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# Modelling Fishers' preferences for alternative management options under the Common Fisheries Policy

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**Abstract**

Failure to understand the potential responses of fishers to new management measures creates a significant risk of revisiting the familiar scenario of perverse and unintended consequences. This paper reports on a Choice Experiment survey to evaluate fishermen's preferences for new management measures proposed under the recent EU Common Fisheries Policy (CFP) reform process. The survey was conducted with fishermen 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. The paper uses a Random Utility Modelling framework to reveal the preferences of the fishermen for the alternative policy attributes and to analyse how respondents make trade-offs. Results show that while there are broad preferences both for healthy stocks and for maintaining the importance of fishing to the local community strong inter-fishery preference differences exist, most notably in relation to a discard ban, to the use of individual transferable fishing rights and to a certain extent to the prioritising of healthy fish stocks.

**Keywords:** Common Fisheries Policy, preference modelling, social choice experiment, fisheries management

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## 1. Introduction

How to conduct fisheries management/governance within an Ecosystem Approach to Fisheries Management (EAFM) remains a difficult issue of global importance. A key component of the EAFM is the pre-requisite for stakeholder engagement at all stages of development (FAO 2003; Garcia & Cochrane 2005). The new EU Common Fisheries Policy (CFP) (EU Regulation [No 1380/2013](#)) is a case in point, and the focus for our study of some of these issues (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 (EU Commission, 2009). These measures include *inter alia* changes to governance arrangements such as regionalisation, economic instruments such as transferable quotas and conservation measures such as a landing obligation (LO) for quota species. As of yet however fishermen's relative preferences for these management measures have not been systematically assessed, in particular those which are likely to be positively received and could incentivise "good" behaviour, and those which will not. If we are to avoid the familiar problem, well known to those involved in fisheries management, of perverse and unintended consequences (Abbott & Haynie, 2012, Degnbol & McCay, 2007) then it is necessary to have a greater understanding of fishermen's likely responses to these new measures, following approaches taken in other regions 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, using Choice Experiments (CE), to assessing fishermen's preferences for management measures and additionally to providing insight into how fishermen are prepared to trade-off between them. Choice Experiments 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 which target those attributes most valued by stakeholders, and which in theory will most incentivise change, can be identified (Eliassen 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 fishermen'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) also modelled the behaviour of recreational Marlin anglers in the Western Pacific. In relation to commercial fisheries Eggert and Martinsson (2003) used CE in a behavioural economics context to explore levels of risk tolerance in commercial

fishers. More recently, Groeneveld (2011) modelled public and fisher attitudes in the Netherlands towards a specific management measure, an area closed to fishing to protect juvenile Plaice. There has 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 fishermen in relation to Marine Protected Areas in the Philippines; while Kanchanaroek et al. (2013) modelled fishermen's choices in a hypothetical auction market for property rights in a Cambodian small scale fishery. To the best of our knowledge there has been no previous application of the choice experiment method to model the preferences of fishermen 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 Choice Experiment 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 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 the researcher to examine whether management preferences differ across alternative types of European fishery, with a broad geographic and technological variation.

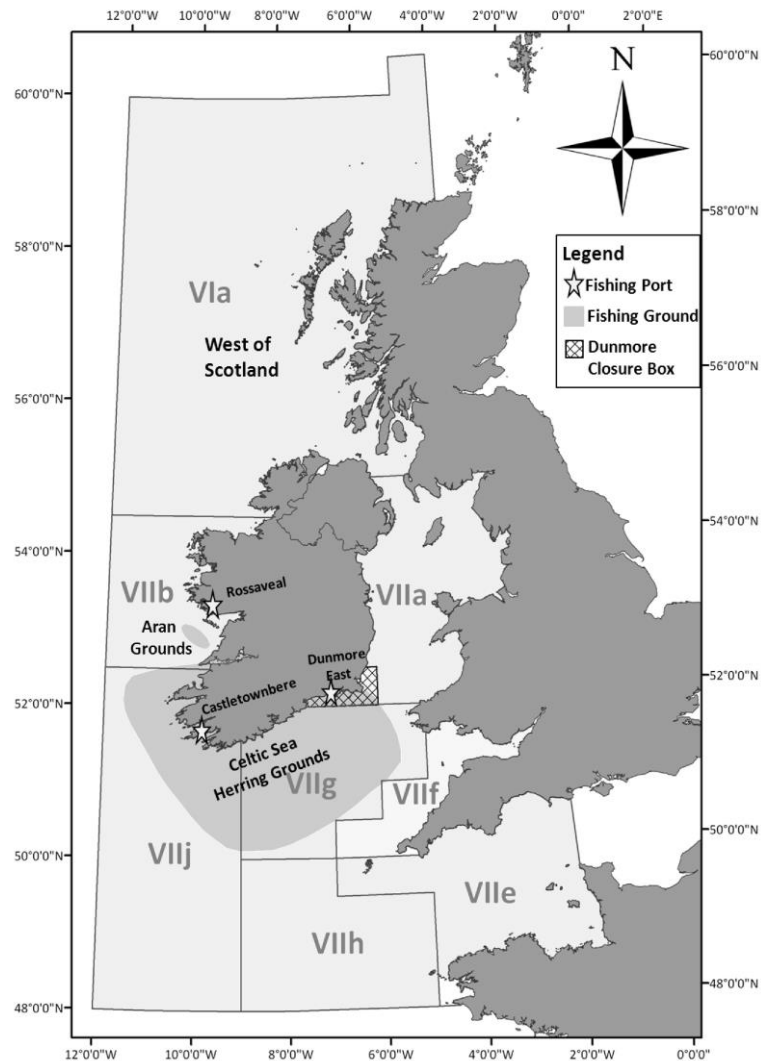
### ***The Celtic Sea Herring fishery***

The Celtic Sea Herring fishery is prosecuted off the South coast of Ireland in ICES areas VIIj, VIIg and the southern part of VIIa (see Figure 1). The fishery is predominantly conducted within approx. 20 nautical miles of the coast and is comprised of a highly diverse fleet of vessels ranging from under 10m multi-purpose inshore vessels up to modern 45m refrigerated seawater tank pelagic vessels. Most of the participating vessels are classed as polyvalent vessels, 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 approx. 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 MSY approaches (Marine Institute, 2013).

