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FISHERS: THE FORGOTTEN SCIENTISTS

Abstract: Fisheries managers and scientists are currently attempting to improve the knowledge base for fisheries management through collation of multi-institutional and multi-disciplinary research. Whilst these attempts at knowledge management are necessary for good practice in fisheries science, they could be in vain. Building on previous research in North America, Europe and the Indo-Pacific, research in Ireland shows that fishers feel omitted from knowledge management exercises connected to fisheries management and resultantly are sceptical of scientific knowledge communicated to them by fisheries managers. This reduces fishers' will to take fisheries management policies based on science seriously and can compromise their compliance with fisheries regulations and their cooperation with fisheries managers. Novel interview techniques conducted on fishers based in Galway Bay show that fishers do indeed have unique knowledge that should be part of the knowledge base for fisheries management. Far from being simply ecological, fishers' knowledge gives detailed insights into the strategies of fishers. Analysis of these strategies by fisheries managers could greatly inform fisheries management policy. Inclusion of fishers' knowledge would help to legitimise fisheries management and science amongst fishers. This legitimisation would increase the chance of fisheries management policy being successful. However, despite recognition by some scientists that fishers' knowledge could be used alongside traditional scientific knowledge to provide a basis for better fisheries management policies, it is rarely used by fisheries managers. The lack of inclusion to date of stakeholders' knowledge in the European Union's common fisheries policy has left European fishers as forgotten scientists.

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1 Introduction

Fisheries science has a lengthening history when it comes to collecting information from fishers in an attempt to understand the state of global fisheries. The volume of data collected to make ecological assessments of fishery characteristics, such as stocks, ecosystem health and dynamics of individual populations, is ever increasing. This "fishers' information" is openly published in national and international reports, as well as in academic journals and a variety of other sources [e.g. European Environment Agency, 2007; Marine Institute, 2009a; O'Neill, et al., 2010]. There is strong evidence to suggest that fisheries scientists are indeed achieving the brief being discussed in this themed conference session[1] (Theme Session R, ICES Annual Science Conference, September 2010, Nantes, France) by "*delivering more science with fewer resources* [...] *through joint programming, communication and knowledge management*." Fisheries scientists and management institutions are collaborating and introducing new techniques from across a number of disciplines. These allow for accrued fishers' information to be broader in scope, more detailed in content and more rapid in its delivery.

One particular example of this is where fisheries scientists have linked up with experts in technological fields to produce real-time data on fish landings. As part of reform in 2002 to the European Union Common Fisheries Policy (CFP) the Community Fisheries Control Centre was set up. As part of one of its work packages it has obligated fisheries management bodies from all the European Union's member states to coordinate an approach that improves monitoring of the region's fishing fleet [Johnson, 2008]. Fleets are now tracked by satellite via a vessel monitoring system (VMS) that can feed back their location in real-time and ultimately produce plots of fishing activity at any scale [e.g. Marine Institute, 2009b, p. 41]. It is the intention, and indeed this is already occurring, that catch data from new electronic log-books are integrated with the VMS data [Johnson, 2008]. It is an excellent example of where fisheries scientists and managers have made a "*best use of* [...] *investment in science through joint programming, communication and knowledge management*." It is not an isolated example. Programmes to track fish movements by collecting electronic tags landed in fishers' commercial catches [Block, et al., 2005] and to monitor discards from fishery vessels with video cameras [McElderry, et al., 2008] are amongst other new methods to collate fishers'. Many of these efforts are collaborative, and although they can potentially be expensive to initially implement, there is likely a pay-off as they produce scientific knowledge that is more reliable, easier to communicate and thus simpler to manage than the historic methods of recording such data by hand. One hope seems to be that programmes such as these, which are seen to cooperate with fishers and are enriched by their

[1] Session theme - Delivering more science with fewer resources: How do we make best use of our investment in science through joint programming, communication and knowledge management?

information, will allow for real-time fisheries management using apparatus like instant quota adjustment [Johnson and Densen, 2007].

It would seem reasonable then to ask why, despite what appears to be an apparent success in the exercise of knowledge management, are fisheries deemed to be in a worsening crisis where often management is criticised [e.g. Daw and Gray, 2005; European Environment Agency, 2007]? As it is supposedly fishers' information that is being used to manage these fisheries, the best answer to this question is potentially sought in their own critique of fisheries science and management.

One reason would certainly be a loss in confidence in scientists' ecological findings and fishery recommendations, specifically stock assessment based on fishery landings. Inshore fishers in Newfoundland blamed fisheries scientists for not preventing the collapse of the Northern Cod in the early 1990s [Neis, 1992; Daw and Gray, 2005]. They believed that they had ecological knowledge that showed that the scientific knowledge on which management was based was incorrect and that their knowledge, which they believed showed the northern cod population to be collapsing, was being ignored by the fisheries scientists and managers. There is evidence now that this was the case [Neis, 1992; Hutchings, et al., 1997]. Fishers are also critical that fisheries science is limited in scope and that scientists only focus on information collected during the operations of fishing and landing fish, where additionally they should also be listening to fishers' views on other ecological aspects and events. In the UK fishers were critical of scientific work done as it did not consider the changes they had seen in climate and populations of other species on fishing mortality [Daw and Gray, 2005].

Secondly, fishers sometimes believe that the ecological information produced is a false representation of their knowledge of the fishery. Where log-book data is used to measure catch per unit effort (CPUE) fishers can be sceptical, as they believe what they catch is controlled not by state of the fishery, but by the fishery's regulations [Johnson and Densen, 2007].

Third, fishers' question the continued focus on the ecological when they believe other facets of their knowledge to be just as crucial for informing fisheries management. This is exampled in the Baltic Cod fishery where log-book data was used to help create marine protected areas. Creation of these protected areas actually resulted in increased discarding of juvenile cod in areas that fishing effort was displaced to. The fishers believe that an understanding of their attitude towards management regulations would have lead to a more effective management plan being created, but they weren't surveyed for these [Suuronen, et al., 2010].

The final critique from fishers' is that fisheries science and management is actually not always "*science through joint programming, communication and knowledge management*", because they themselves are excluded from the processes of programming and communication with the result that their knowledge is also excluded. Many fishers' believe that science and management is carried out in isolation from them [Daw and Gray, 2005] and that data is often taken from them covertly, rather than with their consent [Johnson, 2008]. There is a feeling amongst fishers that this fishers' information is simply a product of the operations of scientists rather than a possession of their own [Johnson and Densen, 2007].

The unfortunate fallout from these criticisms has been a widening gap between fisheries scientists and managers and the fishing industry. A combination of the lack of confidence in fisheries science and management and the fact that contributing their operational information can directly lead to legislation being created that curtails their operations has lead to worse knowledge management [Johnson and Densen, 2007]. Fishers now regularly withhold catch data [Johnson and Densen, 2007], drop out of monitoring programmes [Dobby, et al., 2008] and even land fish illegally to make sure catch levels appear lower [Daw and Gray, 2005].

