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Title	Last of the hunters or the next scientists? Arguments for and against the inclusion of fishers and their knowledge in mainstream fisheries management
Author(s)	Hind, Edward Jeremy
Publication Date	2012-02-27
Item record	http://hdl.handle.net/10379/3022

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Last of the hunters or the next scientists?

**Arguments for and against the inclusion of
fishers and their knowledge in mainstream
fisheries management**

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Submitted for the degree of Doctor of Philosophy

February 2012

“Nothing is more dangerous than an idea when it is the only one you have.”

- Émile-Auguste Chartier [1938]

Abstract

The concept of *fishers' knowledge* is one that has largely been marginalised in mainstream fisheries management, often characterised by soft ecological narratives and social insights when the bias of fisheries managers is for hard quantitative data of a biological nature.

This thesis makes an original contribution firstly, by situating the debate on the contested concept of fishers' knowledge within the political context of traditional fisheries science, which has been undergoing a paradigm crisis and demands for reform.

Secondly, I draw a broad conceptual difference between a reformist account of fishers' knowledge and a more radical discourse which positions fishers' knowledge as an alternative to scientific enquiry. It is argued that a radical approach would be misguided, because fishers' knowledge is not as effective as scientific data for assessing fish stocks. Instead, a case is made to continue to use fishers' knowledge to explain remaining uncertainties in scientific stock assessment, and to explore important aspects of a fishery that other research approaches cannot. Specifically, it should become one of the central information pillars for conducting ecosystem-based fisheries management. Additionally, I advance *fishers' strategies* as a developing concept that if understood, could for the first time allow managers to comprehend not just 'how' fishing effort occurs, but 'why'.

Through a detailed analysis of a rich case study on the west coast of Ireland, these arguments are fleshed out to show how and why the concept of fishers' knowledge may be relevant for resolving serious problems in fisheries politics and policy.

More broadly the thesis covers new ground in areas of study relating to local and experiential knowledge, ecosystem-based management and the political dimensions of environmental sustainability and natural resource management. It would be an interesting point of reference for professionals researching these topics.

Acknowledgments

The process of researching this thesis and putting it together has been a highly enjoyable experience. However, that would not have been true were it not for the kind people who assisted me when there was no obligation for them to do so, offered me their insightful advice and feedback, or were just generally great. Thank you, I am eternally indebted to all of you:

Brendan Flynn (for his excellent supervision), Chris Curtin, Tony Varley, Mark Johnson, Dave McGrath, Emma Martin, Kay Donohue, Paul Connolly, Ollie Tully, Colm Lordan, Sarah Davie, Lorcan O’Cinnéide, Peter Tyndall, Seamus Breathnach, Daragh Browne, Barbara Neis, Grant Murray, Cristina Soto, Nigel Haggan, Kevin Leleu, Tim Gray, Tim Daw, Sarah Coulthard, Wesley Flannery, Sam Shephard, Donna Curtis, Dana Miller, Stephen Hynes and my SEMRU colleagues, Will Maclennan, Jan Lupton, Alan O’Neill, Laurene Schiller, Natalie Hind, the cheerful occupants of Moyola 331, the ‘critics’ in the Writing Club, and the Fishy Knowledge crew.

Thank you especially to the five people who support me the most. To my parents, sister, and grandmother, your faith in me has got me to where I am. Dad, you taught me that fishing is a fine way of life. Mum, the beach transects made me love the marine world. To Jessica, I think you wanted me to succeed even more than I did (especially when I was transcribing).

Above all, I reserve thanks for the fishers I interviewed as part of this research. This is as much your work as it is mine. I hope it is a fair and accurate representation of your considerable knowledge.

This thesis was funded by a Beaufort Marine Research award (Grant-Aid Agreement No. PBA/FS/08/001) and carried out under the *Sea Change* strategy with the support of the Marine Institute and the Marine Research Sub-Programme of the National Development Plan 2007–2013, co-financed under the European Regional Development Fund. It is also a product of the Irish Fisheries Science Research Partnership (IFSRP), which is a collaboration that brings fishers, fisheries scientists and fisheries managers together in order to work towards a sustainable fishing industry.

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Definitions of technical terms and acronyms

Admiralty charts Nautical maps of various seas and oceans produced by the UK Hydrographic Office.

anglerfish A group of benthic predatory fish found globally. In Europe the most important of these to commercial fisheries is the monkfish.

benthic The word used to describe entities that are found on the sea floor (also known as the 'benthos').

berry Nephrops eggs look like small black berries. They are attached to the underside of the body.

BIM Bord Iascaigh Mhara. In English: The Irish Sea Fisheries Board. The Irish state agency responsible for assisting the seafood industry.

bycatch Fish landed that are not the target catch of a fisher. These may be undersized fish of the target species or a non-target species. The former are discarded, whilst the latter may be kept and sold or discarded.

CAFSAC Canadian Atlantic Fisheries Scientific Advisory Committee. The former science advisory body to the Canadian Minister of Fisheries and Oceans, disbanded in the early 1990s.

CFP Common Fisheries Policy. The main instrument of fisheries management for European Union fisheries.

cod-end The terminating end of a fishing net where the catch is kept until it is landed.

Congested Districts Board A historical government agency set up in Ireland to alleviate rural poverty.

CPUE Catch per unit effort. This is the weight or number of fish caught per unit of fishing activity, which is usually measured in time or area covered.

DAFF Department of Agriculture, Fisheries and Food. The government ministry responsible for the management of Irish fisheries.