A total of 86% of the TAC is allocated to Ireland and the fishery has in recent years been dominated by Ireland. 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 (Ryan & Berrow, 2013). Prior to 2012 the fishery was effectively an open access one for vessels under approx. 20m in length while a large 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 which is intended to reduce the number of vessels entitled to participate in the fishery (Dept. of Agriculture, Food and Fisheries, 2012).

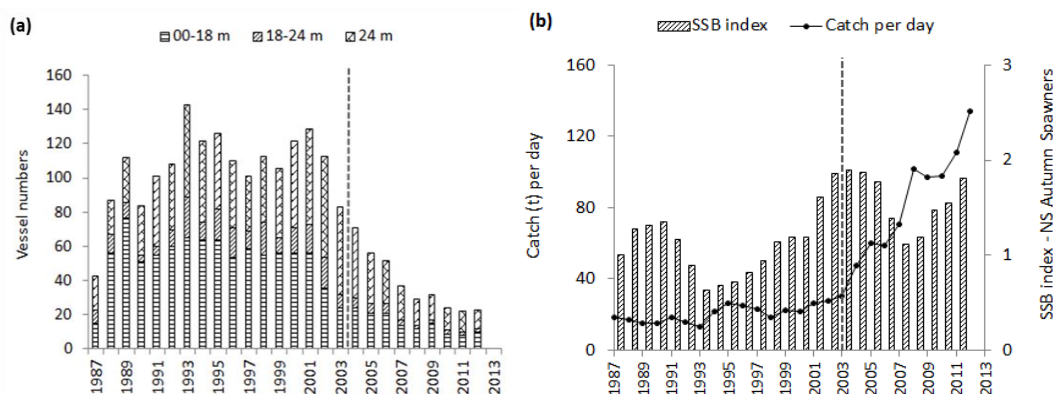
Figure 1. Map of Celtic Sea Herring fishing grounds



## *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 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 approx. 45% of the total annual landing value in Denmark, which was 360 million Euros in 2012.

There have been considerable structural changes in the Danish pelagic fleet since the introduction of the individually tradeable quota (ITQ) system in January 2003, with a decrease in vessel numbers from 130 vessels fishing herring in 2000 to approx. 25 vessels in 2012 (Figure 2a). This fleet-restructuring has resulted in a better balance between fleet capacity and fishing opportunities, and improved economic performance through increases in catch efficiency (Figure 2b). The observed increase in fleet catches per day is a logical consequence of the restructuring, where large vessels with large quota shares become more dominant in the fishery. Catch technology (e.g. gear size and electronic fish-finding and navigational equipment) has also been shown to improve in newer, larger vessels (Eigaard, 2009; Eigaard et al. 2014), adding further to the observed increasing trend in fishing power. In both figures the introduction of the ITQs in 2003 is indicated with a broken line.



*Figure 2. (a) Development in vessel numbers and sizes in the Danish pelagic fleet from 1987 to 2012. Only vessels with at least 5 yearly herring trips (herring landing value > 50% of total landing value of trip) are included. Figure 2. (b) Development in fishing power of the Danish North Sea herring fleet from 1987 to 2012 as defined by catch weight per fishing day in relation to the resource development (Spawning stock biomass (SSB) index of North Sea autumn spawning herring). (Data from the Danish AgriFish Agency)*

## ***The Greek demersal fishery***

The Greek demersal fishery has an essentially multispecies nature with up to 100 species in some sub-areas which 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 issue of new licenses, minimum landing size (MLS), mesh size regulations, and maximum size of fishing gears. The selected study area was the northern part of the FAO General Fisheries Council for the Mediterranean (GFCM) GSA 22.

Stock assessment in the fishery has been seriously constrained by data limitations in the past. Occasionally, samplings over a short period were conducted for a small part of the target species which provided a point estimate of the situation but required restrictive equilibrium assumptions (Caddy 2009). The data situation in the Mediterranean EU member states has been considerably improved in the last decade, after the implementation of the Data Collection Regulation (DCR) programme (EC 1543/2000; EC 1639/2001; EC 199/2008; EC 949/2008) that enabled a time series of effort and landings data in the Mediterranean to be built (Vassilakopoulos *et al* 2014).

According to EU legislation, logbooks in the Mediterranean are not compulsory for vessels of <10 m total length (EC 2847/1993) or for landed net weight of fish <15 kg per species (EC 1967/2006). Under the Data Collection Regulation framework (EC 1543/2000; EC 1639/2001; EC 199/2008), data on effort and landings have been collected in Greece since 2002, from 30 major sites including 209 landing ports on a monthly basis. This has been done using a systematic sampling procedure. The active Greek trawler fleet in the Aegean Sea consists of 299 vessels that use bottom trawl net 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.

## **2. Methodology**

Choice Experiment surveys involve 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 both to cover the range of management options in the new CFP (European Parliament and Council. 2013) and 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 fishermen to their representative organisations. This was felt to be more closely related to management performance than for instance the market price of fish which may fluctuate independently of how well a fishery is managed. The attributes and levels were selected based on a review of the policy options that are in use under the CFP and discussions with relevant stakeholders in the fishing industry. Discussions with the Chairman of the management committee for the Celtic Sea Herring fishery in Ireland were particularly informative in this regard.