This view of fishers that they have more to offer than simply information is gaining increased support amongst a group of academics researching the discipline of fisheries science and management. It is prudent perhaps to consider a difference between quantitative data such as landings and CPUE, a “fisher’s information”, and something more opaque, a “fishers’ knowledge.” Just as scientific knowledge is a knowledge created by fisheries scientists simply undertaking their work, so is fishers’ knowledge. Fishers spend almost their whole career at sea, more time than any scientist, and therefore they accumulate a rich ecological knowledge of the environment they work in, in addition to knowledge of all the other aspects of working in a fishery [Neis, 1992; Pálsson, 1995; Johannes, et al., 2000]. Their knowledge is a socio-ecological construct that can be quantitative, but more often is qualitative and hard to define [Murray, et al., 2008]. With this in mind, and also with reference to literature in comparable fields of research [Hamlyn, 1970; Habermas, 1972; Luen and Al-Hawamdeh, 2001], a concept of what fishers’ knowledge could be can be hypothesised. Figure 1.1 shows this hypothesised concept and theorises a notion of fishers’ strategies. These strategies may be fuelled by quantitative ecological and socio-economic information, but equally they may be influenced by harder to define qualitative knowledge.

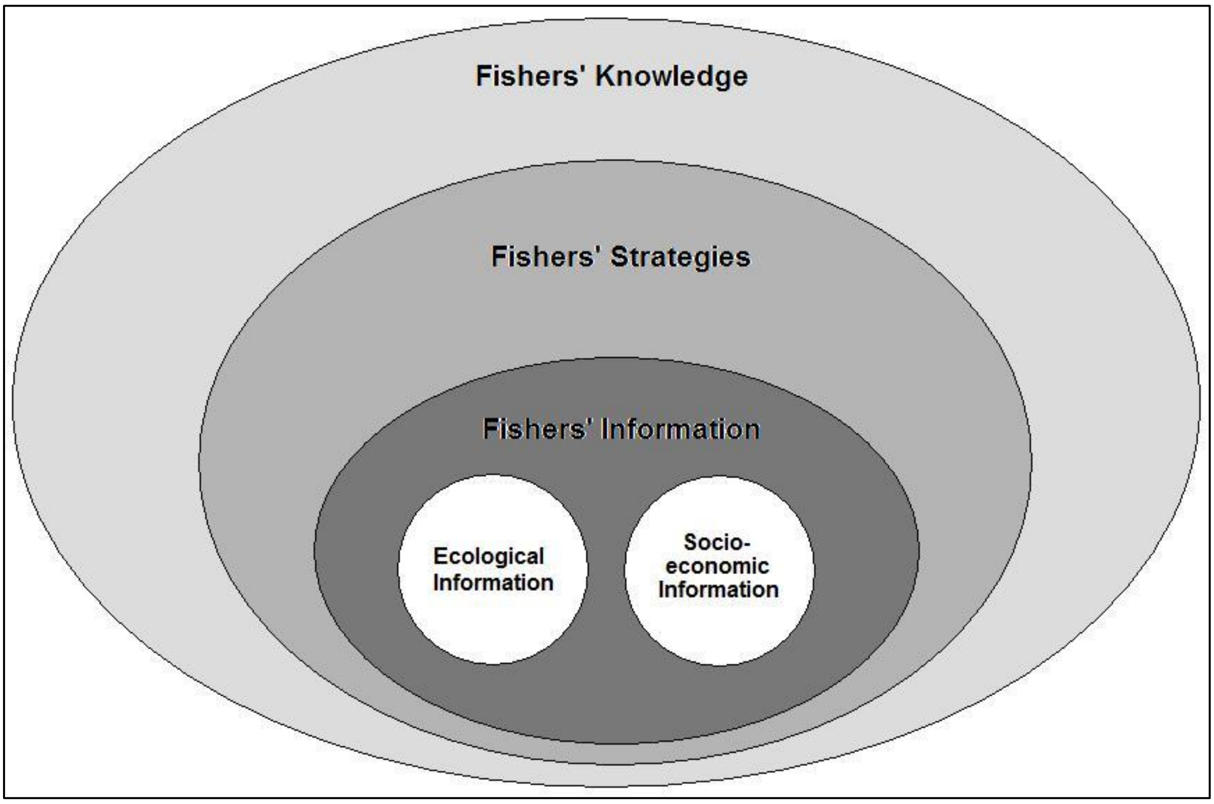

Figure 1.1. Diagram of the hypothesised content of fishers’ knowledge.

Assertions are being made that this more opaque “fishers’ knowledge” is essential for fisheries management. Alongside scientific knowledge it could provide a knowledge base that is even easier to manage, as it would be based on a more complete programme of research with better integrated communication networks [Johannes, et al., 2000; Murray, et al., 2008]. Whether this is true or not, it is certainly clear that this assertion should be investigated. To try and accelerate the achievement of a “perfect” system of knowledge management for fisheries, which may be based on a partially or totally flawed system of programming and communication, could be disastrous for future fishing policy and resultantly the fisheries it legislates.

The Irish Fishers’ Knowledge Project (IFKP) has a goal of ascertaining the nature of “fishers’ knowledge” and evaluating its potential uses within fisheries science and management. The remainder of this working paper will describe the methodologies used to attempt this and provide some preliminary results with particular focus on the theory that fishers; knowledge may include strategies. These results will then be discussed and summarised.

2 Case study

The field site of the IFKP exampled in this paper is the fishery of the Galway Bay and Aran Islands. The fishery is situated off the west coast of Ireland and the major fishing grounds are labelled on figures 2.1 (Inner Galway Bay, the Northwest Corner, the North Sound, the Back of the Island and the Slate) and 2.2 (the Porcupine Bank). Most fishing activity occurs in ICES boxes VIIb, VIIc, VIIj and VIIk [Marine Institute, 2009a]. The main fishing port for the region is Rossaveal.

