP), jointly developed by the local management committee and scientists in 2011 has been evaluated by ICES as being consistent with their precautionary and Maximum Sustainable Yield (MSY) approaches (Marine Institute 2013).

A total of 86% of the Total Allowable Catch is allocated to Ireland and the only other significant players involved in the fishery are Dutch vessels and Dutch owned vessels from France and Germany. It is essentially a single species fishery without any significant bycatch issues (Fitzpatrick 2013). Prior to 2012 the fishery was effectively an open access one for vessels under approximately 20m in length while a pool of larger vessels retained access rights. Numbers of participating vessels increased steadily between 2007 and 2012 in both the main (offshore) and sentinel (inshore) fleet sectors (Le Floc'h *et al.* 2014). In 2012 a restricted access scheme was introduced by the Irish Fisheries Minister intended to reduce the number of vessels entitled to participate in the fishery (DAFF 2012).

The Danish pelagic fishery

The majority of Danish pelagic catches for human consumption are taken in the Northeast Atlantic, where the fleet mainly targets herring and mackerel (*Scomber scombrus*, Scombridae) in the North Sea (ICES area IVa and IVb) and herring in the Norwegian Sea (ICES area IIa). The main fleet consists of approximately ten vessels above 40m using pelagic trawls and purse seines (mainly for mackerel), while a similar sized fleet of smaller trawlers (mostly vessels less than 18m) fish herring in the inshore areas in the Kattegat (ICES area IIIa) and the Baltic Sea (IIIc and IIId). The pelagic fleet is economically important and contributes approximately 45% of the total annual landing value in Denmark.

There have been considerable structural changes in the Danish pelagic fleet since the introduction of an individually tradeable quota (ITQ) system in January 2003, with a decrease in vessel numbers from 130 vessels fishing herring in 2000 to approximately 25 vessels in 2012. This fleet restructuring has resulted in a better balance between fleet capacity and fishing opportunities, and improved economic performance through increases in catch efficiency. Catch technology (e.g. gear size and electronic fish-finding and navigational equipment) has been shown to improve in newer, larger vessels (Eigaard 2009; Eigaard *et al.* 2014), adding to the observed increasing trend in fishing power.

The Greek demersal fishery

The third fishery, the Greek demersal fishery, has an essentially multispecies nature with up to 100 species in some areas, that is typical of Mediterranean fisheries (Caddy 2009). There is a high interaction between gears and fleet segments, since most of the main target species are exploited by more than one fishing technique or strategy, each often concentrating on individuals of different sizes. The fishery is generally managed through input regulations i.e. effort control rules and technical measures, such as closed seasons, closed areas, limited licenses, minimum landing size (MLS), mesh size regulations, and maximum gear sizes. The selected study area was the northern part of the FAO General Fisheries Council for the Mediterranean (GFCM) GSA 22.

The Data Collection Regulation (DCR) programme (EC 1543/2000; EC 949/2008) has enabled a time series of effort and landings data in the Mediterranean to be built (Vassilakopoulos *et al.* 2014) and improved the data limitations which constrained past stock assessments. Under the DCR framework data on effort and landings have been collected in Greece since 2002 from 209 landing ports on a monthly basis. The active Greek trawler fleet in the Aegean Sea consists of 299 vessels that use bottom trawl nets as the main gear. The gear used is more or less the same (40 mm diamond mesh size) irrespective of the target species, with only minor modifications.

Methodology

Choice Experiment surveys involve the respondent making a series of choices between scenarios comprised of component attributes with varying levels. In this study the choice scenarios consist of varying combinations of fisheries management options. The survey attributes were selected based on their prominence in the CFP reform process, on relevance for fishing industry stakeholders and on the need to integrate ecological, economic and social factors. From a comprehensive list of potential choices six attributes with varying levels were selected: long-term biological outlook of the fishery; management scale; importance of fishing to the local community; management measures; access and quota allocation options and a cost attribute. Although not of direct relevance in the analysis presented in this paper, the inclusion of a cost attribute is a requirement to allow for an assessment of welfare impacts arising from moving from one suite of management policies to another. The cost attribute selected was the annual payment made by fishers to their representative organisations. We felt that this financial contribution is more closely related to management performance than for instance the market price of fish that may fluctuate independently of how well a fishery is managed.

An important criterion in the selection of attributes was that they had to be sufficiently generic to be relevant in three case study fisheries, in different countries, and with diverse management arrangements. The only case specific modification required was in changing the Transferable Fishing Concession (TFC) attribute levels to Transferable Territorial Use Rights in Fisheries (TURFs) for the Greek demersal fisheries as quotas are not used in the Mediterranean.

A related issue is that both the choice of attributes and the range of attribute levels used in the survey should as far as possible be meaningful to respondents rather than being purely hypothetical. This is an important consideration in order to avoid speculative or protest responses. Table 1 shows the attributes and their levels.

In a choice experiment, an experimental design is used to map attributes and levels into sets of alternatives to which respondents indicate their choices. For the main survey a D-efficient design was used. A D-efficient design identifies a subset of choice situations from all possible combinations of attribute-levels (full factorial design) and places the subset into groups of alternatives. An experimental design with 24 choice questions was used but the final design was partitioned into two blocks so that each fisher was presented with a total of 12 choice cards. Blocking reduces the necessary cognitive effort for each respondent and the use of efficient design principles means that it is possible to break multiple attributes and levels down into a smaller number of cards designed in such a way as to generate results as efficiently as a full factorial design (Hynes *et al.* 2013).

A pilot survey with 7 fishers from the Celtic Sea herring case study was conducted to obtain informed priors for the design that was then produced in Ngene (Econometric software; version 1.1.0). Fishers were offered 12 choice cards each and were asked to choose one of three different options per card. An example choice card is provided in Figure 2. Some initial issues with the survey design were addressed following the pilot survey. Changes were made to Option C in the main survey as the pilot survey yielded a relatively high number of *status quo* bids possibly due to the fact that the stock status was improving in this fishery and therefore changes to the current management approach may have been viewed negatively. Analysis of the responses following the changes to Option C show that the three options attracted almost evenly distributed numbers of bids and therefore there is no evidence of significant *status quo* bias in the survey overall. Indeed, there was only one respondent in the survey who chose Option C on all cards. Additionally, the use of a cheap talk script in order to reduce hypothetical bias was employed for the main survey. A cheap talk script attempts to reduce bias stemming from the hypothetical nature of the experiments that may increase the propensity of respondents to exaggerate stated opinions. The cheap talk script contained the following text: "We would like to know your opinion in order to assist in the design and selection of management measures that are consistent with sustainability and provide consensus across different stakeholder groups. There are no right or wrong answers – we are only interested in finding out your true opinion of management measures."

In addition to the Choice Experiment some economic and demographic data were collected and follow-up questions asked. The additional data was used during the analysis of results to examine whether economic or demographic factors were explanatory variables underlying survey responses. Follow-up questions covered issues such as whether respondents had ignored any attributes in making their choices and ranking exercises on general fisheries management preferences. These questions were designed and used to compare responses using different survey methods.

Discrete Choice models

The Random Utility Model (RUM) developed by McFadden (1973) was employed to examine fisher's choices amongst alternative management choices. RUM operates on the assumption that utility is composed of an observable component and a random component, which gives a utility function of this form:

$$U_{ni} = V_{ni} + \varepsilon_{ni}. \qquad (1)$$

where U_{ni} is the nth fisher's utility associated with choosing alternative i, V_{ni}, is the non-stochastic portion determined by the characteristics of the alternative management options and ε_{ni} is the stochastic element. It is assumed that the observed choice is the one associated with the highest obtained utility (U_{ni}). The probability that respondent n chooses alternative i from the set of J alternatives is given by:

$$P_{ni} = Prob(V_{ni} + \varepsilon_{ni} \geq V_{nj} + \varepsilon_{nj}; for\ all\ i \in C_n \qquad (2)$$

where C_n is the choice-set of fisher n comprising of the alternative management options A, B and *status quo* option C.

