Fisheries Management Systems and Risk Perception amongst Fishermen in Iceland, Faroe Islands, and UK

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Abstract

This paper investigates whether fisheries management systems influence risk perceptions amongst fishermen in three European countries. The main findings of this paper are that risks related to policy, management and control are most frequently cited by fishermen in the case study countries. These risks are followed by economic, trade and market issues and fishing impact on environment and resources. The risk perceptions of fishermen in the three countries often vary, and the results indicate that 'policy, management and control' risks identified by fishermen operating under an ITQ system were assigned more importance than by those involved in a TAE system. A comparison of scalar values shows that fishermen operating under a TAE system tend to attach more importance to risks relating to the impact of fishing on natural resources. The paper contributes to the analysis of risk within fishing and may assist in the creation of better fishing management regulations.

Keywords: comparative study, fisheries management systems, fishermen, mental modelling, risk perception.

Introduction

In the past decades, widespread concerns have been expressed about the condition of fish stocks in the oceans of the world (Minnegal and Dwyer 2008). On the current state of fishing Pontecorvo and Schrank (2006, p. 68) write: "Many of the world‟s fisheries are in crisis, with stocks greatly depleted. Blame is usually attributed to overfishing, caused by irresponsible regulation, subsides, politics, and greedy fishermen." A common response to this situation has been to implement stringent fishing management regimes in order to ensure conservation of fish stocks and environment, maximum sustainable yield, and economic efficiency of the fishing industry (Arnason 2009; Minnegal and Dwyer 2008).Various fisheries management systems may impact differently on fishermen‟s risk perceptions. An individually allocated catch quota-based system, for instance, seeks to restrict individual fishermen‟s landings, even if there is a perception of stock abundance. From the fishermen‟s point of view, this could mean that the most prominent risks are not perceived to be related to stock collapse, that is the impact of fishing on the natural resource, but more akin to access arrangements (i.e. policy, management and control issues). Also, they would perceive risks relating to economic factors which determine the return generated by this limited catch allowance.

The opposite may apply to management systems based primarily upon individually allocated input controls, such as days at sea restrictions. In these systems, fishermen are more likely to be able to catch as much fish as they can physically handle on a particular trip. As a result, they may be more concerned with stock collapse and environmental issues (e.g. not enough fish in the oceans) as opposed to the details of the management system.

This paper investigates the influence of contrasting fisheries management systems on risk perceptions amongst fishermen in the Faroe Islands, Iceland and the UK. In particular, risk perceptions are analysed in relation to policy, management and control issues, economic and market factors and the impact of fishing on resources and the environment. The main question to be addressed is whether two different fisheries management systems in three European countries influence perceptions of risk amongst fishermen in different ways. The fishing management systems are the Faroese input control system of days at sea restrictions, and output restriction systems in Iceland and UK based on total allowable catches (TACs) and some form of individual transferable catch quota allocation. This is the first known published attempt to systematically compile and analyse data on risk perceptions with regard to fishermen operating under a range of different fisheries management systems. The paper also makes a contribution by analysing risk from a social science perspective in order to understand how fishermen perceive scientific information and governmental regulation. The next section reviews the theory relating to risk perception and systems research. Section three outlines the research methodology employed and the fishing management systems in each of the three case study countries. Section four presents the results and the paper ends with a discussion and conclusions.

Literature review and theory

Most nations of the world have imposed either input/effort control systems in fishing, or output controls. Input systems are based on restricting access, gear used, times of fishing, or areas where fishing may occur. These control systems are often referred to as *total allowable effort* (TAE). Output control systems place limits on the total allowable catch of nominated species. Such systems are usually referred to as *total allowable catch* (TAC) (Minnegal and Dwyer 2008; Kompas, Che and Grafton 2008). Many nations have also imposed Individual Transferable Quota (ITQ) management in combination with TAC (Arnason 2009; Minnegal and Dwyer 2008) which means that quota holders may sell or lease part or all of their holdings. The aim is to introduce free markets, promote competition, and, eventually, eliminate inefficient operators (Minnegal and Dwyer 2008). Previous research has shown that fishing management systems affect the organization of the fishing industry in various ways, and impact on the behaviour of fishermen. Individually Transferable Quotas (ITQs) are generally thought to encourage fishing operators to better match their existing capacity and effort levels with current and future ITQ holdings in an economically rational manner. Thus they are encouraged to adjust their activities, by engendering a sense of responsibility towards ensuring long-run sustainability of resources. However, ITQs have also been criticized in a number of respects, e.g. initial allocation problems and windfall gains, consolidation and employment issues affecting vulnerable communities, increased propensity to discard, loss of smaller boats, high quota prices, etc. (Minnegal and Dwyer 2008; Copes 1986).