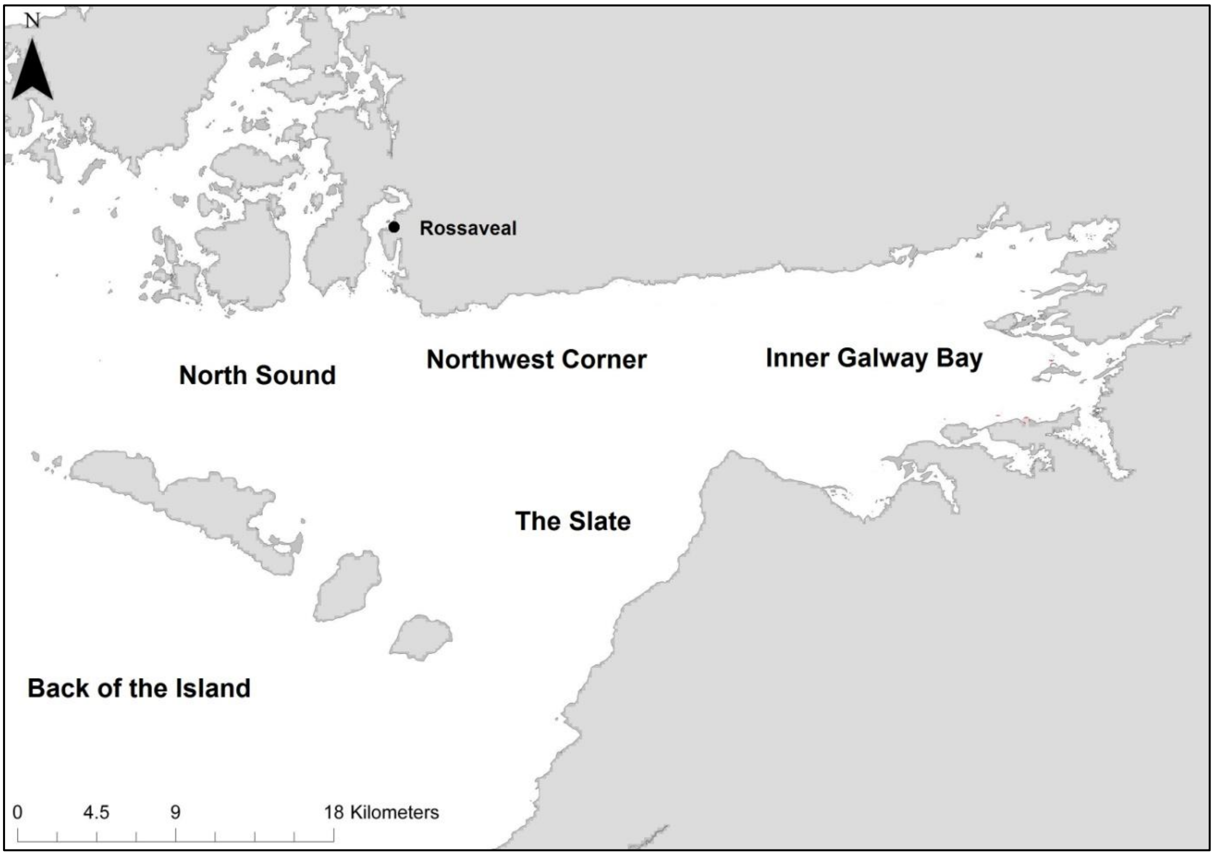

Figure 2.1. Map of commercial fishing grounds and ports of Galway Bay and the Aran Islands.

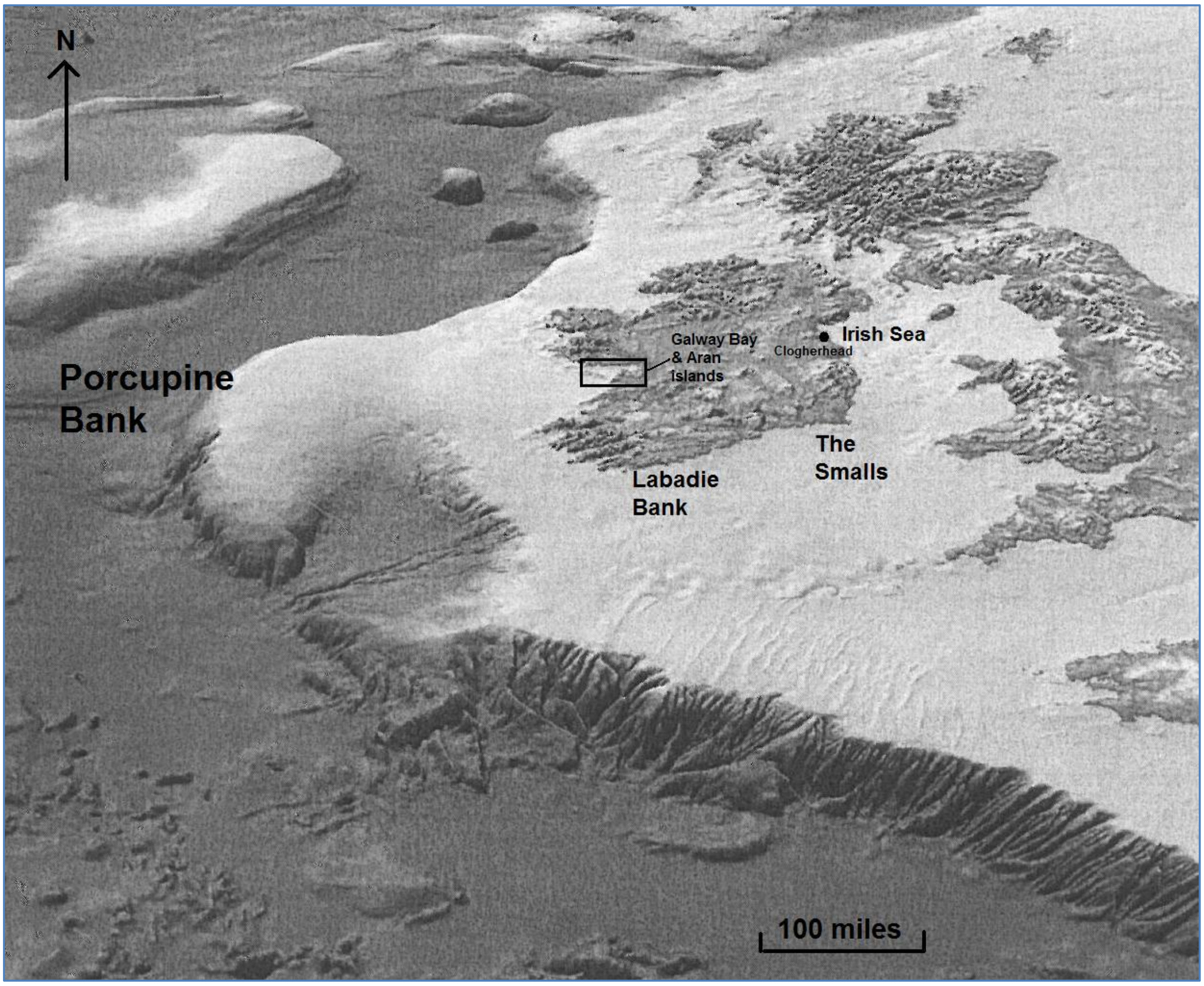

Figure 2.2. Map or offshore fishing grounds and further ports relevant to the Galway Bay and Aran Islands fishery.

The local fleet can roughly be split into three different groups. The first is a group of approximately ten to fifteen large offshore trawlers of over about twenty to thirty metres that would primarily operate demersal otter trawls [DAFF[2], 2008]. These boats would primarily operate on offshore fishing grounds off the west coast of Ireland, including the Porcupine Bank. They would also travel to other offshore grounds around Ireland such as the Smalls, the Labadie Bank and the Irish Sea. One or two of the boats would fish in foreign or international waters. These boats would also fish the Back of the Island ground to varying degrees. A smaller number of these boats would also have the licences and gear required for pelagic fishing or long-lining. A second group of approximately ten to fifteen medium sized trawlers from ten to twenty metres would primarily operate demersal otter trawls on the Back of the Island Ground [DAFF, 2008]. To a lesser extent they would also fish the nearshore grounds, named in figure 2.1, inside of the Aran Islands. Some of these boats would also have the licences and fishing gear required to fish for pelagic species. One or two of these boats would operate a scallop dredge. Of these two groups that primarily operate otter trawls, between 50% and 60% would use a twin-rig setup with two nets as opposed to the single-rig, single-net setup used by the

[2] DAFF – Department of Agriculture, Fisheries and Food

remainder. Both of these groups must land into designated ports, and as Rossaveal is the only such port in the region, the majority of their catch is landed there. A much larger fleet of up to 300 small boats less than ten metres is registered in the Galway Bay and Aran Islands regions [DAFF, 2008]. However, their overall effort would equate to much less than the other boats. These boats are mostly part-time in their activities and operate only within a few miles of shore, rarely travelling far from their mooring. As they are not compelled to land their catch in Rossaveal these boats are found across the region, but mostly on the north shore of Galway Bay and on the Aran Islands. The primary gear used would be lobster, crab and shrimp pots and secondary gear would include dredges, small otter trawls, trammel nets and gill or tangle nets. A small handful of these fishers would deploy specialised pots for catching nephrops.