Careful selection of non-correlated or orthogonal attributes is an important design consideration in CE. If there is correlation between attributes then the same problem which is faced by revealed preference methods is present, i.e. that the relative contribution of an individual attribute to overall utility is more difficult to determine. Another 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 relevant 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. This may be particularly important in the choice of the cost or financial attribute where asking respondents to, for example, pay for a good they have previously freely received is likely to lead to a preference for the status quo option. The number of attributes chosen is also important. Confusion can occur where a respondent is asked to assess the overall utility across too many attributes and some attributes are likely to be ignored (Campbell et al. 2008). This will affect how the survey results can be interpreted. Table 1 shows the attributes and their levels.

Table 1. Attributes and attribute levels used in Choice Experiment

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

For the design of the main survey a D-efficient design with a single block was used. Based on the number of attributes and levels each fisherman was presented with a total of 12 choice cards. As pointed out by Hynes et al. (2013) 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.

A pilot survey with 7 fishermen from the Celtic Sea Herring case study was conducted to obtain informed priors for the design which was then produced in Ngene (Econometric software; version 1.1.0). Fishermen were offered 12 choice cards each and were asked to choose one from three different options per card. The third option on each card was always a status quo option, reflecting current management. An example choice card is provided in Figure 3. Some initial issues with the survey design were addressed following this pilot survey. Changes were made to the status quo option on the choice cards as the pilot survey yielded a relatively high number of status quo bids possibly due to the fact that the stock had been rising in this fishery and that changes to management were not viewed positively. Additionally, the use of a cheap talk script in order to reduce hypothetical bias was found to be useful and was employed for the main survey.

In addition to the Choice Experiment itself a set of additional follow-up questions were included in the survey. These were to be used as possible explanatory variables and to examine the motivation behind survey responses. Additional information included demographic, economic and vessel related information. Follow up questions covered issues such as whether respondents had ignored any attributes in making their choices and straightforward ranking exercises on general fisheries management preferences and priorities.

Figure 3. Example Choice Card

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

### *Discrete Choice models*

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

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

where  $U_{ni}$  is assumed to consist of a systematic part,  $V_{ni}$ , and a stochastic part,  $\varepsilon_{ni}$ . 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:

$$P_{ni} = \text{Prob}(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj} \forall j \neq i) \quad (2)$$

The observed utility  $V_{ni}$  is usually 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  $i$ . If  $\varepsilon_{nj}$  is assumed to be an independently and identically distributed extreme value, this probability will have a closed form expression, leading to the conditional logit model:

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

Frequently, researchers employ the basic conditional logit (CL) model to analyse choice data (Hynes et al. 2013). However, the basic conditional logit model has some important limitations. Firstly, it fails to meet the assumption implied by the independence from irrelevant alternatives property (IIA). Secondly, it cannot handle situations where the unobserved part of the utility function is correlated across repeated choices and finally it represents mean taste variation rather than random taste variation across respondents (Train, 2003). The random parameter logit (RPL) model can be used to overcome these problems and extends the CL model by relaxing the assumption that observations are independent, and allowing the  $\beta$  parameters to vary across individuals (Hynes et al., 2008). The RPL model allows the error components of different alternatives to be correlated, and accommodates heterogeneous preferences in the sampled population by generating a distribution of  $\beta$  parameters which vary randomly over all individuals.

In the RPL model, the unconditional choice probability is the integral of logit formulas over all possible variables of  $\beta_n$  such that:

$$P_{ni} = \int \prod_{t=1}^T \left[ \frac{e^{\beta_n' x_{nit}}}{\sum_j e^{\beta_n' x_{njt}}} \right] f(\beta) d(\beta) \quad (4)$$

The integral in equation (4) may not be evaluated analytically, and the analyst has to rely on a simulation method for calculating the probabilities. As outlined by Train (2003), to estimate the RPL model one has to make assumptions about how the  $\beta$  coefficients are distributed over the population  $f(\beta)$ ; take a set of  $R$  draws from  $f(\beta)$  and then calculate the logit probability for each draw. Therefore, as demonstrated by Train (2003) and reproduced in equation 5 below the simulated

probability  $\hat{P}_{ni}$  is an unbiased estimator of  $P_{ni}$  whose variance decreases as  $R$  increases:

$$\hat{P}_{ni} = \frac{1}{R} \sum_{r=1}^R \left( \prod_{t=1}^T \left[ \frac{e^{\beta'_{nr} x_{nit}}}{\sum_j e^{\beta'_{nr} x_{njt}}} \right] f(\beta) d(\beta) \right) \quad (5)$$

The subscript  $nr$  on  $\beta$  indicates that the probability is calculated for each fisherman using  $R$  different sets of  $\beta$  vectors. In this study of fishermen management option preferences we use a simulated maximum likelihood estimator with Halton draws. In the final estimation of the model 200 Halton draws were used. The results of the CL model are presented in the appendix while the results of the preferred RPL model for each individual fishery and for all fisheries combined are discussed in detail in the following section.

### ***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 in each case study fishery as possible. In the Celtic Sea Herring fishery the number of fishermen surveyed was 36 (with 43 surveys in total conducted including the pilot) which represents 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, which represents approximately 61% of the total number of vessels in the Danish herring fishery. In Greece 13 surveys were conducted which represents approximately 45% of the total number of participants in this fishery. The total number of surveys conducted in total across the 3 locations for this study was 74.