Open access and input restriction systems share the tragedy of the commons (Hardin 1968), meaning that individual fishermen subject to common property arrangement have every reason to grab as large a share of the potential yield as they can and as fast as possible. Otherwise, other fishermen would snatch their share. Thus, the individual fisherman has no means on his own to alter the course of the fishery (Arnason 2009). As a consequence, fishermen tend to substitute restricted input by increasing landings (Campell 1991), and to invest in more productive fishing technology often referred to as “technological creep” (Marchal et al., 2007).

Perrow‘s (1984) central work on Normal Accident Theory demonstrates how complex, tightly coupled technological systems produce accidents or disasters. As accidents are inevitable in such systems they are in a sense “normal”. This work provides a model based on structural analysis of risky systems and attempts to elicit long-term strategies for handling risk as opposed to short-term fixes. Garcia and Charles (2008) note that the complex systemic nature of fisheries has long been recognised but attempts to incorporate this feature into routine fisheries management procedures have been very slow. They identify four features of the fisheries system which contribute to its unique complexity: (1) the fundamentally limited and complex nature of renewable resources; (2) exceptionally high levels of unobservability due to our inability to view fish in the sea; (3) high levels of complexity due to multiple-species and fishing sectors, and: (4) strong political and economic drivers due to high societal interest in ocean systems and high volumes of international fish trade.

Garcia and Charles (2008) go on to discuss linkages in the fisheries system, particularly with regard to energy transfers within the system, e.g. as a result of predation or migration. They also note information transfers between fisheries sector stakeholders, monetary transfers - for example from government to industry or vice a versa - institutional linkages, social relations between individuals in the system, and signals from the environment (e.g. societal expectations, international agreements and norms and climate change). Finally, they note the impact of global drivers, such as globalisation or global environmental pressures. Degnbol and McCay (2006) discuss how a failure to understand linkages in the fisheries system can lead to management strategies that fail to achieve their objectives. They stress the need to recognise links between institutions involved in the production and evaluation of knowledge, on the one hand, and institutions which make management-decisions, as well as being involved in fisheries implementation framework and adaptation, on the other.

Pontecorvo and Schrank (2006) focus on the poor record of fisheries management. They argue that in a competitive industry like fisheries, the main objective is to maximize profits, or harvest, within a very short time horizon; consequently, catch limitations are seen as a threat to income. Unless the TACs are based on convincing scientific advice, the stakeholders in the industry will take any step they can to increase them. When these steps are successful, overfishing results. Pontecorvo and Schrank claim that overfishing is a structural problem involving knowledge limitations of fishery science and the organization of the fishing industry. In order to save the existing wild marine fisheries, they propose a more conservationist fishery policy based on small core/scale fishing.

Minnegal and Dwyer (2008), in their study of locally-based commercial fishers in Victoria, Australia, conclude that fishers utilise diversification, such as multiple targets as manifested in a variety of fishing areas, vessels and markets. Such techniques help them manage risks characterising the biological and economic environments they experience. These measures have contributed to the numerical stability of the local fleet, at a time when most fishing fleets are in decline in the surrounding areas. This has even counteracted the main purpose of most fishing management systems, that is to decrease the numbers of vessels. An implication of these findings is that the ways fishers manage risk offer lessons for fisheries managers as to why their policies fail and how they could be more successful.