Also in existence in the area is a considerable visiting fleet. Approximately ten trawlers of fifteen to thirty metres from the Irish east coast port of Clogherhead regularly fish on the Porcupine Bank and Back of the Island grounds. Spanish, French, Dutch and Scottish boats also fish on the Porcupine Bank.

In 2007 landings by the fleet into Rossaveal consisted of 1385 tonnes of small pelagic, 1382 tonnes of shellfish, 806 tonnes of demersal fish, 127 tonnes of elasmobranchs and 32 tonnes of large pelagic and tuna [Marine Institute, 2009b]. Despite the heavier weight by mass of small pelagic, by far the most important species to the large and medium size trawlers currently is the nephrop (*Nephrops norvegicus*) whose landings are included in shellfish landings. This is the key area of focus in the region for Irish Marine scientists who put most of the scientific effort in the region into monitoring these stocks [Marine Institute, 2009a]. For the small inshore boats, lobster, shrimp and crab compromise the bulk of their current catch.

3 Methods

Crucial in designing methods for the IFKP was to make sure that any type of knowledge or information in figure 1.1 had the potential to be captured. Previous studies, especially in Europe, have involved fishers contributing quantitative inputs such as log-book entries [e.g. Dobby, et al., 2008]. Although these methods can be very effective in capturing fishers' information, they do not capture the more qualitative and opaque aspects of fishers' knowledge. A methodology was devised where fishers' would have the opportunity to contribute both their information and their knowledge. This was greatly influenced by a number of pioneer projects that have focussed on fishers' knowledge rather than information, particularly those conducted by a progressive group of researchers in Canada [Neis, 1992; Neis, et al., 1999; Murray, et al., 2008], by those researching artisanal Indo-Pacific and First Nations fisheries [Johannes, et al., 2000] and by those working on Finding Sanctuary's Fishermap project [Edwards, et al., 2009].

The study was entirely based on individual interviews with fishers, varying in length from one to three hours. The goal of each interview was to allow each fisher to have the opportunity to display their fishery knowledge, of whatever nature, in as full a manner as possible. A semi-structured interview approach was adopted as this is perceived to be one of the best ways to capture qualitative data [Weiss, 1994], but would also give the chance for the interviewer to elicit quantitative data when it seemed possible. For this purpose a number of guide sheets were used, but no specific questions were asked from interview to interview. Fishers were allowed to speak freely and for as long as they chose on any given topic. Interviewers only interrupted to change topic when they perceived that the knowledge being imparted had no relevance to the fishery which was a rare occurrence. A particular effort was made to focus on the individual. Whilst secondary knowledge was recorded, one of the perceived strengths of fishers' knowledge is that it is rich due to personal experience, often over a long career [Murray, et al., 2006], and so questions asked delved into discovering the socio-ecological world it was hoped that each had constructed.

Each interview was loosely carried out in three phases as per the work of Murray, et al. [2006]. However, it should be noted that these were fluid from interview to interview. The majority of control in each interview was given to the fisher and so if they wanted to talk about something outside of that phase they were permitted to. An effort would be made at a later stage to come back to the phase from which the interview had been diverted. Interviews started with a discussion about each fisher's history with regards to the equipment they used (e.g. boat type) and the geographical location of their operations. It was feared that without this approach fishers may focus on conveying their dissatisfaction at fishing policy. Many Irish fishers are unhappy with European Union and Irish fishing policies and much of their experience with fisheries research and management is now of confrontation regarding these issues, Starting interviews with a fisher's history took this confrontation out of focus for much of the interview and allowed for actual knowledge to be expressed. This atmosphere was also achieved through interviewers outlining their position of neutrality at the start of each interview. Fishers therefore understood that they were not talking to scientists who had direct access to changing management policy for the fishery. Each fisher was told that how any knowledge they imparted may be used. The aim of this was to build trust and make the fisher feel at ease with the interview process. Fishers were also guaranteed anonymity so they could feel comfortable of saying what they wanted without personal repercussions. It was also hoped that this anonymity would allow fishers to impart knowledge that ordinarily they may not. To further allow the fishers' to be those who were largely responsible for controlling the interview, they were allowed to choose the location of the interview.

The second stage of the interview focussed on ecological aspects of the fishery. Attempts were made to historically record each species that a fisher had landed and any ecosystem that they had operated in. Particular attention was afforded to events where the fisher perceived the ecology to have changed over the course of time. During this stage of the interview maps (nautical charts of the fishery areas) were put in front of each fisher. They were able to mark anything they chose on each map. Previous fishers' knowledge studies have shown that this can not only help to focus the fishers' mind on a fishery in question, but can also produce much clearer outputs than those that are delivered simply verbally [Murray, et al., 2008; Edwards, et al., 2009]. Visual aids (pictures of local marine flora and fauna) were also given to the fisher so that a species was not omitted from the interview simply because it had not been mentioned by the interviewers.

The final stage of the interview focussed more on policy and management. Questions were asked about fishery regulations, management bodies, scientific knowledge, fish markets, fishing infrastructure, competing fishers and the future of the fishery. Questions such as these do not appear extensively it appears in other fishers' knowledge studies, but it was believed that answers to them could help to build an understanding of fishers' strategies.

An initial pilot study was conducted to assess the viability of the project and since then the total number of fishers interviewed to date, at what is still an interim stage in the IFKP, is thirty-two. Rather than use a random sample it was seen as important to select respondents. Previous work has shown that it is important to interview fishers with the most knowledge [Johannes, et al., 2000; Murray, et al., 2006] and therefore the study has targeted the most experienced or eldest fishers and those identified by their peers as particularly knowledgeable. An initial sample was obtained through consulting a local organisation that worked closely with fishers and then the technique of snowballing was used to identify further respondents [Murray, et al., 2006]. At the end of each interview the respondent was asked to identify any fishers who they thought would be good to interview and interested in answering questions. Care was also taken in making sure the sample was representative of the fishery. The problem with peer recommendations can be that interviewees simply recommend their close friends. Where it was perceived that one sector of the fleet was not represented, an effort was made to seek respondents from that fleet. It was also perceived that fishers and managers were only recommending active fishers. Because retired fishers are often the most experienced [Johannes, et al., 2000] these were also traced. Most of the interviewees have spent the majority of their careers fishing in the Galway and Aran Islands fishery. Most also operate from the port of Rossaveal or from moorings on the Galway Bay or Aran Islands coastline. The current breakdown of respondents is twelve from large offshore trawlers (of whom one is from Clogherhead), thirteen from medium size trawlers and seven from small inshore fishing boats. Seven of the respondents have retired.