Selection of respondents was made through consultation with the relevant fishermen's organisations in each country. In all cases the survey was conducted as a face-to-face survey. Each respondent was given some background information on the purpose of the survey and an explanation of how it would be conducted. They were asked to answer some preliminary questions on general fisheries management knowledge and preferences and then given a practice choice card to familiarise them with how the choice experiment survey worked. Then the respondents were asked to complete the 12 choice cards. Following this respondents were asked to answer a small number of follow-up questions and to provide some demographic and economic data.

### 3. Results

Table 2 below gives the results from the Random Parameters Logit model described in the previous section (The results of Conditional Logit models are contained in Appendix A). All of the statistical metrics used to aid the researcher in selecting the most appropriate model (Log likelihood, AIC, Bayes IC and Hannan Quinn) indicated the use of the RPL over the Clogit model.

One of the most interesting results evident from the individual fisheries models presented in Table 2 is that there are no management attributes which elicit the same preference structure across all three fisheries. The Irish and Danish fishermen both prefer management options which are more likely to result in a good biological outlook for the stock. The responses of Greek fishermen revealed that this 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 this attribute indicates a wide diversity of preferences, both positive and negative (Rigby and Burton, 2003) suggesting that this attribute provokes a mixed response.

In relation to the management scale attribute there were quite different results across the three fisheries. Irish fishermen have a strong preference for co-management over regional, EU or national management frameworks. Greek fishermen had no significant preferences for any of the management scale attribute levels. The Danish pelagic fishermen appear to prefer regional or national management frameworks to co-management or EU based management. However there appear to have been some issues around the understanding of the meaning of co-management in the Danish case. These issues are addressed in more detail in the Discussion section.

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

	Celtic Sea Herring				Greek Demersal				Danish Pelagic			
	Mean of Coefficient		Standard Deviation of Coefficient		Mean of Coefficient		Standard Deviation of Coefficient		Mean of Coefficient		Standard Deviation of Coefficient	
Good biological outlook	2.27	(0.380) ***	1.09	(0.278) ***	-0.54	(0.509)	0.84	(0.443) *	1.44	(0.624) **	1.32	(0.743) *
National Management	-0.58	(0.323) *	0.38	(0.267)	0.73	(0.526)	0.27	(0.479)	2.28	(0.670) ***	1.39	(0.419) ***
Regional Management	-1.45	(0.423) ***	0.73	(0.447)	0.69	(0.563)	0.68	(0.841)	2.08	(0.756) ***	3.27	(1.213) ***
Central European Management	-1.08	(0.368) ***	0.06	(0.497)	-0.37	(0.672)	0.46	(0.632)	-1.58	(0.959) *	4.75	(1.171) ***
Community importance of fishing maintained at current level	0.83	(0.298) ***	0.34	(0.368)	1.10	(0.593) *	1.15	(0.558) **	1.21	(0.773)	0.99	(0.755)
20% increase in importance of fishing to local community	1.99	(0.332) ***	0.23	(0.437)	0.10	(0.430)	0.10	(0.533)	1.02	(0.749)	1.84	(0.586) ***
Catch Quota system/Discard Ban	-0.81	(0.434) *	1.24	(0.407) ***	-2.23	(0.748) ***	0.41	(0.636)	4.20	(1.022) ***	0.74	(0.549)
Temporary Area Closures	-0.11	(0.365)	0.28	(0.612)	-0.10	(0.637)	1.23	(0.670) *	3.73	(1.057) ***	2.17	(0.957) **
Permanent Area Closures	0.04	(0.339)	0.69	(0.293) **	-2.05	(0.686) ***	0.69	(0.553)	0.61	(0.814)	3.05	(0.672) ***
Limited Access based on track record	1.31	(0.493) ***	3.21	(0.617) ***	-0.31	(0.510)	0.47	(0.557)	1.10	(0.719)	1.04	(0.739)
Nationally tradable TFC's/TURF's	-1.59	(0.452) ***	2.17	(0.403) ***	0.78	(0.498)	0.88	(0.661)	4.05	(0.800) ***	1.53	(0.677) **
Internationally tradable TFC's/TURF's	-4.57	(1.221) ***	3.53	(1.291) ***	-0.71	(0.478)	0.47	(0.399)	5.40	(1.280) ***	5.71	(1.352) ***
Cost	-0.002	(0.001) ***	0.001	(0.0004) **	0.001	(0.001)	0.002	(0.001) *	0.00001	(0.0000)	0.00001	(0.000)
	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 .3463612				McFadden Pseudo R-squared .1561099				McFadden Pseudo R-squared .4591223			
	AIC 1.53697				AIC 2.18755				AIC 1.43142			
	<p>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 is preferred to base case while negative values indicate that base case is preferred to attribute.</p>											



Measures, which maintain or strengthen the importance of fishing within the local community were prioritised to some extent in all three fisheries. This preference was most strongly expressed in the Irish case where both measures which maintain the importance of fishing in the community and which increase it were strongly and significantly preferred. For the Greek fishermen measures which maintain 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 fisheries had significant negative attitudes towards a landing obligation while the Danish pelagic fishery strongly supported it. The Danish fishery also supported the use of temporary spatial closures much more strongly than the Irish fishery while Greek fishermen had mixed attitudes. Permanent area closures were strongly and significantly disliked by Greek fishermen while provoking a mixed reaction among both Irish and Danish fishermen.

Greek fishermen had no significant preferences for any of the levels associated with the access and quota management attribute while Irish and Danish fishermen have almost diametrically opposed preference structures. Celtic Sea Herring fishermen are strongly negatively inclined towards tradable fishing concessions while access based on track record has a mixed response. Danish fishermen on the other hand strongly prefer tradable concessions over other access or quota options.