A study of other risk-related research in the fisheries context reveals that most research published to date has tended to focus upon a few issues, such as fishermen’s safety risks (see e.g. Törner and Eklöf 2000; Roberts 1992), fish food safety (Sumner, Ross and Ababouch 2004) economically-driven risk behaviour (Eggert and Martinsson 2004), dealing with risk and uncertainty in the provision of fisheries science advice for management (Rosenberg and Restrepo 1994; Kompas et al. 2008), risk management issues in respect of fisheries or ecosystem-related risks (Fletcher 2005; Astles, Holloway, Steffe, Green, Ganassin and Gibbs 2006) and fishermen’s risk management strategies (Edwards, Link and Rountree 2004).

Based on the literature review the following hypothesis is put forward:

H1: Fishermen operating under ITQ fishing management systems that limit catches will perceive the most prominent risks as being related to access restrictions, i.e. the policy, management and control of fishing.

The authors also intend to analyse the data in order to find whether the problem of the commons (fish as much as they can while at sea) encourages fishermen in TAE systems to increase landings and invest in more effective fishing technology.

Methodology

Mental modelling

This research was based on a series of qualitative, detailed, semi-structured interviews and utilised a ‘mental modelling’ approach. Mental Modelling is a qualitative analysis technique used by social scientists, cognitive psychologists and decision-making theorists. It is used to explain an individual’s thought process in relation to how something works in the real world and seeks to examine how people construct accounts of reality (Taylor-Gooby and Zinn 2006; Taylor-Gooby 2006). The Mental Modelling interview process was developed to elicit interviewee perceptions of risk and the strength of these perceptions in relation to the fisheries sector. The methodology was also designed to capture explanatory information in relation to perceived linkages between risk factors, e.g. ranking, weighting and direction of linkages. A series of semi-structured face-to-face interviews were carried out in 2007 in each country with a variety of fisheries sector stakeholder groups relevant to the case study fisheries.

Interviewees were initially presented with Mental Model 1: Blank model and asked to fill in as many variables in the bubbles as appropriate with a separate risk issue that they felt was of relevance to the fisheries sector. The interviewer did not influence the interviewee or make any suggestions as to what people may perceive as a risk in the fisheries sector. Interviewees were also asked to rank their risks numerically (e.g. from 1 to *n* depending on number of risks identified) and to assign a weight to each risk, using the scale 0.1 to 1.0, with 1.0 being the highest possible weight representing the most serious risk. By definition, a weight of 0.3 represents three times more risk than 0.1. The interviewer recorded the reasons why the interviewees ranked risks in the way they did and also noted any linkages between risks by drawing lines and arrows between bubbles. Weights and arrow heads could also be assigned to the lines to show the strength of these linkages and their respective direction. Following the completion of the Blank model, interviewees were shown the 'Comprehensive model' (Mental Model 2). A separate 'Comprehensive model' was constructed for fishermen, to be used consistently across all Case Study Countries, based on the results of pilot surveys undertaken in each Case Study Country in 2006. Whilst the range of perceived risks for fishermen was expected to vary between countries, it was thought appropriate to construct one 'Comprehensive model', for use in each country, to allow for cross-country comparison. The variables in the comprehensive model were not linked or ranked, so as not to influence the interviewee's response in any way.

Figure 1. Mental Model 2: Comprehensive model. Example of inshore fishers.

After being shown the Comprehensive model, interviewees were asked if they wished to revise the model they constructed at the Mental Model 1: Blank model stage. The interviewees were asked why they chose to add (or to omit) risks that had been included in the Comprehensive model. See Figure 1 as an example of a model for inshore fishermen. Interviews in each country were targeted at fisheries sector stakeholders with a direct or partial interest in a particular type of fishery. These targets were the North Sea cod fishery in the UK, the cod fishery in Iceland, and the cod fishery in the Faroes. These target fisheries are important in each Case Study Country in terms of the size of the active fleet, their contribution to national landings, their historical importance, the political profile, and the fact that they are all believed to be overfished to some extent. They also share comparatively extensive administration systems.

Each fishery is mainly carried out by means of mobile net and trawl fishing, but handlines and longlines are also used in some cases. For these reasons, a degree of comparability is possible between results from interviews in each country.