All the interviews have been transcribed and then analysed to ascertain what quantitative and qualitative fishers' information or fishers' knowledge they contain. The maps created by the fishers have received similar analysis. Some of the transcribed interviews have undergone a process of content analysis using the software package *QSR NVivo 8*. They have been coded using four nodes (fishers' ecological knowledge, fishers' socio-economic knowledge, fishers' management and policy knowledge, fishers' operational knowledge). These nodes or broad themes were selected as they covered a majority of fishers' knowledge whilst at the same time minimising overlap. There was some overlap due to the fact that knowledge gained from fishing operations clearly was the source of much other knowledge. Where overlap occurred sections of the interview were coded with two nodes. Ecological knowledge includes any knowledge fishers had of the natural environment, such as fish stocks, ecosystem characteristics and benthic conditions. Socio-economic knowledge consists of fishers' knowledge of fish markets, financial operations relevant to the fishery and social conditions of those operating in or depending on the fishery. Management and policy knowledge contains anything fishers know about national and international legislation influencing fisheries, the fisheries science process and existing or potential management options and organisations. Operational knowledge is perhaps the most diverse and hard to define category and is made up of knowledge of fishing gear and boats, fishing grounds, fishing techniques and landward activities such as actually landing fish.

4 Results

It is impossible to analyse and present the results of the IFKP completely in a short working paper, but it is possible to show examples of fishers' knowledge by focussing on a few areas. In this section parts of the general content of fishers' knowledge are examined in addition to elements of their ecological knowledge and some of their strategies.

General Content of Fishers' Knowledge

Figure 4.1 starts to break down the content of each fisher's knowledge. Although it is only an example of three of the thirty-two fishers interviewed so far in this case study it clearly shows that there are variations in the content of fishers' knowledge. Despite each interview following the same method it is evident that each interview covered different themes to varying extents. Because the interview was guided by the fisher and the interviewer towards each fisher's area of expertise, it shows that the nature of expertise is far from uniform. Fisher A for example seems to have a broad base of all four knowledge types. Fisher B shows a similar degree of expertise when it comes to knowledge of ecology, policy and management and operations, but has less knowledge of socio-economic conditions. Fisher C in contrast has strong ecological and operational knowledge, but seemingly poor knowledge of socio-economics and policy and management. Analysis of the transcript for fisher C does not reveal why their socio-economic knowledge is of a lesser degree to fisher A and B, but it does show that they retired from fishing over ten years ago. Fishers A and B are both still active. It is possible that fisher C has less policy and management knowledge because they have not fished in recent times when much of the legislation that governs modern fisheries was created. These three fishers have not been picked deliberately to show difference. It is anticipated that as analysis of the collected transcripts continues, that difference will continue to be shown from individual to individual.

Figure 4.1. Chart showing content of fishers' knowledge for 3 different fishers (fishers A, B and C) for four broad themes/types of knowledge (ecological knowledge, socio-economic knowledge, policy and management knowledge and operational knowledge).

Although the interviews are primarily qualitative, they did elicit a fair degree of quantitative data, or fishers' information. In general fishers were very skilled at recalling operational information and usually responded instantly and authoritatively to questions about their fishing equipment. Confidence can be taken in the historical figures they provide for dimensions of their boats (e.g. boat length, tonnage assigned to the boat, engine power) and gears (e.g. mesh size, size of net in fathoms). They could also describe fishing grounds accurately, whether it be the depth in fathoms or the geographical location. A nuance that should be noted is that whilst younger fishers described location through coordinates obtained from modern GPS systems, most of the older fishers still used references from the now discontinued Decca navigation system.

Whereas fishers references to quantitative data about fishing operations were in measurements common to fisheries science (Decca references excluded), their quantitative information pertaining to the natural environment was generally in language exclusive to the fishing industry. Whilst they did on occasion refer to quota limits and some landings in the unit of tonnes, they more often used less acute measurements. These include 'number of boxes landed' for measuring total catch and volume of fishery discards and they measured fish size by the 'length of a box'[3] or the 'number that could be accommodated in a box'. Figures given during the

[3] A box is one of the boxes provided by the local Galway and Aran fishing Cooperative to use for landing fish.

interviews were often not precise and were sometimes rough estimates. For instance, when asked what a good catch were likely to be, they gave a range. This can be seen in the following example:

"*You could end up with 50 or 60 boxes in a day*." [Anonymous fisher, 2010]

When talking about the size of the main fishery species of nephrops, fishers did not talk about 'mean carapace length in millimetres' as scientists would [Marine Institute, 2009a] but instead of the 'number of nephrops to the kilogram' (i.e. a class 1 nephrop would weigh 1 kilogram). For units of effort fishers did not talk about 'hours spent trawling' (the unit that contributes to CPUE), but of the number of tows completed in a day.

Far superior to the volume of quantitative information reported by fishers was the amount of qualitative knowledge. It was often anecdotal, lengthy in its delivery and hard to summarise. However, it was also rich in detail and wider ranging in variety than both fishers' information and scientific information. The following two examples are cited in an attempt to give a representation of its common constituent nature. In the first example a fisher talks about how he uses his old barograph sounder to identify hard (rock) and soft (sand or mud) ground whilst trawling:

> "*The barograph had its own odd way of showing you the hard and the soft. If you are going along, flat ground right, now before you come up to a rock, across the road or further away from a rock, it will actually give you, a mark on the piece of paper. That's you going along and you'll have a little trigger like that, you know the sandy bottom? Now there's a rock here going up here. Now you know the shape here of where the rock is going out beneath the sand, the sounder would put a tail down and you get lines coming down and they were getting longer and longer as we were getting nearer the rock. The ordinary one now will not show you that. They will show you everything up here, all the fish, all the weeds and everything up the top, but they won't show you the hard, when you're coming on hard ground*." [Anonymous fisher, 2010]

This fisher would rather have used his old barograph sounder than a modern electronic one as he believed that the output is more accurate and with higher detail. He used it to avoid getting caught on fasts whilst trawling and to find new lobster grounds[4] that he believed the modern sounders could not find.

The second example is a brief extract of a fisher talking about the migration of haddock and whiting into Galway Bay:

> "*They come in about now* [4th March 2009] *and I'd say around Paddy's Day you'd see them coming back out again. And then they just go woosh. They seem to come. Not much. But they come. Mating, or something*

[4] Lobsters generally live on rocky ground.

> *similar. I'm not sure what it is, but they come and they go again*." [Anonymous fisher, 2009].

This fisher is one of many who knew that the whitefish leave Galway Bay on the saint's day of Ireland's patron saint, St. Patrick ("Paddy"), on the 17th March every year. They used this information to plan their fishing schedules. Most fishers would fish whitefish for two weeks up to this day and then return to nephrop fishing immediately afterwards.

Fishers' Ecological Knowledge

To illustrate the makeup and quality of fishers' ecological knowledge focus can be trained on their measurements of fish stocks. As has already been described when analysing fishers' information, their estimates of fish landings are not specific and are hard to quantify. This is not the sole limitation of their landings data. When comparing fishers' landing estimates great variety can also be seen between fishers. When asked to report the landings for a good tow whilst trawling for nephrops on the Back of the Island ground, across the sample an average of forty-five boxes could be calculated, but the range was from eight boxes to seventy-five. This is true of a number of other landed species as well, such as monkfish with a range of one to five boxes and whiting with a range of forty to eighty. This range may have been due to inaccuracy of reporting, though was just as likely to be explained by different fishers having different fishing capabilities (e.g. fishing gear setup, boat size and power).