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

Table 3. Results of pooled RPL model with fisheries and vessel size as interaction factors

	Pooled data				Greek			Danish			Vessel Size				
	Mean of Coefficient			Standard Deviation of Coefficient			Heterogeneity in Mean			Heterogeneity in Mean			Heterogeneity in Mean		
<b>Good biological outlook</b>	1.845	(0.41)	***	0.51109	(0.388)		-2.314	(0.463)	***	-1.521	(0.524)	***	0.006	(0.014)	
<b>National Management</b>	-0.195	(0.483)		0.24212	(0.34)		1.375	(0.632)	**	1.725	(0.636)	***	-0.017	(0.018)	
<b>Regional Management</b>	-1.099	(0.598)	*	0.58501	(0.473)		1.995	(0.663)	***	2.345	(0.782)	***	-0.014	(0.022)	
<b>Central European Management</b>	-0.248	(0.566)		0.67036	(0.342)	**	1.020	(0.798)		2.543	(0.777)	***	-0.039	(0.021)	*
<b>Community importance of fishing maintained at current level</b>	1.499	(0.488)	***	0.16579	(0.327)		-0.022	(0.493)		0.550	(0.662)	*	-0.027	(0.018)	
<b>20% increase in importance of fishing to local community</b>	2.855	(0.533)	***	0.36904	(0.285)		-1.451	(0.537)	***	0.743	(0.722)		-0.047	(0.019)	**
<b>Catch Quota system/Discard Ban</b>	-1.416	(0.74)	*	1.20009	(0.409)	***	-1.860	(0.780)	**	3.970	(0.909)	***	0.033	(0.026)	
<b>Temporary Area Closures</b>	0.476	(0.676)		1.15592	(0.309)	***	-0.314	(0.744)		2.853	(0.876)	***	-0.026	(0.025)	
<b>Permanent Area Closures</b>	0.380	(0.647)		1.10544	(0.277)	***	-1.581	(0.746)	**	1.320	(0.931)		-0.036	(0.026)	
<b>Limited Access based on track record</b>	-0.487	(0.666)		2.2606	(0.421)	***	-0.637	(0.821)		-0.827	(1.007)		0.040	(0.023)	*
<b>Nationally tradable TFC's/TURF's</b>	-3.241	(0.628)	***	1.7007	(0.356)	***	1.058	(0.754)		1.599	(0.809)	**	0.109	(0.022)	***
<b>Internationally tradable TFC's/TURF's</b>	-6.352	(1.056)	***	1.84572	(0.477)	***	2.272	(0.963)	**	4.097	(1.034)	***	0.124	(0.029)	***
<b>Cost</b>	-0.002	(0.0003)	***	0.00002	(0.00001)		0.002	(0.001)	***	0.001	(0.0002)	***	0.000003	(0.000004)	
	Log likelihood function			-639.75558			Figures in parentheses indicate the values of the standard errors.								
	Chi squared [ 65 d.f.]			667.22982			*** = significant at 1% ** = significant at 5% * = significant at 10%. Positive								
	McFadden Pseudo R-squared			.3427420			coefficient values indicate that attribute is preferred to base case while negative								
	AIC			1.59087			values indicate that base case is preferred to attribute.								

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. It is also possible to examine possible explanatory factors of the heterogeneity that exists amongst fishermen 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.

Table 3 displays the results of such a pooled RPL model with fishery and vessel size interactions with the Irish fishery as the base case, and the other fisheries compared against that. It can be seen that these model results reinforce the findings from the separate RPL models in Table 2 of significant heterogeneity in preferences across fisheries<sup>1</sup>.

In particular being in the Danish fleet has a significant influence on the preferences for all except two of the attributes in the pooled model relative to the preferences of the base case. The effect is particularly strong 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 is also revealing with regard to some aspects of the Greek responses which were not apparent from the individual fishery RPL model. Participation in the Greek fishery is associated with a stronger preference for regional and national management and a weaker preference for measures increasing the community importance of fishing (again compared to the base case of being in the Irish fleet).

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

In addition to the choice cards fishermen were also asked a number of other attitudinal questions in the survey which can help explain the preferences shown in the models above. In particular, responses to the supplementary question on high level fisheries management objectives (Figure 4) showed no consistent pattern across the three case studies with each case prioritising a different objective. In line with the

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<sup>1</sup>While the individual fisheries models explain variation in a deterministic way for each fleet, by a segmentation of the fishers into mutually exclusive subsets, there is now, in the case of the pooled model, an additional, purely random variation in tastes within each might be expected to be present. While we attempted to control for this scale effect using a generalised logit model (G-MNL) as proposed by Fiebig et al. (2010) we failed to get the model to converge. Nevertheless, we feel that interacting the attribute levels with the fishery dummies should allow us to control for some of the differences that one might expect in tastes across these alternative populations.

model results, the “Importance of fishing in the local community” ranked as the highest priority fisheries management objective among Celtic Sea Herring fishermen while “Ecosystem Productivity” and “Profits and Return on Investment” were the highest for the Greek and Danish fishermen respectively.

The other supplementary question asked respondents to rank 10 CFP related management measures in order of their potential to improve fisheries management (Figure5). 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 for Celtic Sea fishers. Greek respondents omitted this option from the list as quotas are not used in Mediterranean fisheries. Perhaps the most interesting and potentially significant result from a policy perspective from this question was that a landing obligation ranked as the measure least likely to improve fisheries management or the least preferred measure across all three case studies.