The observed utility V_{ni} is assumed to be linear in the parameters so that $V_{ni} = \beta' x_{ni}$ where x_{ni} is a vector of observed variables relating to alternative i and β is the associated vector of coefficients. If ε_{ni} is assumed to be independently and identically distributed with the Type 1 extreme value distribution, this probability will have a closed form expression, leading to the Conditional Logit (CL) model:

$$P_{ni} = \frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}} . \qquad (3)$$

The CL model has some important limitations in analysing choice data, (outlined in detail in Train, 2003) and the Random Parameter Logit (RPL) model can be used to overcome these problems. The RPL relaxes the assumption that observations are independent, and allows the β parameters to vary across individuals and thus accommodates heterogeneous preferences in the sampled population by generating a distribution of β parameters which vary randomly over all individuals (Hynes *et al.* 2008). The RPL model also allows the error components of different alternatives to be correlated. The RPL model outputs are presented in the Results section. Additionally all of the statistical metrics used to aid the researcher in selecting the most appropriate model (Log likelihood, AIC, Bayes IC and Hannan Quinn) indicate that the RPL provided an improvement in fit over the CL model (Table 2). A McFadden's pseudo R^2 value between 0.2 to 0.4 is considered to indicate a model of good fit (McFadden 1979) and the value in our model of 0.34 indicates that the attributes in the model do a good job in explaining the variability in choices made.

The RPL model is a flexible logit model that allows parameters associated with the observed variable to vary across individuals where there is a known population distribution. The probability of fisher *n* choosing alternative *i* on choice occasion *t* is given by the following logit formula:

$$P_{njt} = \frac{e^{(\beta_n x_{nit})}}{\sum_{j=1}^{J} e^{(\beta_n x_{njt})}} \qquad (4)$$

where β_n is a random parameter with unconditional density $f(\beta_n|\theta)$ and θ is the distribution of β_n. The RPL model is estimated using simulated maximum likelihood estimation procedures. For an in-depth discussion of the family of RUM modelling approaches the interested reader is directed to Train (2003) and for the RPL model in particular to Revelt and Train (1998). In this study we use a simulated maximum likelihood estimator with 200 Halton draws in the final estimation of the model.

The RPL model demonstrates whether heterogeneity exists around the mean population parameters through the estimation of a standard deviation parameter associated with each random parameter estimate. The RPL model also examines possible explanatory factors of the heterogeneity that exists amongst fishers by interacting the random parameters with variables that the researcher suspects may be a possible driver of variation in values. In this case we accomplish this by interacting the vessel size and nationality variables with our attribute levels in a pooled RPL model.

Survey implementation

The survey was conducted in the three case study countries; Ireland, Denmark and Greece, with as high a sampling ratio of the population as possible. In the Celtic Sea herring fishery the number of fishers surveyed was 36 (with 43 surveys in total conducted including the pilot) representing approximately 75% of the total number of participants in the fishery. In Denmark 18 surveys with owners and/or skippers of 14 vessels were conducted, representing approximately 61% of the total number of vessels in the Danish herring fishery. In Greece 13 surveys were conducted representing approximately 45% of the total number of participants in this fishery. The total number of surveys conducted across the 3 locations was 74.

Although the overall sample size (N = 74) is small in comparison with some other choice experiments it does represent over 50% of the total population available and is comparable with other published literature. De Bekker-Grob *et al.* (2015) reported that 32% of choice experiments in the healthcare area had sample sizes less than 100. Wielgus *et al.* (2009) used a sample of 87 when estimating anglers willingness to pay for angling locations. Adams *et al.*

(2014) had 92 respondents in a choice experiment survey analysing landholder's spatial conservation priorities. Rose and Bliemer (2013) also demonstrate that D-efficient choice experimental designs require much smaller sample sizes than random orthogonal designs.

Selection of respondents was made through consultation with the relevant fisher's organisations in each country. In all cases the survey was conducted as a face-to-face survey. Each respondent was given background information on the survey purpose and an explanation of how it would be conducted. They were given a practice choice card to familiarise them with how the choice experiment survey worked. The choice options on the practice card were not the same as those on the real cards to avoid any anchoring effects. Anchoring occurs when the initial choices and their associated attribute levels provide a focal point or anchor for respondents that are uncertain about their true preferences. Anchoring is usually related in particular to the initial bid values provided in the sample choice card. Using attributes that are familiar to the respondents, as was done in this study, also reduces these anchoring effects. The respondents were then asked to complete the 12 choice cards.

Results

Table 2 gives the results from the RPL model described in the previous section. The coefficients in the models are interpreted as showing the average impact of the respective choice attributes on fisher *n*'s utility. Given that the choice probability P_{ni} depends only on the difference in utility and not its absolute level, the analyst concentrates generally on the sign of the coefficient where a positive sign indicates that on average the presence of the associated attribute level in a management option contributes positively to a fisher's utility and a negative sign indicates it contributes negatively to the fisher's utility. The preferences for the discrete attribute levels, represented in the coefficient signs, are interpreted relative to their base case. The base case for each attribute is given in Table 2.

One of the most interesting results evident from the individual fisheries models presented in Table 2 is that there are no management attribute levels that elicit the same preference structure across all three fisheries. The Irish and Danish fishers both prefer management options that are more likely to result in a good biological outlook for the stock. The responses of Greek fishers revealed that biological outlook was less important in comparison to other variables. However, it should be mentioned that the size and significance (albeit at the 10% level) of standard deviation for biological outlook indicates a wide diversity of preferences, both positive and negative suggesting that this attribute provokes a mixed response (Rigby and Burton 2003).

Preference structures for levels of the management scale attribute were quite different across the three fisheries. Irish fishers had a strong preference for co-management over regional, EU or national management frameworks. Co-management was the base case level for the management scale attribute. The negative sign for the regional, EU or national management frameworks indicate that they are less preferred relative to co-management. Greek fishers had no significant preferences for any of the management scale attribute levels. Danish pelagic fishers appear to prefer regional or national management frameworks to co-management or EU based management. There may however have been some misunderstanding of the meaning of co-management in the Danish case and these are addressed in more detail in the Discussion section.

Measures that maintain or strengthen the importance of fishing within the local community were prioritised to some extent in all three fisheries. This preference was most evident in the Irish case where measures that maintain or increase the importance of fishing in the community were significantly preferred. For the Greek fishers measures maintaining the community importance of fishing at its current level are significantly preferred. Based on the significance of the standard deviation associated with measures increasing the social importance of fishing it is evident that only in the Danish case is there any indication that this attribute provoked a mixed response.

In relation to the management measures attribute both the Celtic Sea herring and particularly the Greek demersal fishers had significant negative preferences with regards to a landing obligation while the Danish pelagic fishery supported it. Danish fishers also supported the use of temporary spatial closures more than Irish fishers while Greek fishers had mixed preferences. Greek fishers had significant negative preferences for permanent area closures while both Irish and Danish fishers had mixed responses.

Greek fishers had no significant preferences for any of the levels associated with the access and quota management attribute while Irish and Danish fishers have almost diametrically opposed preference structures. Celtic Sea herring fishers are negatively inclined towards tradable fishing concessions while Danish fishers prefer them over other access and quota management options.

In relation to the financial attribute only the Irish case shows the expected preference for management scenarios that minimise costs. The implications of this are explored in more detail in the Discussion section.

Table 3 displays the results of a pooled RPL model where all 3 samples are combined. The pooled model facilitates the inclusion of fishery and vessel size interactions with the Irish fishery as the base case. These model results reinforce the findings from the separate RPL models in Table 2 of significant preference heterogeneity across fisheries. While the individual fisheries models explain variation in a deterministic way for each fleet, by a segmentation of the fishers into mutually exclusive subsets the pooled model allows for an additional, purely random, variation in tastes across all fleets.

Looking at the interaction terms, Danish fishers have significantly different preferences for all except two of the attributes in the pooled model when compared to the base case of Irish fishers. The effect is particularly evident in relation to the landing obligation attribute and the internationally tradable TFCs attributes, reflecting the findings in the Danish model presented in Table 2.