An area where fishers can provide knowledge that is not covered by scientific knowledge is in long term qualitative trends of stocks of varying species. For instance, recording of landings in the West of Ireland for cod only started in 1988 and for haddock in 1984 [Marine Institute, 2009a]. Two fishers surveyed had been fishing since the 1950s and many more had been fishing since the 1960s and 70s. Only three fishers surveyed had started after 1990. Additionally, fisheries scientists only consider commercially landed species when collecting fishers' information. Fishers in this study displayed knowledge of other species they had caught (but not landed) and simply observed in the field. Examples of these included echinoderms, jellyfish and the poor cod (*Trisopterus minutus*). Regarding the main target species of nephrops, 58% of fishers believed nephrop stocks to be static during their time fishing, 25% thought stocks had decreased and 17% believed they had increased. The other trends that were commonly expressed by fishers were large increases in numbers of dogfish, starfish, seals and shrimp, as well as decreases in Atlantic cod (*Gadus morhua*), halibut, skate, brown crab, lobster, whiting, hake, black pollock, white pollock, spurdogs and all flatfish populations.

When a local near or total extinction of a species had occurred there was a strong consensus amongst to fishers as to when this had occurred. The most reported case by fishers was the disappearance of Atlantic cod in the area. By linking these ecological events to their operational knowledge they were able to give precise years for when they last made or heard of a commercial catch of cod. The years 1989 and 1990 were given as the year this occurred by seven fishers, which would appear a strong enough result for it not to be a coincidence. This may be a collapse that is foreign to scientific knowledge due to the fact that cod stocks only started to be surveyed in 1988 in this region [Marine Institute, 2009a].

The map work conducted with fishers perhaps showed fishers most valuable knowledge for consideration. Almost all of the fishers could identify current or former spawning grounds and nurseries for juvenile fish. Unfortunately, at this stage it is impossible to include these maps in this working paper. An agreement was made with the fishers interviewed that no detailed maps would be released in an open forum without their prior approval in order to not release crucial commercial information to their competitors. This was a decision based upon previous research where this information has proved valuable [Maurstad, 2002]. However, the nature of some of these areas can be described. Former spawning grounds for cod were identified in the grounds located at the North Sound, Northwest Corner, Back of the Island and in close proximity to the Slate. A major herring spawning ground was identified on the Northwest Corner ground. A nursery for juvenile fish whitefish was also identified on the Back of the Island Ground, and one for juvenile flatfish in a region near the Slate. It is hoped that, when published, maps of these features will reveal new spawning grounds and nurseries novel to scientific knowledge. A final feature revealed by two fishers, but potentially crucial to the future of fish stocks, is the presence of a maerl bed. Fishers knew of its presence as they were bringing up the coralline algae in their otter trawl nets. The location they identified was noted by a previous study [Maggs, 1983], but does not show up in a review of more modern literature on maerl beds. This is potentially important as maerl is a rare and often protected habitat due to its structural complexity which makes it good ground for protecting juvenile fish and spawn [Maggs, 1983]. This potential maerl bed does coincide with one of the former cod spawning grounds identified by fishers.

Fishers' Strategies

By looking at just a few operational choices made by fishers it quickly becomes apparent that these are based on the deep knowledge they have of not just the fishery's ecology, but also of the socio-economic conditions and fisheries legislation and management.

One such operational choice is that of which fishing gear to deploy whilst trawling, and specifically whether to operate two nets in a twin-rig setup or just the single net with a single-rig setup. The first boat to start twin-rigging in our sample of the Galway and Aran trawl fleet was in 1988. Fishing on the Porcupine Bank ground the boats' skipper found that catches of nephrops immediately increased dramatically with the new gear. Another fisher converted to twin-rigging a few years later as he concurred that it was better for nephrop fishing and had the additional benefit of being a more efficient way to catch flat fish. What the fishery then experienced was what has been termed a “colleague effect” [Neis, et al., 1999]. Many of the fishers we talked to had upgraded simply because their colleagues had. Two fishers had actually bought a larger boat just to twin-rig, as their previous boat was too small to pull the larger gear. As figure 4.2. (constructed from fishers’ operational information) shows, a number of boats upgraded to the twin-rig in a short period of time from 1988 to 1995 and horsepower increased to pull these larger gears. This phenomenon would have lead to a much higher fishing effort overall in the fishery. 67% of the fishers in the interviewed whom were still active on large or medium trawlers were using a twin-rig.

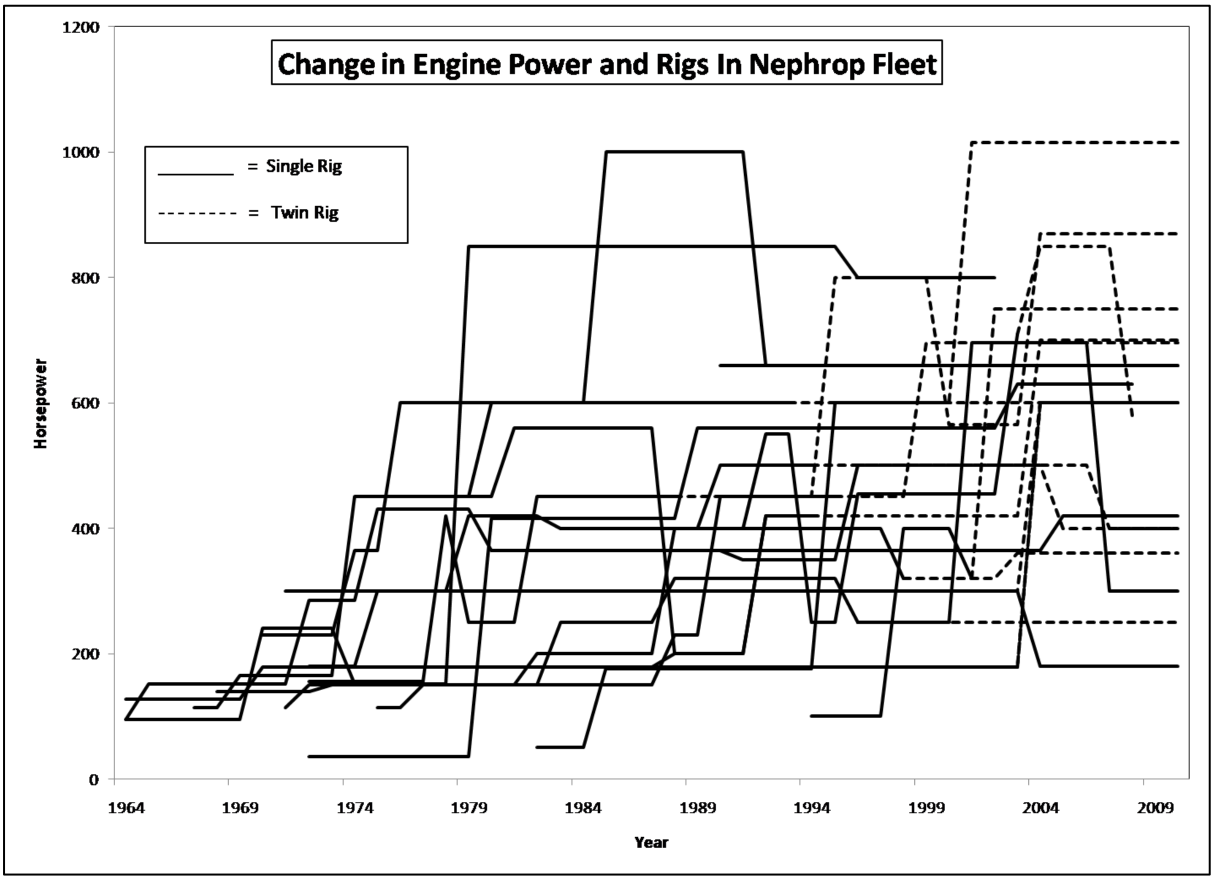

Figure 4.2. Graph showing change in horsepower and the number of rigs/nets employed in the Galway and Aran fleet targeting nephrops.