In total, interviews were carried out with 29 inshore fishermen (5 in the Faroes; 5 in Iceland, 8 in the UK, 11) and 43 offshore fishermen (5 in the Faroes, 8 in Iceland, 17 in the UK). Relatively few fishermen were interviewed in some cases, therefore any generalisation of results should be treated with caution. The depth and qualitative nature of the interviews, however, yielded a rich data-set and the small samples should be viewed in the context of a much larger number of country-specific interviews which took place with a range of other fishing sector stakeholders and the results of which are reported in full in Authors (2008). In all countries, mixture combination of prior fishing sector knowledge, key contacts and established networks was used to pre-select interviewee selection (with the exception of interviews with consumers) and a snow-balling technique was employed to identify subsequent interview candidates. All fishermen interviewed were male.

Case study fishery management systems

The Faroese cod fishery is subject to a 'Fishing Days System' under which no global cod TAC is specifically set. The days at sea can be transferred or sold. Faroese fisheries within domestic waters have been regulated by a transferable effort-based system according to vessel size and gear type since 1996. Gear and fishing area restrictions also protect nursery and spawning stocks. Faroese fisheries scientists and ICES recommended that fisheries for cod and haddock should be closed in both 2008 and 2009, but this was opposed by industry. This highlights the current internal debate regarding fisheries management in the Faroes with polarised opinions between groups who support scientific-based regulation/administration of Faroese fisheries and those which fundamentally question the fisheries scientists and their research (Authors 2008) In Iceland, the catch limitation system is based on the catch share allocated to individual vessels (ITQ). Each vessel is allocated a certain share of the total allowable catch (TAC) of the relevant species. These ITQs are permanent, perfectly divisible and freely transferable. The catch limit of each vessel during the fishing year is thus determined on basis of the TAC of the relevant species and the vessel's share in the total catch.

The total allowable catch (TAC) is set by the Minister of Fisheries and Agriculture and this decision should be based on scientific advice from the Icelandic Marine Research Institute. The Icelandic fisheries management includes many other management measures than ITQ, such as area restrictions, fishing gear restrictions, and the use of closed zones to conserve important vulnerable habitats. This system was introduced in Iceland in 1984 and now extends to most commercial fisheries. Fishing rights for Icelandic fleet catches have been subject to a financial levy since 2004 and management costs are also recovered. Icelandic fisheries targeting cod are subject to the ITQ system. Icelandic fleet consolidation and employment reduction within recent years has reflected a rationalisation of ITQ ownership. However, in 2007 Icelandic scientists recommended a significant decrease in the TAC for cod and a 30% cut was imposed (Authors 2008).

In the UK, Total Allowable Catches (TAC) - imposed by the EU – are allocated to individual fishing operators in the form of Fixed Quota Allocations (FQAs). An inter-annual trade in the annual lease of excess holdings of FQAs has developed but permanent transfers are prohibited. Aggregate fleet size is capped in terms of tonnage and engine power and a variety of technical measures used. Tradable effort-based management measures (days at sea) were additionally introduced in 2003 under the CFP in the North Sea cod fishery in a further effort to aid the recovery of cod. Inshore fisheries (vessels under 10m in length) tend to fish for cod against a collective monthly quota pool (TAC) administered by government and are not subject to 'days at sea' restrictions or FQA allocations. The offshore North Sea cod fleet (vessels over 10m in length) is subject to a separate TAC and both the FQA and 'days-at-sea' restrictions. The environmental impact of fishing on stocks and habitats is being increasingly raised as a concern by UK lobby groups and despite significant fleet reduction in recent years, overcapacity still exists in the most overexploited fisheries. (Authors 2008).

Results

This section reviews the key risks identified by fishermen in Faroese, Iceland and UK case-study fisheries operating under the two fishing management systems. The section also analysis whether fishing management systems affects risk perception among fishermen. A wide variety of risk issues were identified by interviewees in the three countries. Common risks identified by the fishermen were overfishing, poor political management, cost of fishing and illegal fishing to name but few. Some variations were also noted among the fishermen, although most of them mentioned similar risks in each country.

In the Faroes, for instance, three out of five inshore fishermen mentioned poor political management and illegal by-catch, rating these as high risks. Similarly, five out of five offshore fishermen in the Faroes referred to cost of fishing as a high risk, while four out of five brought up illegal fisheries. A similar pattern was noted in the other countries. In order to increase the comparability of results, the identified risks were clustered into groups of related risks by the research group (see Table 1).