The pooled model also reveals that Greek fishers have a preference for regional and national management and derive less utility from measures increasing the community importance of fishing, again compared to the base case of Irish fishers.

The interaction variable for vessel size also shows that owners of larger vessels have significantly less preference for management scenarios that increase the importance of fishing to the local community and significantly prefer both nationally and internationally tradable individual fishing concessions.

In addition to the choice cards fishers were also asked a number of other attitudinal questions in the survey that can help explain the preferences shown in the models above. In particular, responses to the supplementary question on high level fisheries management objectives (Figure 3) showed no consistent pattern across the three case studies with each case prioritising a different objective. "Importance of fishing in the local community" was the most highly prioritised management objective among Celtic Sea herring fishers, a finding which is consistent with the RPL model outputs, while "Ecosystem Productivity" and "Profits and Return on Investment" were the highest for Greek and Danish fishers respectively.

The other supplementary question asked respondents to rank 10 CFP related management measures in order of their potential to improve fisheries management (Figure 4). The most preferred option for both Celtic Sea and Danish respondents was to "Increase industry input, role and responsibilities". The highest ranking management issue for Greek respondents was to "Improve the regional decision making structure of the CFP". As was evident in the individual fishery RPL models, one of the more divisive management options was to "Make quotas individual and transferable" which was the second highest ranked objective for Danish respondents while being the second lowest ranked for Celtic Sea fishers. The Greek survey omitted this option from the question as quotas are not used in Mediterranean fisheries. A landing obligation ranked as the measure least likely to improve fisheries management across all three case studies.

Discussion

One of the most interesting findings from this research is that there are no management attributes that provoke a unanimous response across the three case studies. This dissensus is evident in both the estimated discrete choice models and the ranking exercises of fisheries objectives and management measures. The lack of unanimity highlights the fact that there are no panaceas in fisheries management and that generic solutions, untailored to the social, economic or cultural context of specific fisheries, create a significant risk of non-compliance and associated unsustainability. For this reason the discussion will focus on the preference structures within each case study fishery followed by overarching conclusions that may be drawn more generally about European and global fisheries management.

Celtic Sea herring fishers were found to have strong preferences for a management system that prioritises stock health, is based on co-management, promotes the community importance of fishing, with non-tradable quotas and that minimises costs. This could be seen as a support for the management system currently in place but there are a few more complex issues evident from a closer examination of the results. The strong support for precautionary management that prioritises stock health may be due in part to two previous stock collapses in the fishery (Fitzpatrick 2014). The long established local co-management system governing the fishery receives a strong endorsement as all other management frameworks are strongly rejected. Both the strong emphasis on the community importance of fishing and the rejection of ITQ systems reflect official Irish positions in CFP reform negotiations (DAFF 2010).

Although a restricted access system based on track record has replaced a *de facto* open access system in the fishery (DAFF 2012) and appears to be supported it should be noted that the high standard deviation coefficients in relation to a limited access regime and nationally tradeable quotas indicate a diversity of preferences for these options. These results mirror conflicting attitudes evident at meetings of the local co-management body, attended by one of the authors, between those who support traditional access rights versus those who support more restricted access. A landing obligation was not supported by a majority of respondents but preferences for the measure were diverse. This may be due to the fact that the participants in the fishery are made up of a combination of exclusively pelagic fishers and polyvalent skippers switching between pelagic and demersal fisheries. A landing obligation may be expected to present different challenges for these sectors as evident in the different timelines for implementation of the CFP landing obligation in the pelagic and demersal sectors. Preference differences on the issues of quota individualisation and discards may be driven by these sectoral differences as exclusively pelagic fishers, whose vessels tend to be larger and more highly capitalised, will not face the same level of discard related issues such as choke species nor are they still involved in fisheries with open access arrangements.

Greek demersal fisher's preferences with regards to good biological outlook were mixed. Information collected during follow-up interviews to discuss the CE results explored in more detail why some respondents consider the maintenance of stock health a low priority while others are in favour of rebuilding stock status as they consider the resources overexploited. Those fishers assigning a low priority to the resource level are not necessarily discounting the importance of stock status but rather they consider other issues of greater immediate importance *e.g.* the CFP landing obligation, overcapacity, low fish prices, high costs and taxes. The fishers who support the idea that future stock health should be a top priority feel that action towards this could be implemented through a more regionalised governance approach. This is evident from the supplementary question on ranking management measures (Figure 4) and from the pooled RPL model (Table 3).

One of the main issues in Greek fisheries management is the conflict between the coastal and trawl fishers (Maravelias *et al.* 2014). Coastal fishers consider the trawlers responsible for the deteriorating state of the stocks while the trawlers consider that they are over-regulated and controlled while at the same time coastal fisheries are favourably treated by the system. Trawl fishers envisage that managing the fishery at a regional level will better alleviate this inequity than co-management would.

Danish pelagic respondents have strong preferences for a management system that prioritises stock health, is based on national or regional management, a landing obligation, temporary closures and allows the trading of quotas at national and international level.

In relation to the management framework, feedback from the researcher conducting the Danish surveys indicate that there may have been a misunderstanding of the term co-management while results from the supplementary questions indicate that a regionalised co-management structure may be their preferred management framework. The Danish pelagic herring fishery takes place with large vessels across most of the North Atlantic with stocks that are managed through international bodies and negotiations. Such a broad management scale probably promotes a more regional rather than local mind-set that may have caused some unintended confusion with regards to the meaning of co-management, and this may be the reason for the somewhat surprising Danish preference for regional management. This confusion has been verified by follow-up phone calls conducted with the original respondents subsequent to the survey. The strong diversity in preference structures across Danish respondents, evidenced by significant standard deviation coefficients for most attributes, may be due to the fact that the sample was split between very large modern vessels with associated high investment levels and smaller vessels with investment levels at least an order of magnitude smaller. The most significant preference differences are evident in management scale, community importance of fishing, use of permanent closures and international trading of quotas.

Implications for fisheries governance

The main implication of this research can be found in the heterogeneity of the preferences in the three different fisheries examined. It is notable that the three fisheries clearly showed different priorities in the ranking of high level management objectives, with the Irish favouring support for the local community, the Danish emphasising profits, and the Greeks emphasising ecosystem productivity. This does not necessarily reflect national differences but may be due to the different nature of each of the fisheries examined, ranging from industrialised pelagic fishing in Denmark to quite small scale demersal fisheries in Greece, with Ireland somewhere in between. There are also some important similarities, most significantly in terms of community wellbeing and implementation of the CFP landing obligation.

Support for measures that maintain or strengthen the importance of fishing to the local community was evident to some extent in all three fisheries both in the Choice Experiment and in ranking exercises. This community aspect is important as it highlights an area of fisheries management which is seldom highly prioritised (Haapasaari *et al.* 2013; Symes and Phillipson 2009). Clear biological, economic and ecosystem objectives do exist e.g. MSY (Ye *et al.* 2013), Maximum Economic Yield (MEY) (Norman-Lopez and Pascoe 2011) and the EU Marine Strategy Framework Directive descriptors (Commission of the European Communities 2008) but no such clear objectives have been formalised in the social arena (Urquhart *et al.* 2011). Finding clear community-based objectives in the EU CFP, for example, is difficult. This contradiction between fishers perceptions of the importance of social issues and community wellbeing and the lack of associated management objectives points to a policy failure within the EU and opens the door to an opaque lobbying process rather than a transparent social assessment of management performance.

Social issues and associated objectives obviously matter then but have been notoriously difficult to clearly identify (Symes and Phillipson 2009) although mechanisms to do so exist (Dutra *et al.* 2015; Fletcher 2015). We need indicators associated with social objectives against which we can evaluate any fisheries management measures that are undertaken. A possible starting point was provided by Dichmont *et al.* (2012) in Australia. Under a heading of "Maximise social outcomes", they identified a number of objectives; maximise employment, ensure equity, and maximise other social benefits from the use of the resource to the local community. They were also able to propose indicators for each objective. The approach was further developed by Pascoe *et al.* (2014) with an acknowledgement that such objectives were highly context specific. That context is obviously spatial, as in different areas, as well as in different fisheries, but it may also display variability in time. Rindorf *et al.* (2016) noted that social objectives can vary quickly, e.g. as economies expand or decline, while biological objectives may be more stable.