It may be expected from a “colleague effect” that most fishers would be content with the upgrade. Results show though, that 64% of respondents would consider an end to twin-rigging through a ban on the activity. Many of these were twin-riggers themselves. A further 22% indicated they may consider a ban and only 14% were totally against a ban. This is a perhaps unexpected result to a scientist or outsider looking at figure 4.2. It was found that knowledge fishers had gained since operating twin-rigs had either lead them to doubt their strategy or in some cases change their strategy.

Firstly, ecological knowledge they had gained showed them that twin-rigging may be ecologically unsound. This was reflected by the fact that 70% of fishers believed the activity was causing ecological harm. A number of fishers had gained this opinion through experiences trawling behind twin-rigged boats. They found that in their nets they were picking up damaged nephrops that they believed to have been crushed by the weight that twin-rigged boats must tow between their two nets. Another fisher from the Porcupine Bank deepwater nephrop fishery noted that he and his father had fished a specific area of that ground for many years. He had fished this alongside Spanish fishers who like him were deploying only a single-rig. He said that within two years of Irish twin-rigged boats fishing the same ground, that the grade/size of nephrops had decreased dramatically. This was particularly a problem for his strategy as he relied on the higher market price he received for the larger grade nephrops.

It was this market or socio-economic knowledge that had also caused a doubting of the twin-rig strategy. For a number of fishers it was not part of their strategy to upgrade, but they argued that once others did it they had to in order to compete financially. One fisher told of how the increased nephrop catches from twin-rigging meant that the local market at Rossaveal was getting flooded and price was being depressed. He had to catch more nephrops to make the same money as he had made on a smaller catch before twin-rigging. The only way to catch more nephrops was to twin-rig. 67% of the fishers in the interviewed whom were still active on large or medium trawlers were using a twin-rig. One fisher had used his knowledge of the market to withdraw from twin-rigging. He had researched heavily the landward side of the fishing business and has discovered that by “trading down” he could make more money than some of the skippers in the largest boats in the fleet. He argued that these skippers were landing a lot of nephrops, but they were also using a lot of expensive fuel to conduct trips on the Porcupine Bank and tow the twin-nets (which need bigger engine power). He also noted that they needed large crews, all of whom must be paid. He had sold his larger boat and purchased a smaller boat, at the same time discarding his twin-rig for a single-rig. He intended to do one trip a day with just one other crew member. Instead of selling his nephrops wholesale he would instead sell them direct to the consumer in his own eatery and shop.

Having learned through the process of fishing many fishers showed remorse for upgrading to twin rigging:

> “*Well everyone else was doing it. I just joined the club. But I think it was a bad move to go to twin-rigging*.” [Anonymous fisher, 2009].

As has been seen there was a good deal of will to ban the process. The fishers though did for the most part admit to a lack of knowledge in how to engage in a process that could lead to that ban.

Another operational choice that fishers have to make is that of where they fish. By looking briefly at a number of examples it can be seen how this choice is made.

Based on ecological harm they perceive to have been done to a number of fishing grounds fishers had chosen to restrict fishing effort in certain areas. One fisher talked about how he refused to fish on a certain ground which he knew to be a fish nursery, because of damage he had seen done to another nursery for whiting and other whitefish on the Back of the Island ground. On a similar theme a potter had restricted the area in which he placed his pots and reduced his overall number of pots because of declines of the lobster and crab population in Inner Galway Bay where he believed pots had been spread over too wide an area and too densely. One fisher in contrast had deliberately chosen to increase their effort in a certain area in order to ensure a better catch. He focussed all his trawling effort on the inshore nephrop grounds in the North Sound and the Northwest Corner as he believed that the more you fished these grounds, the more nephrops you got out of them. He had witnessed over the years that when the grounds weren't fished they became dominated by echinoderms and it became hard to catch nephrops, but when fishing effort increased on them, the echinoderms were cleared and nephrop landings increased again.

Providing an overlap between use of ecological and socio-economic knowledge in strategy formation were a group fishers who fish for quality, not quantity. May of these were the fishers who targeted nephrops on the Porcupine Bank. They had sought secondary knowledge from French and Spanish fishers as well as experimented themselves over the years to find the areas of the Porcupine Bank ground with the largest nephrops. These large nephrops had a far larger market value than the smaller nephrops on the grounds at the Back of the Island, North Sound and Northwest Corner. Resultantly, in response to a recent closure of the Porcupine Bank fishery, this group of fishers (and colleagues from Clogherhead) will not displace their fishing effort to the Back of the Island where they believed the nephrops to be inferior, but instead to other grounds on the Irish south coast (e.g. the Smalls, the Labadie Bank).

Strategies based purely on economics are displayed by two fishers who fished with otter trawl nets in Inner Galway Bay. It was widely known amongst fishers that fishing (potting excluded) had been poor in Galway Bay since the 1970s or before due to a collapse in the fishery. However, these fishers had small boats with low or zero payments to make on them and used very little fuel in their operations as they were on calm seas and fishing close to their home port (reducing journey time). They had thus made a living on targeting species such as blonde and thornback ray, where large boats trying to undertake the same activity would certainly have made a loss.

A short-term change in strategy which affected far more of the fleet was the a rise in fuel price in 2007 and 2008. It meant large boats could not make money from trips to the Porcupine Bank and medium sized trawlers were struggling to do the same fishing nephrop on the Back of the Island ground. The result was a couple of months where almost 20 trawlers focussed entirely on the nephrop ground on the Northwest Corner because it was so close to their home port of Rossaveal and involved using very little fuel to fish.

A final example is of fishers who were attempting to transfer their fishing effort from nephrop grounds like the Back of the Island to the nearshore west coast pelagic fisheries. Some of these were worried about the future market for nephrops, others were disappointed at what they believed to be a reduction in size of the nephrops on the Back of the Island and a surprisingly large number did not enjoy nephrop fishing.

This latter group found the trawling up and down required to catch nephrops to be boring and they believed that “hunting” pelagic fish would be a more enjoyable fishing experience. They were using their knowledge of legislation to access these pelagic grounds for herring and mackerel. Most had tried to get pelagic licences from the Irish authorities, but had been rejected. Instead they have built or purchased boats that they call “rule beaters”. If a boat were registered under sixty-five feet it had an automatic entitlement to fish for pelagic species. It was this loophole that they had been exploiting to catch fish that they believed was more valuable, more sustainable or simply more fun to catch.