Table 1. The main characteristics of fishing management in Iceland, the UK and the Faroe Islands.

	Iceland	UK	Faroe Islands
Characteristics of management systems	TACs	TACs, TAE- Days at sea (North Sea)	TAE – Days at sea
Transferable quota	ITQ	Fixed quota Allocation	Partly
Area restriction	Yes	Yes	Yes
Vessel size restriction	No	Yes	Yes
Fishing gear restrictions	Yes	Yes	Yes

One of the most important groupings consisted of risks relating to the (1) 'impact of fishing on natural environment and resources. Another major risk grouping concerned (2) detailed 'policy, management and control' issues, (3) 'Economic and market-related factors', (4) 'Working environment and conditions', and (5) 'prevailing environmental conditions'. The remaining risk groupings focused upon different types of conflict as perceived by fishers: (6) 'conflict with non-fisheries sector stakeholders using (or with interest in) marine resources', (7) 'conflict within the fisheries sector' and (8) 'conflict between political priorities'.

These risk groupings represent an attempt to partition risks in respect of the fisheries sector according to whether they are driven by, or arise as a result of, catalysts from outside the fisheries sector, and are, therefore, generally outside its control – known to be a key factor influencing risk perceptions (Slovic and Weber 2002). For example, groups 2, 3, 4, 5, 6 and 8 could generally be argued to be beyond the control of fishermen. It is possible, however, that group 6 - conflict with non-fisheries sector stakeholders using (or with interest in) marine resources - could be to some extent appeased by the way in which the fishing sector responds to other users. The same could be assumed for group 7 - risks (conflicts within the sector). Group 1 represents the risk from the fishing activity itself on the natural environment and its resources. It is, therefore, arguably under the influence of both government/regulators (who design the management measures) and the fishermen themselves in terms of how they respond to these measures.

Figure 2 shows the proportion of total risks cited in each Case Study Country by fishermen in terms of the above-mentioned major academic categories. Perceived risks in relation to 'policy, management and control' issues are the most frequently cited amongst fishermen in all countries, ranging from 30-35% of all risks identified. 'Economic, market and trade' risks were the second most frequently cited risks in Iceland, The cost of fishing was generally most often cited as the major specific risk in this category, although issues to do with crew retention and obtaining appropriate crews were also brought up. Icelandic fishermen also notably mentioned the risk emanating from fluctuating and unfavourable exchange rates. Faroese fishermen cited the highest proportion of risks compared to other countries, in relation to the 'impact of fishing on the natural environment and resources'. The main risks identified here were overfishing, stock depletion and habitat damage or modification.

It is striking to note that neither overfishing nor stock reduction was identified as a risk, nor any other issues in this category, by any UK offshore fishermen. Icelandic and UK fishermen were more likely to identify risks in relation to 'prevailing environmental conditions' with Icelandic concerns centering upon climate change.