Assuming that we can provide agreed social objectives, we can then combine these with already existing biological, economic and ecosystem objectives. Trenkel *et al.* (2015) indicated that *"If the target reference points are positioned correctly relative to the limits and are the product of governance processes that did capture social and economic goals effectively, then managing to keep mature biomass and fishing mortality near their respective targets will achieve ecological, social and economic sustainability, if such full sustainability is possible to achieve"*. If this is accepted, then there is a clear need, in EU and non-EU fisheries alike, to get to the point where we do have those important social goals captured, perhaps by following the Australian example described above.

The very different responses between the case studies on tradable rights may also reflect community issues. It is commonly assumed that tradable rights will lead to concentration of fishing opportunities with associated social changes (van Hoof 2015). Such measures were strongly opposed in the Irish case study where social issues ranked highest, but were positively viewed by the Danish fishers. The Greek respondents were in favour of nationally tradable rights, but not internationally tradable ones, presumably reflecting a social objective of retaining ownership within the state. The tendency for smaller vessel operators to prefer community objectives and to oppose tradable rights can also be seen in a social context. Small-scale fishers will be close to their own communities, and will likely oppose the perceived concentration of fishing rights in a few hands when those rights are tradable. Conversely bigger vessels will tend to have a weaker link to any one community, may tend to be more driven by profit and will be more confident of maintaining access to those rights under a tradeable system due to their superior economic capacity (Thøgersen *et al*. 2015).

Perhaps the nearest thing to a unanimous response to a management measure was towards a landing obligation. All three fisheries ranked it as the measure least likely to improve the management of their fishery in the supplementary question and two of the three fisheries had a significant negative preference for it in the choice experiment. This negative response may not come as a surprise as EU fishers have broadly denigrated the landing obligation (see for example EAPO and EUROPECHE 2016). However the advantage of the choice experiment method over simple ranking questions is evident in the fact that the Danish respondents ranked a discard ban as their lowest choice in a simple ranking exercise but when they were in effect forced to trade-off in the choice experiment they were prepared to accept a discard ban in preference to other measures such as area closures or effort control. This finding indicates that at least for pelagic fishers implementation of the landings obligation is perceived to be workable but that significant challenges exist in demersal fisheries.

We found significant variation both within and across fisheries. This highlights the need to include a broad range of fishers in decision-making processes on management measures, particularly where there may be significant social and economic impacts. It might also suggest that there could be a different approach for larger and smaller vessels. For instance, the most significant difference in the preferences of large vessel owners was for transferable quota arrangements. This difference indicates that transferable quotas might be appropriate for more industrial fleets and less so for the more artisanal ones. This finding may not be surprising but it has significant policy implications. Many fishing fleets are still dominated in numbers by small vessels, while high level representation and political influence arguably give the owners of larger vessels a greater voice in debates (McGoodwin, 2001, Béné *et al.* 2007). Further research is warranted into how such power asymmetries in fishers representation may influence policy-making and whether this might tend to shift fisheries management decisions towards business based decisions by the larger operators and away from community-based decisions.

Although this research was conducted with European fishers there are a number of reasons why we consider the findings to be relevant for fisheries globally. Firstly, the principal issue that we were exploring, how fishers value a range of management measures and trade off between them, is relevant to fishers and managers anywhere. Many of the trade-offs and conflicts discussed in this paper are topical issues beyond the EU (e.g. the conflict between individualised quotas or catch shares and perceived coastal community wellbeing in the US (Clay *et al.* 2014)). Secondly, a diversity of fleet sectors were included in our survey, all of which have similar counterparts in fisheries in other regions. Thirdly, the Choice Experiment method has been useful in testing a previously underutilised tool for analysing the key issue of how fishers trade-off between management measures and provides a more complex understanding of fishers preferences than simple ranking or prioritisation methods.

In conclusion, the main finding of this study is that in fisheries management, one size does not fit all, and that it is vital to consider the context in each case. Major differences in preferences with regards to management, ecosystem, economic and social sustainability issues were identified between the three fisheries. Even on issues where there appears to be widespread agreement, such as support for local communities, closer analysis reveals differences between and within fisheries particularly based on vessel size. The need for clear, agreed and contextual social objectives was clearly identified. This is a very strong argument for more regional and even intra-sectoral approaches based on overarching principles, but with local, contextual nuance, rather than prescriptive single measures.

Acknowledgements

This research was funded by the European Commission within the Seventh Framework Programme (2007-2013) as part of the SOCIOEC (Socio economic effects of management measures of the future CFP - Grant Agreement No. 289192) and the MYFISH (Maximising yield of fisheries while balancing ecosystem, economic and social concerns - Grant Agreement No. 289257) projects.

Figure 1 was produced by Pascal Thoya of DTU Aqua in Denmark.

References

Abbott, J.K. and Haynie, A.C. (2012) What are we protecting? Fisher behavior and the unintended consequences of spatial closures as a fishery management tool. *Ecological Applications* **22**, 762-777.

Adams, VM, Pressey, RL, and Stoeckl, N. (2014) Estimating Landholders' Probability of Participating in a Stewardship Program, and the Implications for Spatial Conservation Priorities. *PLoS ONE* **9** (6): e97941.

Béné, C., Macfayden, G. and Allison, E.H. (2007) Increasing the Contribution of Small-Scale Fisheries to Poverty Alleviation and Food Security (FAO Fisheries Technical Paper, no. 481). FAO, Rome.

Birol, E. and Cox, V. (2007) Using choice experiments to design wetland management programmes: The case of Severn Estuary Wetland, UK. *Journal of Environmental Planning and Management* **50**, 363-380.

Caddy, J. F. (2009) Practical issues in choosing a framework for resource assessment and management of Mediterranean and Black Sea fisheries. *Mediterranean Marine Science* **10**, 83-119.

Clay, P.M., Kitts, A. and Pinto da Silva, P. (2014) Measuring the social and economic performance of catch share programs: Definition of metrics and application to the U.S. Northeast Region groundfish fishery. *Marine Policy* **44** 27-36.

Chhun, S., Thorsnes P. and Moller, H. (2013) Preferences for Management of Near-Shore Marine Ecosystems: A Choice Experiment in New Zealand. *Resources* **2**, 406-438.

DAFF (2010) Ireland's response to the Commission's Green paper on Reform of the Common Fisheries Policy. Department of Agriculture, Food and Fisheries, 44 pp.

DAFF (2012) Management Arrangements and Fleet Policy Statement for Irish Herring fisheries, June 2012. Department of Agriculture, Food and Fisheries, 4 pp.

De Bekker-Grob, E. W., Donkers, B., Jonker, M. F., and Stolk, E. A. (2015) Sample Size Requirements for Discrete-Choice Experiments in Healthcare: a Practical Guide. *The Patient* **8** (5), 373–384.

Degnbol, P. and McCay, B.J. (2007) Unintended and perverse consequences of ignoring linkages in fisheries systems. *ICES Journal of Marine Science* **64**, 793-797.

Dichmont, C.M., Pascoe, S.D., Jebreen, E.J., Pears, R.J., Brooks, K.J., Perez, P. (2012) Providing social science objectives and indicators to compare management options in the Queensland trawl planning process. CSIRO. Brisbane. pp. 87.

Duffield, J., Neher, C., Allen, S., Patterson, D. and Gentner, B. (2012) Modeling the Behavior of Marlin Anglers in the Western Pacific. *Marine Resource Economics* **27**, 343-357.

Dutra, L. X. C., Thebaud, O., Boschetti, F. Smith, A.D.M. and Dichmont, C.M. (2015) Key issues and drivers affecting coastal and marine resource decisions: Participatory management strategy evaluation to support adaptive management. *Ocean & Coastal Management* **116**, 382-395.