This just represents a small sample of the results from the IFKP. The fact that so much rich information can be gleaned so easily is potentially a good sign for future interpretation of results. It is hoped that new techniques can be applied to this data to make it accessible in a more concise fashion.

5 Discussion

In isolation, the relatively poor quality of the quantitative information collected from fishers during the IFKP would suggest that the current format of fisheries science and management is not omitting a great deal by only partially engaging with fishers and instead focusing on collecting landings data and other scientific information. The responses of fishers were too variable and lacked the precision needed to make good stock assessments or other ecological judgments based on catch composition. Additionally fishers’ qualitative knowledge of trends of change in fish stocks would add little to stock analysis as is reported in scientific publications such as those published by ICES and national science bodies [e.g. Marine Institute, 2009].

Taken in a broader context though, the results of the IFKP, even at this interim phase, have shown that there is a great deal of fishers’ knowledge outside the current knowledge management exercise of fisheries science and management and that much of it is of a quality on which management decisions could be based.

The strongest suit of fisheries science currently is the ecological information it provides, but even here fishers’ knowledge could add depth. As was shown in the case of the collapse of the northern cod in Newfoundland it was fishers’ who highlighted the collapse first [Neis, 1992]. The same is true of Galway Bay where fishers have recorded the disappearance of another cod stock that science cannot report. In this case the cause of the collapse is unknown, but the reason it is known about at all is because fishers’ knowledge pre-dates the commencement of collection of landings data for Atlantic cod on the Irish west coast. Similarly, the fishers’ knowledge is in some ways more comprehensive than the scientific knowledge, as it covers a broader spectrum of marine fauna and flora than traditional scientific stock assessment does. Fisheries scientists and managers are often criticised for approaching fisheries management as a single-species exercise, especially those working in Europe under the CFP [Daw and Gray, 2005]. The qualitative trends identified by fishers for non-commercial species would appear to be highly useful for tracking trends in an ecosystem, especially where supplemented by fishers’ knowledge of extinctions, spawning grounds and nursery grounds. For instance, in other global ecosystems, blooms of echinoderms have been seen as an indicator of succession of an ecosystem to a less desirable state [Done, 1992]. Even fishers' qualitative descriptions of changes in population trend of commercial species could be used to support technical data scientific knowledge that untrained policy makers can find too technical [Corbin, 2002]. Their knowledge of species is supplemented by knowledge of physical characteristics of the ecosystem gained from operating demersal trawls and echo-sounding equipment. The knowledge fishers have of individual ecosystems that are relatively unstudied by scientists, yet are high in biodiversity, such as maerl beds, could be of immense value in protecting and managing threatened species. Ecosystem-based fisheries management has been championed by many academics as the direction in which fisheries management should go [Pikitch, et al., 2004], and indeed it has been referenced as so in proposed reforms to the CFP [European Commission, 2009]. Fishers' ecological knowledge may not be easily managed under a single-species agenda, but perhaps it has a far more important role to play under an ecosystem based one.

A clear finding is also that it may be a mistake to focus on collecting simply ecological information from fishers'. The content of the interviews conducted with fishers A, B and C (see figure 4.1) display that ecological knowledge is just one dimension of a fishers life world in his or her "office" at sea. Socio-economic, policy and management, and operational knowledge also make up a large part of a fisher's consciousness. These different types of knowledge rarely seem to exist in isolation and often overlap, as can be seen in a lot of the case studies in section 4. The fisheries science referred to in section 1 is highly focussed on the ecological, and although other research programmes exist to look at socio-economic data from fisheries [van der Burg, 2000] this is often separate to the work of fisheries scientists. As Suuronen, et al. [2010] say, fishers are rarely consulted for their policy and management knowledge at all.

Finally, the results also show a whole new dimension to knowledge, one that definitely proves that fishers' knowledge is more than information. Fishing is not just an activity that fishers get out of bed to do every morning. It is a profession where important operational decisions are continually addressed and re-addressed based upon experiential knowledge gathered over a whole career and shared between others in the same peer group. These are "fishers' strategies". The existence of these strategies raises two important points for consideration. Firstly, Pálsson [1995] described *how* the lifeworlds and operations of fishers were different to those of fisheries scientists and managers. The uncovering of these strategies shows *why* the lifeworlds and operations are different. Current mainstream fisheries policy, including the European CFP, does not allow this question of *why* to be asked during day-to-day research. Resultantly, this knowledge is not entering the management process. Secondly, the strategies show that every single fisher is different. He or she each has their own strategy for how to survive and make a living. This is because each bases their strategy on their own very different knowledge. The current format of fisheries management though, does not allow for research of the individual and quite often treats stakeholders as homogenous groups. Recent proposals to engage more with stakeholders in a reformed CFP talk about interacting with representative bodies from industry [European Commission, 2009]. This is an undoubtedly positive step, but at the same time most of the respondents in the IFKP were represented by these bodies, yet had differing strategies and goals. The current research platform for fisheries science will not allow each fisher's strategies to be communicated.

6 Implications

The implications of these results for those working in organisations such as ICES working groups differ depending on their position. For those involved in the mainstream of ecological fisheries science, they have to address whether they are content to omit the majority of fishers' knowledge? Whilst this themed session asks for demonstrations of methods that improve "*joint programming and communication*", for the most part fishers are being omitted from both. Fisheries science may be able to reach a stage where it doesn't need stakeholders to actively contribute any knowledge, as electronic logbooks and VMS are already demonstrating. However, if an end point of development is reached, where the sustainability of fish populations remains under threat and fisheries scientists cannot provide full assessments of fisheries, will there be the time left and the will present to re-engage with fishers? Fishers' knowledge could be a vital part of the knowledge that needs to be managed in order to deliver the sustainable and well managed fisheries that everybody craves. If that knowledge does not become managed soon, it is unlikely it ever will be.

For those involved in projects designed to illicit fishers' knowledge, including the IFKP, challenges are raised over how to present fishers' knowledge. It has to be recognised that although the fishers' knowledge is of quality in content, fisheries scientists and managers are unlikely to have the time or training to analyse every individual interview in depth. Similarly, the process of interviewing every single fisher in a legislative jurisdiction is likely to increase costs and time. It may even be totally unworkable. This conference session calls for knowledge to be managed with "*fewer resources*". Social and interdisciplinary scientists must find ways to improve the collection, processing and dissemination of fishers' knowledge. This is a future goal of the IFKP. A potential direction is to follow the lead of the fisheries scientists who have linked up with technological experts (see section 1). Work done in the USA and the UK with stakeholders and interactive mapping technologies [Edwards, et al., 2009, Gleason, et al., 2010] may lead to a situation where fishers could report their knowledge in real-time. Research into solutions such as these should continue.

7 Conclusion

Fisheries scientists and managers have tried to incorporate fishers' knowledge into the knowledge they use to manage global fisheries. The engagement though has primarily been with fishers' information, not their knowledge. The only question that has been asked of fishers is *how* they operate, and even then mostly at an ecological level. The interim result of the IFKP show that fishers have a much broader knowledge which is more than ecological and that consists of strategies that show *why* they operate in the manner they do. Fisheries policy makers must decide whether this *why* is an important part of the knowledge needed to manage fisheries. If they decide it is, then this must be acknowledged in fisheries policy, including the forthcoming review of the European CFP.

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