Figure 4. Fisheries Management Objective Priorities across case studies

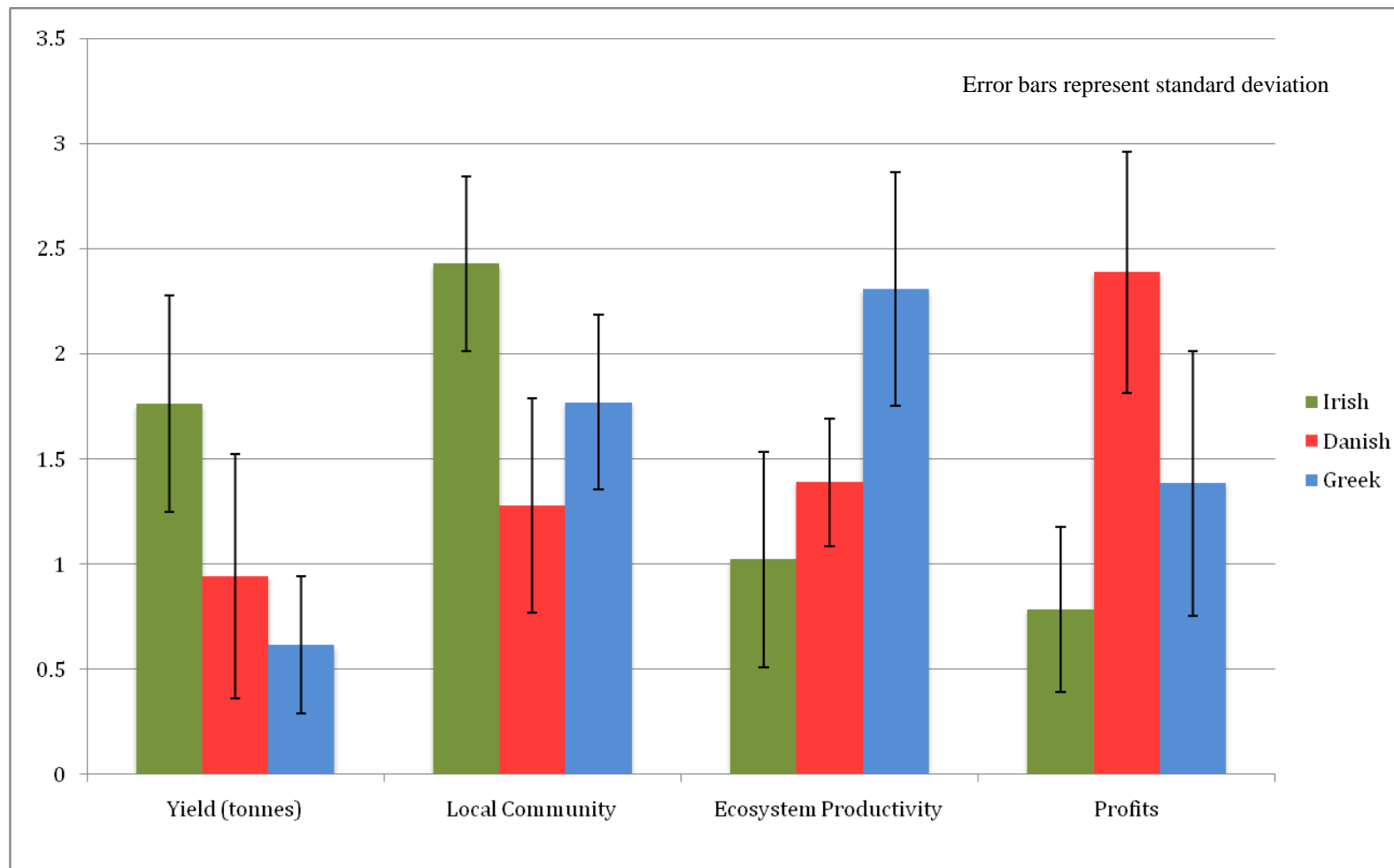
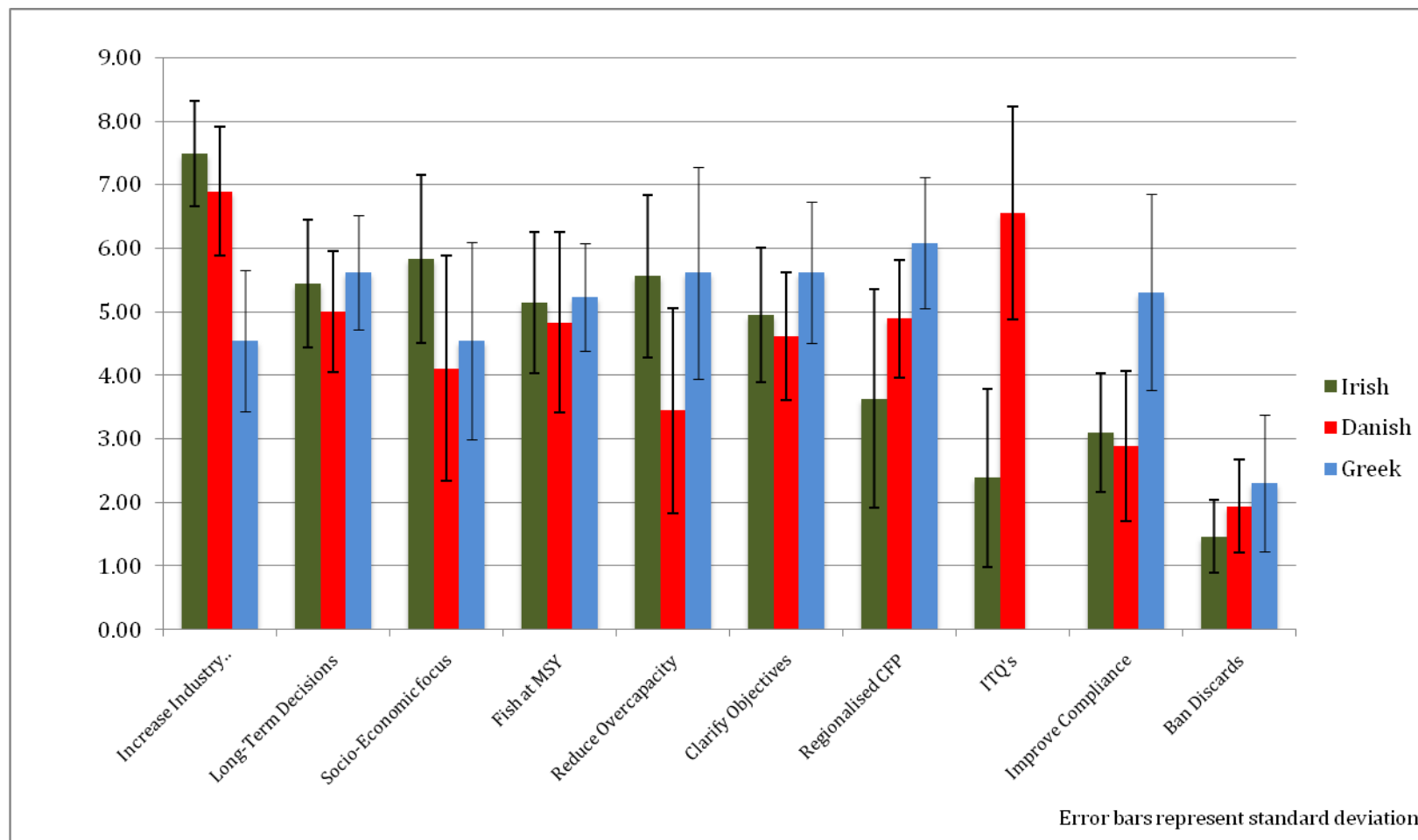