EAPO and EUROPECHE (2016) 2nd Position Paper on the Implementation of the Landing Obligation. Last accessed July 2016 at: http://eapo.com/UserFiles/EAPO & Europeche 2nd Position Paper on Implementation of Landing Obligation.pdf.

Eggert, H., Martinsson, P. (2004) Are commercial fishers risk-lovers? *Land Economics* **80** (4), 550-560.

Eigaard, O.R. (2009) A bottom-up approach to technological development and its management implications in a commercial fishery. *ICES Journal of Marine Science* **66**, 916-927.

Eigaard, O.R., Marchal, P., Gislason, H. and Rijnsdorp, A.D. (2014) Technological development and fisheries management. *Reviews in Fisheries Science & Aquaculture* **22**, 156–174.

Eliasen, S.Q., Papadopoulou, K.N., Vassilopoulou, V. and Catchpole, T. (2014) Socio-economic and institutional incentives influencing fishers' behaviour in relation to fishing practices and discard. *ICES Journal of Marine Science* **71**, 1298-1307.

European Commission (2008) Decision 949/2008/EC adopting a multiannual Community programme pursuant to Council Regulation (EC) No 199/2008 establishing a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy. *Official Journal of the European Union* L 346, 37–88.

European Commission (2008) Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

European Commission (2009) Green Paper on Reform of the Common Fisheries Policy. Brussels. *COM (2009) 163*, 26 pp.

European Council (2000) Regulation No 1543/2000 of 29 June 2000 establishing a Community framework for the collection and management of the data needed to conduct the common fisheries policy. *Official Journal of the European Union* L 176, 1–16.

European Parliament and Council (2013) Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy. *Official Journal of the European Union L 354, 22–61.*

FAO (2016) The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome, 200 pp.

Fiebig D.G., Keane M.P., Louviere J. and Wasi N. (2010) The Generalized Multinomial Logit Model: Accounting for Scale and Coefficient Heterogeneity. *Marketing Science* **29**, 393-421.

Fitzpatrick, M. 2013. *Pretty good governance: balancing policy drivers and stakeholder interests in developing fisheries ecosystem plans*. PhD Thesis, University College Cork, 232 pp.

Fitzpatrick, M. (2014) From boom and bust to local stewardship: a governance benchmark for Celtic Sea fisheries management. In *Social issues in sustainable marine fisheries management* (eds Urquhart, J., Acott, T.G., Symes, D. and Zhao, M.) MARE Publication Series, Amsterdam University Press/Springer, Amsterdam and Dordrecht, pp 43-63.

Fletcher, W. J. (2015) Review and refinement of an existing qualitative risk assessment method for application within an ecosystem-based management framework. *ICES Journal of Marine Science* **72**, 1043–1056.

Fulton, E. A., Smith, A. D. M., Smith, D. C. and van Putten, I. E. (2011) Human behaviour: the key source of uncertainty in fisheries management. *Fish and Fisheries* **12**, 2–17.

Groeneveld, R. (2011) Quantifying fishers' and citizens' support for Dutch flatfish management policy. *ICES Journal of Marine Science* **68**, 919–928.

Haapasaari, P., S. Kulmala, and S. Kuikka. (2012) Growing into Interdisciplinarity: How to Converge. Biology, Economics, and Social Science in Fisheries Research? *Ecology and Society* **17**, 6.

Hanley, N., Wright, R. E. and Adamowicz, W. (1998) Using Choice Experiments to Value the Environment. *Environmental & Resource Economics* **11**, 413-428.

Hynes, S., Hanley, N., Scarpa, R (2008) Effects on welfare measures of alternative means of accounting for preference heterogeneity in recreational demand models. *American Journal of Agricultural Economics* **90** (4), 1011-1027.

Hynes, S., Tinch, D. and Hanley, N. (2013) Valuing improvements to coastal waters using choice experiments: An application to revisions of the EU Bathing Waters Directive. *Marine Policy* **40**, 137–144.

Hynes, S. and D. Campbell (2011) Estimating the welfare impacts of agricultural landscape change in Ireland: a choice experiment approach. *Journal of Environmental Planning and Management* **54**, 1019-1039.

Kanchanaroek, Y., Termansen, M. and Quinn, C (2013) Property rights regimes in complex fishery management systems: A choice experiment application. *Ecological Economics* **93**, 363-373.

Launio, C., Aizaki, H. and Morooka, Y. (2009) Understanding Factors Considered by Fishermen in Marine Protected Area Planning and Management: Case Study of Claveria, Philippines. *Journal of Applied Sciences* **9**, 3850-3856.

Le Floc'h, P., Murillas, A., Aranda, M., Daurès, F., Fitzpatrick, M., Guyader, O., Hatcher, A., Macher, C. and Marchal, P. (2015) The regional management of fisheries in European Western Waters. *Marine Policy* **51**, 375-384.

Maravelias, C.D., Maynou, F. and Pantazi, M. (2014) Fisheries management scenarios; Trade offs between economic and biological objectives. *Fisheries Management and Ecology* **21**, 186-195.

Marine Institute (2013) The Stock Book: Annual Review of Fish Stocks in 2013 with Management Advice for 2014. Marine Institute, Galway, Ireland, 534 pp.

McFadden, D. (1974) Conditional logit analysis of qualitative choice behaviour. In *Frontiers in econometrics*, (ed. P. Zarembka), Academic Press, New York, pp 105-142.

McFadden, D. (1979) Quantitative Methods for Analyzing Travel Behaviour of Individuals: Some Recent Developments. In *Behavioural Travel Modelling*, (Eds. Hensher, D. and Stopher, P.), Croom Helm, London, pp 279-318.

McGoodwin, J.R. (2001) Understanding the Cultures of Fishing Communities: A Key to Fisheries Management and Food Security. *FAO Fisheries Technical Paper 401*, Food and Agriculture Organization of the United Nations, Rome, pp 287.

Norman-Lopez, A. and S. Pascoe (2011) Net economic effects of achieving maximum economic yield in fisheries. *Marine Policy* **35**, 489-495.

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

Pascoe, S., Proctor, W., Wilcox, C., Innes, J., Rochester, W. and Dowling, N. (2009) Stakeholder objective preferences in Australian Commonwealth managed fisheries. *Marine Policy* **33**, 750-758.

Pascoe, S., Brooks, K., Dichmont, C.M., Jebreen, E., Schirmer, J., and Triantafillos, L. (2014) Social objectives of fisheries management: What are managers' priorities? *Ocean & Coastal Management* **98**, 1-10.

Revelt, D., and Train, K. (1998) Mixed logit with repeated choices: households' choices of appliance efficiency level. *Review of economics and statistics* **80,** 647-657.

Rigby, D. and Burton, M. (2003) Capturing preference heterogeneity in stated choice models: a random parameter logit model of the demand for GM food. *The University of Manchester, School of Economic Studies Discussion Paper Series*, No. 319.

Rindorf, A., Dichmont, C.M., Thorson, J., Charles, A., Worsøe Clausen, L., Degnbol, P., Garcia, D., Hintzen, N.T., Kempf, A., Levin, P., Mace, P., Maravelias, C., Minto, C., Mumford, J., Pascoe, S., Prellezo, R., Punt, A., Reid, D.G., Röckmann, C., Stephenson, R.L., Thebaud, O., Tserpes, G. and Voss, R. (2016) Quo Vadimus: Including ecological, economic, social and institutional considerations when setting targets and limits for multispecies fisheries. *ICES Journal of Marine Science* (in Press).

Rose, J.M. and Bliemer M.C. (2013) Sample size requirements for stated choice experiments, *Transportation*, **40**, 1021-1041.

Symes, D., and Phillipson, J. (2009) Whatever Became of Social Objectives in Fisheries Policy? *Fisheries Research* **95**, 1-5.

Thøgersen, T., Eigaard, O., Fitzpatrick, M., Mardle, S., Andersen, J. and Haraldsson, G. (2015) Economic gains from introducing international ITQs - the case of the mackerel and herring fisheries in the Northeast Atlantic. *Marine Policy* **59**, 85-93.