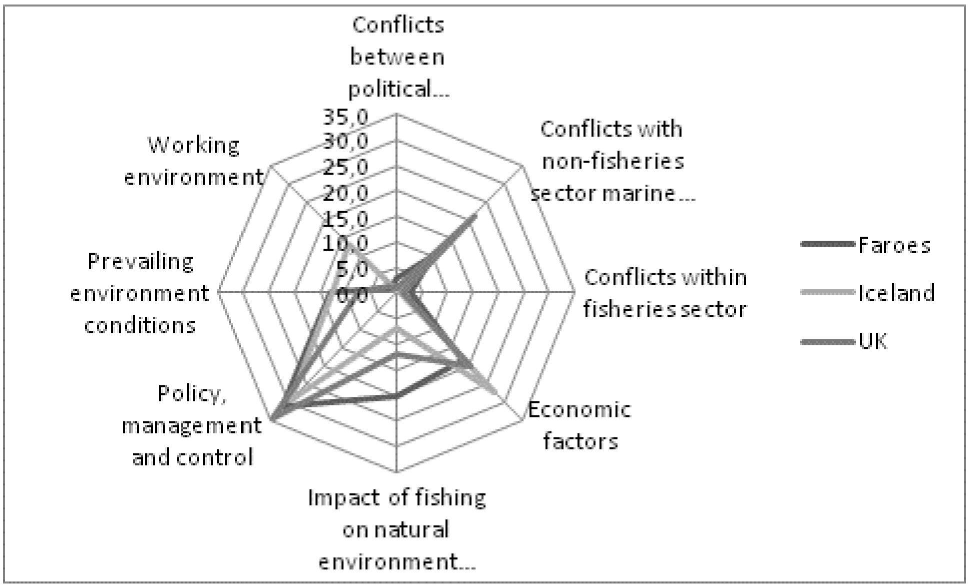

Figure 2. Proportion of total risks represented by major categories.

British fishermen were most concerned about 'conflicts with non-fisheries sector marine stakeholders', while the Icelandic ones were least concerned. Compared to the major risk groupings discussed above, personal risks, such as safety-at-sea, were generally much less frequently cited than those concerning policy, economic or environmental issues.

Figure 3 highlights results relating to the most important risk categories as generally identified by most fishermen. The three risk categories of policy, economic and fishing impacts account for 61%-82% of total risks cited by the fishermen in each country. These categories are also most relevant for the purposes of this analysis, namely, to consider the possible influence of the fisheries management system on risk perceptions in each country.

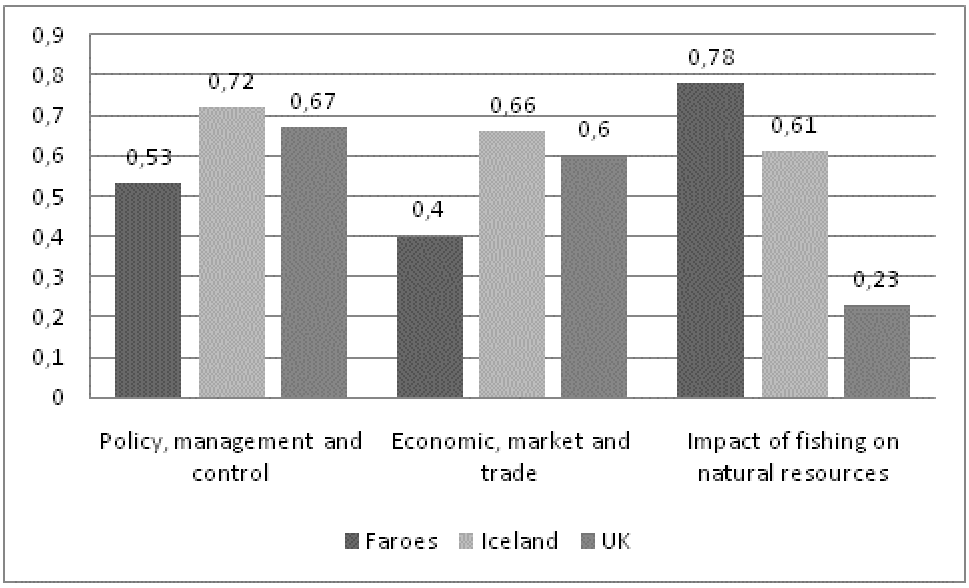

Figure 3. Mean scalar values assigned by fishers to main categories of risks.

Note: The figure only involves positive risk scalar values assigned. The scalar values range from 0.1-1.0.

The mean scalar value assigned by Faroese fishermen to 'policy, management and control' risks was lower than assigned by fishermen in Iceland and UK. That was also the case regarding economic, market and trade risks. However, the opposite was true regarding the impact of fishing on natural resources. Figure 4 shows a market difference between Faroese and British fishermen in that respect.

The difference between scalar values concerning 'policy, management and control', 'economic, market and trade' risks and those relating to 'impacts on natural resources' was tested according to the type of fisheries management system each group of fishermen was operating under. The management systems in each country were grouped into two major categories based on the type of management instruments in use in each country and the results of the aforementioned statistical comparison of means are as follows:

(1) 'ITQ' representing scalar values assigned by all Icelandic fishermen and UK offshore fishermen (UK2) who were operating under some form of individually allocated catch quota system with an element of incentivising tradability, and/or leasing as in the case of FQAs, which has been set within the context of a binding TAC. As inshore fishermen in UK operate under a different system they were omitted from the analysis.