Figure 5. Management Measure priorities across case studies



## 4. Discussion

One of the most interesting findings from this research is that there are no management attributes which provoke a unanimous response across the three case studies. This result is evident in both the estimated discrete choice models and the supplementary questions on ranking high-level objectives and measures which could improve management. For this reason the discussion will focus on the preference structures within each case study fishery followed by overarching conclusions which may be drawn about European fisheries management in general.

Celtic Sea Herring fishermen were found to have strong preferences for a management system which prioritises a good biological outlook, i.e. stock health, is based on local co-management, promotes the community importance of fishing, where quotas are not tradeable and which minimises costs. This could be seen as a support for the *status quo* management system currently in place but there are a few more complex issues evident from a closer examination of the choice experiment results. The strong support for precautionary management which prioritises stock health may be due in part to two previous stock collapses in the fishery (Fitzpatrick, 2014). The long established co-management system in place for 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 recent official Irish positions in CFP reform negotiations (DAFF, 2010).

Although a restricted access system based on track record has recently replaced a *de facto* open access system in the fishery (Department of Agriculture, Food and Fisheries, 2012) and appears to be supported it should still be noted that the high standard deviations in relation to the limited access and nationally tradeable quota indicate a diversity of attitudes towards these options. These results mirror conflicting attitudes evident at recent meetings of the local co-management body, attended by one of the authors, between those who oppose the restriction of traditional access rights versus those who support further rationalisation. A landing obligation was not supported by a majority of respondents but attitudes towards 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 fishermen 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 a landings obligation in the pelagic and demersal sectors contained in the new CFP (European Parliament and Council, 2013). Preference differences on the issues of quota individualisation and discards may be driven by these sectoral differences as exclusively pelagic fishermen, 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 fishermen's attitudes towards good biological outlook were mixed. Information collected during follow-up interviews to discuss the Choice Experiment 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 satisfied with the current stock status but rather they consider other issues of greater importance *e.g.* the forthcoming discard ban, fleet overcapacity, low fish prices and 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 prioritising management measures (Figure 5) 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 fishermen (Maravelias et al 2014). Coastal fishermen 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 fishermen envisage that managing the fishery at a regional level will alleviate this inequity rather than through co-management.

Danish pelagic respondents have strong preferences for a management system which prioritises stock health, is based on national or regional management, which incorporates a discard ban and temporary closures and which 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. These terms of business probably facilitate a very regional mind-set, which might have caused an unintended artificial contradiction with co-management, and this is probably the reason for the somewhat surprising DK preference for a regional management framework over co-management. This has been verified by some follow-up phone calls conducted with the original respondents to discuss this further subsequent to the conducting of the interviews. The strong diversity in preference structures across Danish respondents, evidenced by significant standard deviation levels 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 a



number of smaller vessels with investment levels at least an order of magnitude smaller. Particularly significant mixed attitudes are evident in relation to the management scale, the community importance of fishing, the use of permanent closures and international trading of quotas.

## 5. Conclusion

Support for measures, which maintain or strengthen the importance of fishing to the local community is evident to some extent in all three fisheries. This is a significant finding as it highlights an area of fisheries management which is seldom highly prioritised. Discussions on how or whether to define social objectives in fisheries management are frequently inconclusive and clearly defined biological, ecosystem or economic objectives are more common (Symes and Phillipson, 2009). Finding clear or strong community or social-based elements or objectives in the new EU CFP is difficult. Nevertheless it appears that most fishers across three distinct and diverse fisheries do prioritise measures which support coastal communities. It may be the case that most fishers are keen to maintain the social fabric of their communities but find that real world management frameworks do not easily provide the scope for that and instead generally reward self-interested decision making. Conceptually, the three pillars of sustainability give equal weight to ecosystem, economic and social sustainability. This research indicates that the social pillar, at least in the context of the questions asked, is actually more consistently emphasised than the others. As with the wording in the CFP, this has not been given specific detail in this study, but it illustrates that there is an appetite for such objectives. This would suggest that an appropriate follow up would be to find out what aspects of the local community wellbeing the respondents are actually considering, and perhaps to focus management efforts on these.