Train, K. (1998) Recreation demand models with taste differences over people. *Land Economics* **74**, 230–239.

Train, K. (2003) *Discrete Choice Methods with Simulations*, 2nd edition. Cambridge University Press, Cambridge.

Trenkel, V. M., Rochet, M.-J. and Rice, J. C. (2015) A framework for evaluating management plans comprehensively. *Fish and Fisheries* **16**, 310–328.

Urquhart, J., Acott, T., Reed, M., & Courtney, P. (2011) Setting an agenda for social science research in fisheries policy in Northern Europe. *Fisheries Research* **108,** 240-247.

Van Hoof, L. (2013) Design or pragmatic evolution: applying ITQs in EU fisheries management. *ICES Journal of Marine Science* **70**, 462–470.

Vasilakopoulos P., Maravelias C.D., and Tserpes, G. (2014) The alarming decline of Mediterranean fish stocks. *Current Biology* **24**, 1643-1648.

Villasante, S., do Carme García-Negro, M., González-Laxe, F. and Rodríguez, G. R. (2011) Overfishing and the Common Fisheries Policy: (un)successful results from TAC regulation? *Fish and Fisheries* **12**, 34–50.

Wielgus, J., Gerber, L., Sala, E., and Bennett, J. (2009) Including risk in stated-preference economic valuations: Experiments on choices for marine recreation. *Journal of Environmental Management* **90**, 3401-3409.

Ye, Y., Cochrane, K., Bianchi, G., Willmann, R., Majkowski, J., Tandstad, M., & Carocci, F. (2013) Rebuilding global fisheries: the World Summit Goal, costs and benefits. *Fish and Fisheries* **14**, 174–185.

Table 1: Attributes and attribute levels used in Choice Experiment

<table>
<tr><th>Attributes</th><th colspan="7">Levels</th></tr>
<tr><td>Long-term biological sustainability of the fishery</td><td colspan="4">Medium to Poor</td><td colspan="3">Good</td></tr>
<tr><td>Management Scale</td><td colspan="2">Central European Management</td><td colspan="2">Regional Advisory Council Management</td><td colspan="2">National Management</td><td>Co-Management</td></tr>
<tr><td>Fishing Community viability</td><td colspan="2">Importance of fishing industry to local community maintained at current level</td><td colspan="3">Decline in importance of fishing industry to local community (-20%)</td><td colspan="2">Increase in importance of fishing industry to local community (+20%)</td></tr>
<tr><td>Management measures</td><td colspan="2">Permanent area closures</td><td colspan="2">Temporary area closures</td><td colspan="2">Discard ban</td><td>Effort control (days at sea)</td></tr>
<tr><td>Access & quota allocation regime</td><td colspan="2">Open to all current licensees and eligible new entrants</td><td colspan="2">Limited access regime based on track record in fishery</td><td colspan="2">Nationally Tradable TFCs/TURFs</td><td>Internationally Tradable TFCs/TURFs</td></tr>
<tr><td>Increase in subscription to management organisation</td><td>0</td><td>+10%</td><td>+20%</td><td>+35%</td><td>+50%</td><td>+75%</td><td>+100%</td></tr>
</table>

Table 2: Results of Random Parameters Logit Model for the three case study fisheries

	Celtic Sea Herring						Greek Demersal						Danish Pelagic					
	Mean of Coefficient			SD of Coefficient			Mean of Coefficient			SD of Coefficient			Mean of Coefficient			SD of Coefficient		
Good biological outlook	2.27	(0.38)	***	1.09	(0.28)	***	-0.54	(0.51)		0.84	(0.44)	*	1.44	(0.62)	**	1.32	(0.74)	*
(Base case is Medium to Poor biological outlook)																		
National Management	-0.58	(0.32)	*	0.38	(0.27)		0.73	(0.53)		0.27	(0.48)		2.28	(0.67)	***	1.39	(0.42)	***
Regional Management	-1.45	(0.42)	***	0.73	(0.45)		0.69	(0.56)		0.68	(0.84)		2.08	(0.76)	***	3.27	(1.21)	***
Central EU Management	-1.08	(0.37)	***	0.06	(0.50)		-0.37	(0.67)		0.46	(0.63)		-1.58	(0.96)	*	4.75	(1.17)	***
(Base case is Co-Management)																		
Community importance of fishing maintained at current level	0.83	(0.30)	***	0.34	(0.37)		1.10	(0.59)	*	1.15	(0.56)	**	1.21	(0.77)		0.99	(0.76)	
20% increase in importance of fishing to community	1.99	(0.33)	***	0.23	(0.44)		0.10	(0.43)		0.10	(0.53)		1.02	(0.75)		1.84	(0.59)	***
(Base case is 20% decline in importance of fishing to the local community)																		
Discard Ban	-0.81	(0.43)	*	1.24	(0.41)	***	-2.23	(0.75)	***	0.41	(0.64)		4.20	(1.02)	***	0.74	(0.55)	
Temporary Area Closures	-0.11	(0.37)		0.28	(0.61)		-0.10	(0.64)		1.23	(0.67)	*	3.73	(1.06)	***	2.17	(0.96)	**
Permanent Area Closures	0.04	(0.34)		0.69	(0.29)	**	-2.05	(0.69)	***	0.69	(0.55)		0.61	(0.81)		3.05	(0.67)	***
(Base case is Effort Control)																		
Limited Access based on track record	1.31	(0.49)	***	3.21	(0.62)	***	-0.31	(0.51)		0.47	(0.56)		1.10	(0.72)		1.04	(0.74)	
Nationally tradable TFC's/TURF's	-1.59	(0.45)	***	2.17	(0.40)	***	0.78	(0.50)		0.88	(0.66)		4.05	(0.80)	***	1.53	(0.68)	**
Internationally tradable TFC's/TURF's	-4.57	(1.22)	***	3.53	(1.29)	***	-0.71	(0.48)		0.47	(0.40)		5.40	(1.28)	***	5.71	(1.35)	***
(Base case is Open to all current licensees and eligible new entrants)																		
Cost	-0.002	(0.00)	***	0.001	(0.00)	**	0.001	(0.00)		0.002	(0.00)	*	0.00	(0.00)		0.00	(0.00)	

Log likelihood function	-370.53735	Log likelihood function	-144.62886	Log likelihood function	-127.16200
Chi squared [26 d.f.]	392.69318	Chi squared [26 d.f.]	53.50931	Chi squared [26 d.f.]	215.88207
McFadden Pseudo R-squared	.34636	McFadden Pseudo R-squared	.15610	McFadden Pseudo R-squared	.45912
AIC	1.53697	AIC	2.18755	AIC	1.43142

Figures in parentheses indicate the values of the standard errors. *** = significant at 1% ** = significant at 5% * = significant at 10%. Positive coefficient values indicate that attribute level is preferred to base case while negative values indicate that base case is preferred to the attribute level. “Medium to Poor” is the base case level in terms of the Long-Term Biological outlook attribute. “Co-management” is the base case level in terms of the Management Scale attribute. “Decline in importance of fishing industry to local community” is the base case level for the Fishing Community Viability attribute. “Effort control” is the base case for the Management Measures attribute. “Open to all current licensees and eligible new entrants” is the base case for the Access & Quota Allocation Regime attribute.