(2) 'TAE' representing values assigned by Faroese fishermen operating under a system of fishing days.

Table 2. Risk clusters and examples of risks identified by fishers.

Risk clusters	Examples of risks
Impact of fishing on natural resources	Overfishing, stock reduction, habitat environment and damage and/or modification
Policy, management and control	Ineffective policy and legislation, lack of quota availability, effort restrictions, poor fisheries science, illegal fishing, discarding, etc.
Economic and market-related factors	Market prices, fishing cost, exchange rate fluctuations, interest rates, obtaining appropriate crew, etc.
Working environment and conditions	Personal risk, safety-at-sea
Prevailing environmental conditions	Climate change, pollution, bad weather, natural cycles
Conflict with non-fisheries sector stakeholders using marine resources	Environmental groups, aggregate dredging, recreational/sport fishers, potential reduced fishing areas
Conflict within the fisheries sector	E.g. between inshore and offshore fishers, communication problems between industry, management and politicians
Conflict between political priorities sustainability	Employment protection versus long-run resource

The results of Tables 2 and 3 indicate that 'policy, management and control' risks identified by fishermen operating under an ITQ system were assigned more importance, i.e. given higher risk scalars, at a statistically significant level with 95% confidence, than by fishers operating under a TAE system. 'Economic, market and trade' risks were more important for those operating under an ITQ as compared to a TAE system. However, in relation to the 'impact of fishing on natural resources' fishermen operating under a TAE system did not attach more importance to these risks than those working under an ITQ/FQA at a statistically significant level with 95% confidence (p=0.077).

Table 3. Mean scalar values for selected risks categories by fisheries management system groupings

	Iceland/UK ITQ/FQA	Faroese Islands TAE
Policy, management and control		
No of observations	90	22
Mean scalar value	0.76	0.54
Standard deviation	(0.243)	(0.222)
Economic, market and trade		
No of observations	77	13
Mean scalar value	0.68	0.42
Standard deviation	(0.240)	(0.250)
Impact of fishing on natural resources		
No of observations	10	14
Mean scalar value	0.58	0.77
Standard deviation	(0.326)	(0.177)

Table 4. Comparison of risk scalars for selected risk categories by ITQ and TAE fishing management systems.

	t	*df*	*p*
Policy, management and control	4.014	110	0.000
Economic, market and trade	3.485	88	0.001
Impact of fishing on natural resources	1.856	22	0.077

Note**:** Independent Samples *t*-test

Discussion and conclusions

This paper investigated whether fisheries management systems affect risk perceptions amongst fishermen in three European countries. The main research question addressed was whether two different fisheries management systems influence perceptions of risk amongst fishermen in different ways. The results of the analysis are generally in accordance with the hypothesis presented earlier in the paper. Namely that a management system centred on individually allocated and tradable catch quotas with a binding TAC may be more likely to influence fishermen's risk perceptions in terms of policy, management and control. However, Table 3 shows that fishermen operating under TAE are more concerned about resource health than fishermen operating under ITQ systems. The difference, however, is not statistically significant. Having said this, we would have expected a greater difference of risk perception in relation to the 'impact of fishing on natural resources' between the two contrasting fishing management systems.

We expected, and found, that those fishermen operating under ITQ systems assigned higher values to 'policy, management and control' risks than those operating under other systems. These systems are more binding in terms of fish catches and less open to the damaging effects of input substitution. The management system in the UK, imposed under the CFP, has been heavily criticised for many years. In Iceland there had been a 30% cut in cod TAC during 2007, when the interviews were conducted. These developments may well have further impacted upon perceptions of 'policy, management and control' risks, focusing concerns more towards the policies perceived to be causing the problems than the actual impact of the problem itself – i.e. overfishing. However, given the poor health of cod stocks as defined by ICES, it would also seem reasonable to expect a greater level of concern about risks relating to the 'impact of fishing on natural resources and the environment' in the case of Icelandic and UK fishermen operating under ITQ. The mean scalar value was comparatively low for inshore Icelandic fishermen, moderate for offshore Icelandic fishermen and zero for offshore UK fishermen. These results could also reflect the fact that risk perceptions tend to be strongest where risks are perceived to be involuntarily imposed or potentially unknown. For example, fishers often complain that management measures or science results are involuntarily imposed upon them; or they may be concerned about potential new management measures being introduced which they know nothing about.