Perhaps the nearest thing to a unanimous response was towards a discard ban. 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 response towards it in the choice experiment. However the advantage of the choice experiment method over simple ranking questions is evidenced by 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. What this might suggest is that the implementation of new management measures such as the landing obligation should be presented in the context of a fuller range of possible measures that might achieve the same objective. The negative response by all three fisheries in the ranking questions suggests that the landing obligation is unwelcome from first principles by fishers. However, they may take a more positive approach given a better presentation of the wider picture and the alternatives. The predominantly negative attitudes

towards a landing obligation points to significant upcoming challenges in the implementation of a landings declaration in EU fisheries over the next few years.

Even more significantly than in the case of the discard ban are differences in preference structure relating to individual quotas or fishing rights across the three fisheries. Perhaps unsurprisingly given the successful (in terms of reducing overcapacity and increasing the economic performance of the remaining quota-holders) introduction of an individual quota system in Denmark respondents there have a strong preference for such measures. In the Irish fishery where the access regime and economic rationalisation are very different to the Danish situation, attitudes towards tradeable quotas are almost diametrically the opposite. These differences highlight more than on any other attribute the need for contextual issues to be considered in the establishment of management measures. What is appropriate in one or more fisheries may not be the right measure in all. This is highly relevant as the introduction of transferable fishing concessions was mandatory at one stage of the recent EU CFP reform process. Additionally the blanket promotion of tradeable quotas as a solution to problems in fisheries of all scales and regardless of extant quota management arrangements remains common in fisheries management debates..

The finding that larger vessel owners have weaker support for community based management measures and greater support for individual quotas has significant policy implications. Many fishing fleets are still dominated in numbers by small vessels while high level representation and political influence arguably favour larger vessels (McGoodwin, 2001). Larger vessels will also tend to catch more fish, so in terms of stock management may be the most important part of the fleet to manage. These findings of significant heterogeneity within and across fisheries highlight the need for decision-making processes on management measures having significant social and economic impacts to be inclusive of a broad range of fishers. It might also suggest that there could be a different approach for the larger vessels, than for the smaller. For instance, the most significant difference in attitudes of large vessel owners was to transferrable quota arrangements. This might indicate that these would be appropriate for the more industrial fleet components, and less for the more artisanal. Further research would also be productive into how power asymmetries in fisheries representation may influence policy making and shift fisheries management decisions towards individual and away from community-based decisions.

In conclusion, the main finding of this study is that in fisheries management one size does not fit all. Major differences in attitudes to management, and ecosystem, economic and social sustainability issues were identified between three fisheries. The only near consistencies lay in support for local communities and opposition to the landing obligation. But even here there were disagreements. Furthermore, there were differences within each fishery as well, based on vessel size. This is a very strong argument for much more regional and even intra-sectoral approaches based on overarching principles rather than prescriptive single approaches.

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# Appendices

## Appendix A.

Variable	Coeff.	Std.Err.	Danish	Greek	Interaction			
Good biological outlook	1.00991 ***	0.14489	DBIOG	-0.66322 ***	0.247631	GBIOG	-1.07391 ***	0.3037
National Management	-0.15402	0.18302	DNAT	0.459806	0.34217	GNAT	0.739187	0.3966
Regional Management	-0.47091 **	0.21109	DREG	0.855987 **	0.394068	GREG	1.1634 ***	0.41098
Central European Management	-0.30317	0.21424	DEUG	0.4016	0.376672	GEUG	0.209496	0.48159
Community importance of fishing maintained at current level	0.360268 *	0.17519	DCOM_0	-0.20794	0.302185	GCOM_0	0.668093 *	0.36293
20% increase in importance of fishing to local community	0.796062 ***	0.18379	DCOM_UP	-0.22211	0.341048	GCOM_UP	-0.74741 *	0.4012
Catch Quota System/Discard Ban	-0.61585 ***	0.22133	DMEASDIS	2.13841 ***	0.42896	GMEASDIS	-0.85841 *	0.44051
Temporary Area Closures	-0.14824	0.20469	DMEASTEM	1.10377 ***	0.416705	GMEASTEM	0.14335	0.4375
Permanent Area Closures	-0.2713	0.19414	DMEASPER	0.490599	0.42065	GMEASPER	-1.51799 ***	0.48458
Limited Access based on track record	0.12066	0.18899	DACC_LTD	0.180733	0.364032	GACC_LTD	-0.56841	0.46862
Nationally tradable FC's/TURF's	-0.37419 **	0.17795	DACC_NTQ	1.94872 ***	0.335241	GACC_NTQ	1.03876 ***	0.39476
Internationally tradable FC's/TURF's	-1.99312 ***	0.26369	DACC_ITQ	3.49597 ***	0.40522	GACC_ITQ	1.08999 ***	0.46663
LNPRICE1	-9.84E-02 ***	2.85E-02	DPRICE	0.125295 *	6.45E-02	GPRICE	7.94E-02	9.17E-02

Log likelihood function: 768.55241  
 Estimation based on N=86, K=9  
 Information Criteria: Normalization=1/N  
 AIC Normalized: 615.10482  
 AIC Unnormalized: 822.92292  
 Fin. Smpl. AIC: 827.08618  
 Bayes C: 0.3362801  
 Hannani-Quinn: 1.90347686

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