Table 3: Results of pooled Random Parameters Logit model with fisheries and vessel size as interaction factors

	Pooled data						Greek			Danish			Vessel Size		
	Mean of Coefficient			SD of Coefficient			Heterogeneity in Mean			Heterogeneity in Mean			Heterogeneity in Mean		
Good biological outlook	1.84	(0.41)	***	0.51	(0.39)		-2.31	(0.46)	***	-1.52	(0.52)	***	0.01	(0.01)	
(Base case is Medium to Poor biological outlook)															
National Management	-0.19	(0.48)		0.24	(0.34)		1.37	(0.63)	**	1.72	(0.64)	***	-0.02	(0.02)	
Regional Management	-1.10	(0.60)	*	0.59	(0.47)		1.99	(0.66)	***	2.34	(0.78)	***	-0.01	(0.02)	
Central European Management	-0.25	(0.57)		0.67	(0.34)	**	1.02	(0.80)		2.54	(0.78)	***	-0.04	(0.02)	*
(Base case is Co-Management)															
Community importance of fishing maintained at current level	1.50	(0.49)	***	0.17	(0.33)		-0.02	(0.49)		0.55	(0.66)	*	-0.03	(0.02)	
20% increase in importance of fishing to local community	2.86	(0.53)	***	0.37	(0.29)		-1.45	(0.54)	***	0.74	(0.72)		-0.05	(0.02)	**
(Base case is 20% decline in importance of fishing to the local community)															
Discard Ban	-1.42	(0.74)	*	1.20	(0.41)	***	-1.86	(0.78)	**	3.97	(0.91)	***	0.03	(0.03)	
Temporary Area Closures	0.48	(0.68)		1.16	(0.31)	***	-0.31	(0.74)		2.85	(0.88)	***	-0.03	(0.02)	
Permanent Area Closures	0.38	(0.65)		1.11	(0.28)	***	-1.58	(0.75)	**	1.32	(0.93)		-0.04	(0.03)	
(Base case is Effort Control)															
Ltd. Access based on track record	-0.49	(0.67)		2.26	(0.42)	***	-0.64	(0.82)		-0.83	(1.01)		0.04	(0.02)	*
Nationally tradable TFC's/TURF's	-3.24	(0.63)	***	1.70	(0.36)	***	1.06	(0.75)		1.60	(0.81)	**	0.11	(0.02)	***
Internationally tradable TFC's/TURF's	-6.35	(1.06)	***	1.85	(0.48)	***	2.27	(0.96)	**	4.10	(1.03)	***	0.12	(0.03)	***
(Base case is Open to all current licensees and eligible new entrants)															
Cost	-0.002	(0.00)	***	0.00	(0.00)		0.002	(0.00)	***	0.001	(0.00)	***	0.00	(0.00)	

Log likelihood function	-639.75558
Chi squared [65 d.f.]	667.22982
McFadden Pseudo R-squared	.34274
AIC	1.59087

Figures in parentheses indicate the values of the standard errors. *** = significant at 1% ** = significant at 5% * = significant at 10%. Positive coefficient values indicate that attribute level is preferred to base case while negative values indicate that base case is preferred to the attribute level. “Medium to Poor” is the base case level in terms of the Long-Term Biological outlook attribute. “Co-management” is the base case level in terms of the Management Scale attribute. “Decline in importance of fishing industry to local community” is the base case level for the Fishing Community Viability attribute. “Effort control” is the base case for the Management Measures attribute. “Open to all current licensees and eligible new entrants” is the base case for the Access & Quota Allocation Regime attribute.

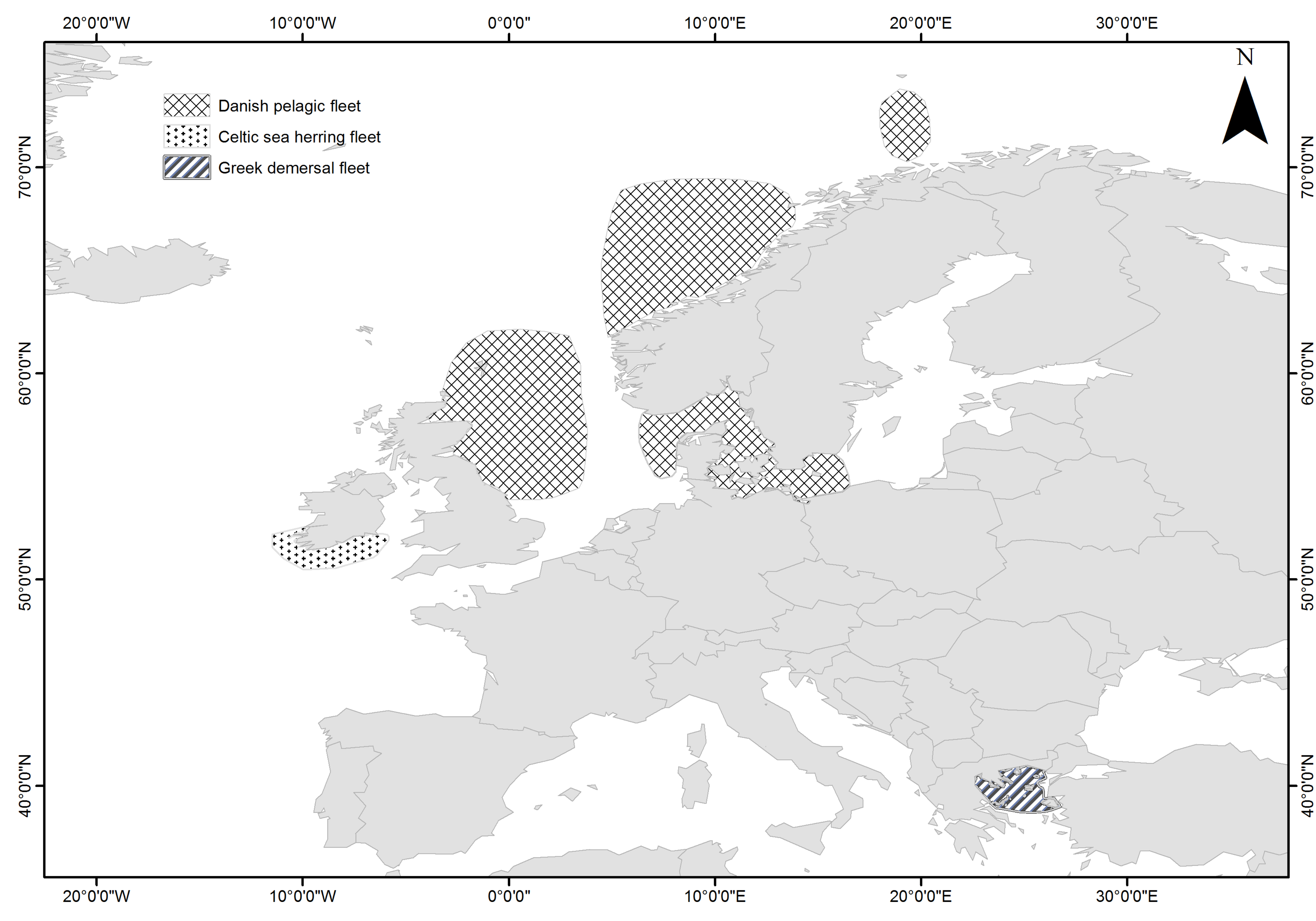
Figure 1: Map of grounds fished by surveyed fleets.

Figure 2: Example Choice Card given to survey respondents.