By contrast, familiar risks tend to be of less concern. For example, the risk of endangering resource sustainability and health is something that fishermen have known about and 'lived with' for many years, especially in respect of North Sea cod.

The higher risk perception shown in relation to the Faroese TAE system with regard to the 'impact of fishing on natural resources and the environment' could be related to the trauma of the cod collapse in the Faroes in the early 1990s. Many Faroese still remember the consequences leading to economic crisis, bank collapse, and emigration from the islands. It could also reflect the greater relative importance of the fisheries sector on the Faroese economy, even compared to Iceland, which also has a strong tourism industry and, until recently, financial sector. By comparison, the Faroese fisheries sector accounts for 95% of national export value. The physical, societal and psychological connection of the tiny population to nature, and particularly the sea and its resources, is also very important. Whilst the problem of resource sustainability has been discussed in the Faroes for many years, the impact of a fishery collapse would be disastrous to the Faroese economy and way of life, i.e. the 'dread' risk factor is arguably higher for the Faroese than for any other case study country – even Iceland. An analysis of the nature of risks identified by fishermen in the Case Study Countries, shows that according to the risk clustering, risk perceptions are primarily driven by actors or influences out of control of the fishing sector. That is the case with economic and market factors, and to a large extent, policy, management and control; comprising ineffective fishing management, lack of scientific knowledge, inadequate law enforcement, insufficient quota availability, illegal fisheries, etc. The category of fishing impact on environment is, on the other hand, to some extent under the control of both regulators and fishermen. These findings are similar to those of previous social science research, i.e. that risks felt to be out of personal control, or of unknown character, are considered to pose a more serious threat than others (Slovic and Weber 2002).

The ever more complex fisheries management systems in most countries seem to impose more risks on fishermen relating to lack of control over the fishing grounds, lack of knowledge, chronic problems, etc. This relates to the analysis by Degnbol and McCay (2006) on the failure to understand linkages in the fishing management system and potential weaknesses in management strategies.Fishing is among the most dangerous occupations in the world. Nevertheless, our results indicate that fishermen do not consider the work environment to be particularly risky compared to other issues. This finding is similar to previous research which indicates that the social norms and cultural patterns of fishermen counteract safety culture (Roberts 1992; Törner and Eklöf 2000).The findings of the paper also confirm the basic tenet of social science that a risk event or hazard can mean different things to different people and that these perceptions are also context and culture dependent (see Taylor-Goodby and Zinn 2006). Our findings suggest that fishing management systems designed to minimize risk, such as overfishing and stock collapse, are by themselves perceived as risk by fishermen. This can impact their operation and functioning. Our findings also suggest that the access restrictions of different fishing management systems influence fishermen's risk perception, and even their behaviour. This relationship needs to be elaborated in future research in order to further improve sustainable fishing.

This is the first known published attempt to systematically compile and analyse data on risk perceptions in respect of fishermen operating under a range of different fisheries management systems. The paper also makes a contribution by analysing risk as seen by stakeholders in fishing, not the least in order to understand how scientific information and governmental regulation is perceived by fishermen. As such, it can make a contribution to the future development of risk analysis. Qualitative and semi-quantitative data was collated through a series of semi-structured interviews based around a mental modelling methodology. Results are analysed qualitatively and by using simple descriptive statistics and comparisons of means. In some countries, e.g. the Faroes, interview sample sizes were small. We suggest, however, that the in-depth, qualitative nature of these interviews is satisfactory, given the exploratory nature of this research. Larger sample sizes would be required in future research to validate findings and allow for more certainty in the generalisation of results. Further research would also benefit from open access to fishing, as in the Mediterranean Sea, being included in the analysis.

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