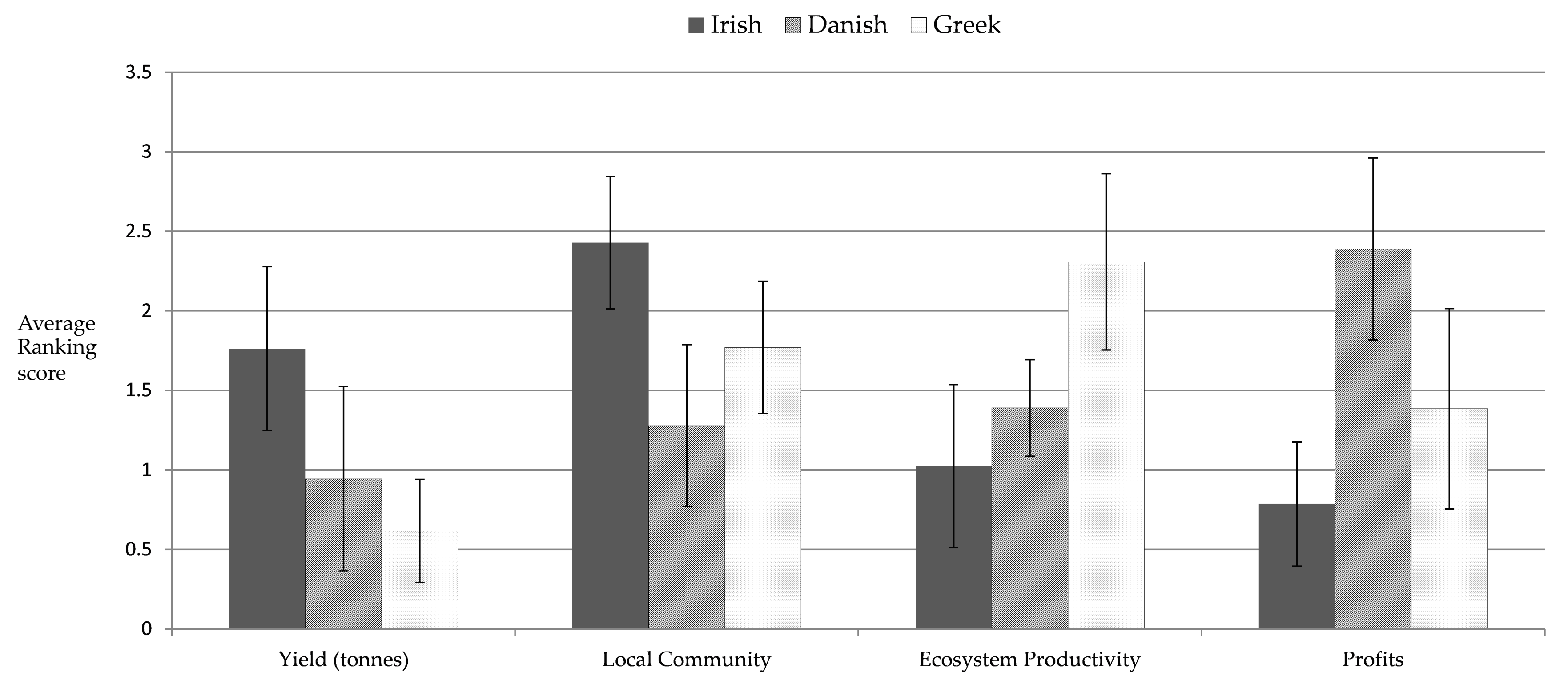
Figure 3: Ranking of high level fisheries management objectives across case studies

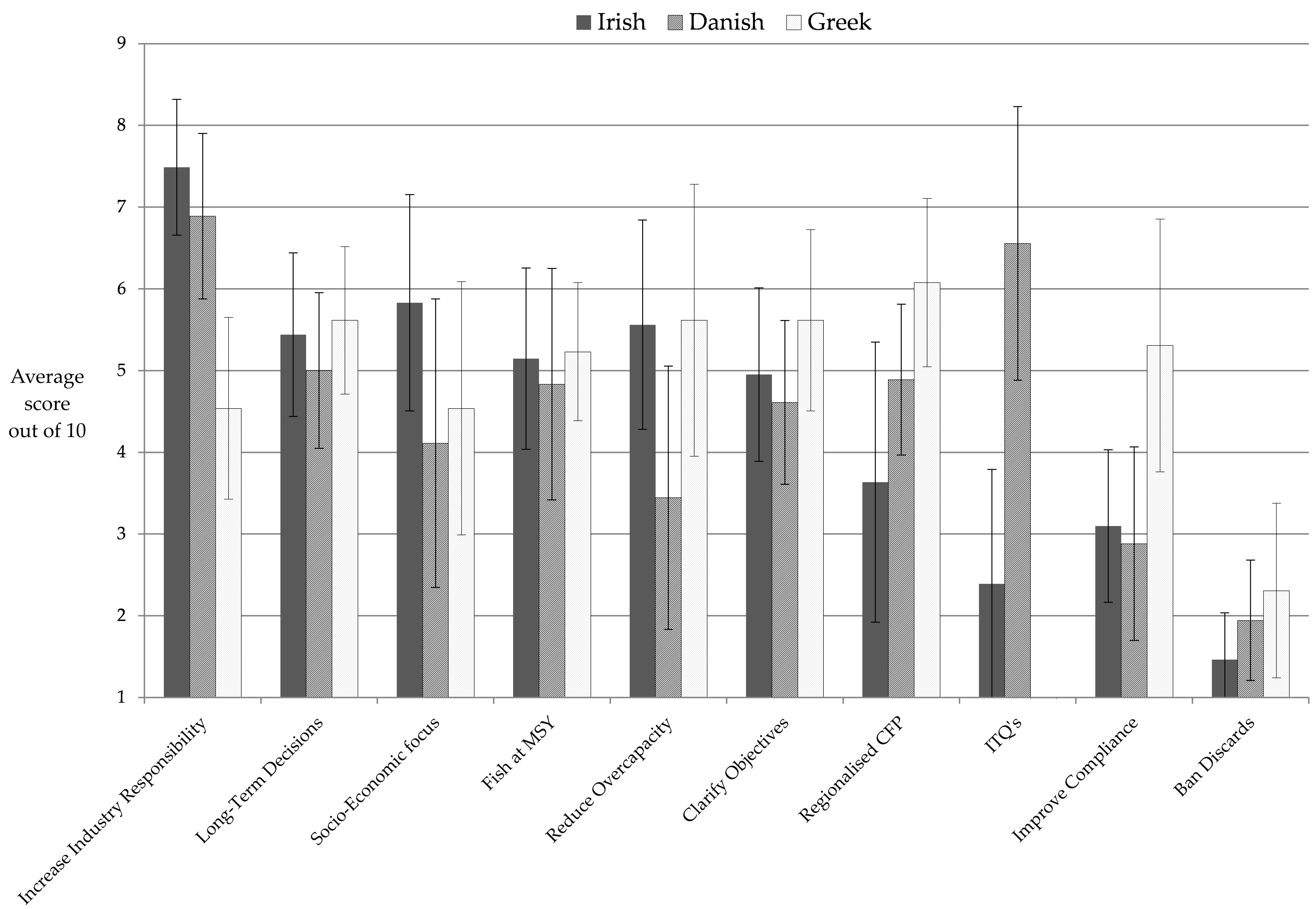
(Respondents were asked to rank the four fisheries management objectives in terms of their importance for them. Error bars represent standard deviation).

Figure 4: Average scores for management measures proposed during CFP reform across case studies. (Respondents were asked to rank, from 1 to 10, the measures in order of their potential to improve fisheries management. Error bars represent standard deviation).


20°0'0"W
10°0'0"W
0°0'0"
10°0'0"E
20°0'0"E
30°0'0"E
70°0'0"N
60°0'0"N
50°0'0"N
40°0'0"N
N
Danish pelagic fleet
Celtic sea herring fleet
Greek demersal fleet

	Option A	Option B	Option C
Long-term biological outlook of the fishery	Good	Good	Moderate to Poor
Management Scale	Regional Sea Management	Central European Management	National Management
Fishing Community viability	Decline in importance of fishing industry to local community (-20%)	Increase in importance of fishing industry to local community (+20%)	Importance of fishing industry to local community maintained at current level
Management measures	Temporary area closures	Catch Quota System	Permanent area closures
Access & quota allocation regime	Limited access at vessel level based on track record in fishery	Internationally Tradable Transferable Fishing Concessions	Open Access
Increase in subscription to representative or management organisation	+ 100%	+ 20%	0
Choice (TICK ONE OPTION)	☐	☐	☐


Irish
Danish
Greek
3.5
3
2.5
2
1.5
1
0.5
0
Average Ranking score
Yield (tonnes)
Local Community
Ecosystem Productivity
Profits


Irish
Danish
Greek
Average score out of 10
9
8
7
6
5
4
3
2
1
Increase Industry Responsibility
Long-Term Decisions
Socio-Economic focus
Fish at MSY
Reduce Overcapacity
Clarify Objectives
Regionalised CFP
ITQ's
Improve Compliance
Ban Discards