Defra Department for Environment and Rural Affairs. UK government department with a large role in fisheries management.

decommissioning A fisheries management measure where boat owners are paid a subsidy to scrap their vessels. The aim of the policy is to remove capacity from the fishing fleet.

demersal The zone just above the sea floor/benthos.

discards Landed fish thrown overboard by fishers as unwanted, for a number of reasons: they are either too small to be legally landed, the fisher has run out of quota to land fish of that species, there is no market for the

species, the fisher would prefer to use the space on their boat to land more valuable fish.

DFO Department of Fisheries and Oceans. The Canadian government's institution for managing its marine interests, including fisheries.

dynamite fishing This is the practice of throwing explosives into the water to create an underwater explosion. The explosion is designed to kill fish instantly so that they float to the surface where they can easily be extracted from the sea.

EBFM Ecosystem-based fisheries management. Also known as the ecosystem approach to fisheries management, this is where ecosystems are managed holistically. It is in contrast to population ecology where individual fish populations are managed.

EC European Commission. The executive body of the EU.

echinoderms Benthic invertebrates, of which starfish are the most commonly known group.

EEZ Exclusive Economic Zone. The area to 200 nautical miles offshore where the nation-state has privileged rights over marine resources.

EU European Union. The international government of twenty-seven nation-states in Europe with shared institutions and policies for fisheries.

FAO Food and Agriculture Organization. The UN institution responsible for the mission of defeating hunger, partially through assisting management of sustainable fisheries.

FIE Friends of the Irish Environment. An Irish NGO advocating environmental protection.

FIF Federation of Irish Fishermen. The umbrella organisation representing Ireland's four biggest trade unions for commercial fishers.

First Nations A Canadian term used to describe indigenous populations that pre-dated the European colonisation of North America. Some of these populations still exist and are often treated differently by fisheries managers. A more globally accepted term for First Nations' people is 'Inuit'.

FSRS Fishermen and Scientists Research Society. A network of Canadian fishers and scientists interested in the sustainability of North Atlantic fisheries.

gillnet A fishing net with mesh that is slightly too small for the targeted fish to escape through by swimming forwards. When the fish tries to escape by swimming away from the net, it is often unable to because its gills have become snared in the mesh.

GPS The Global Positioning System is a geo-locating device enabled by satellites that can be used to record where a boat is.

groundfish Fish that spend the majority of their lives near the sea floor/benthos.

GRT Gross registered tonnes are those that make up the volume of the productive space on a ship. They exclude unproductive spaces such as the engine room and crews living quarters. 1 GRT is equal to 100 cubic feet. As a whole measure GRT essentially represents the area for storing a fishers' catch.

handline A traditional fishing gear consisting of a baited hook at the end of a line.

ITQ Individual transferable quota. These are quotas for fish that can be passed from fisher to fisher, usually in an economic transaction.

IWC International Whaling Commission. The intergovernmental legislative institution mandated to manage global whale fisheries.

IWDG Irish Whale and Dolphin Group. An NGO concerned with the protection of cetacean species in the Irish Republic.

jigger An unbaited gear 'jigged' up and down in mid-water to attract fish.

longlining The fishing practice of deploying single lines from fishing vessels in motion or at anchor. Lines can be deployed at varying depths and in industrial fisheries can have thousands of baited hooks.

long-term sustainable yield The total mass of fish that can be caught per year to ensure that a fishery is in a healthy state and can continue to provide similar or better catches in future years.

LRP Limit reference point. The point indicating the limit beyond which the state of a fishery is not considered desirable.

maerl Found in large beds, this is coralline algae. It is considered to be habitat that supports high natural biodiversity and therefore often achieves protected status.

MI Marine Institute. The Irish state agency charged with conducting fisheries science. Have a similar role to the UK's Cefas, Canada's DFO and the Netherlands' IMARES.

mojarra A common bait fish found globally.

MPA Marine protected areas. Designated regions of the sea where fishing activity is usually restricted and possibly prohibited altogether.

MSY Maximum sustainable yield is seen as the maximum number of fish that you can remove from a fish population without that fish population decreasing in size year-on-year.

nephrops A common crustacean of the lobster family that is found in European marine waters. Also known as 'Norway lobster', 'Dublin Bay prawn', 'scampi' or 'langoustine'.

NIFA Newfoundland Inshore Fisheries Association. Local representative body for small-scale cod fishers.

NPWS National Parks and Wildlife Service. A public sector institution within Ireland's Department of the Environment, Heritage and Local Government. Responsible for conducting marine science not covered by the Marine Institute's fisheries scientists.

NUIG National University of Ireland, Galway. The institution that undertook the *Irish Fishers' Knowledge Project*.

NWWRAC North Western Waters Regional Advisory Council. This body, including representatives from the fishing industry and environmental NGOs, provides advice to the European Commission.

otter trawl The otter trawl is fishing gear comprised of a demersal net towed between two boards (called 'otter boards'). These boards push outwards when towed through water, acting to keep the mouth of the net open.

precautionary principle A policy tool to prevent potentially serious or irreversible threats to the health of the environment. In action it is the introduction of policy to reduce the impact or potential hazards to the environment before there is strong proof that they are causing actual harm.

prime fish Usually flatfish of high net worth (e.g. brill, turbot).

RACs Regional Advisory Councils. Institutions set up within European fisheries management to allow fishery stakeholders (industry and NGOs) to advise on policy.

rubber Wheels or discs attached to the footrope of an otter trawl net, designed to give the net slight clearance from the benthos.

scraper Side panel on a fishing net, used to guide fish into main body of net.

scup A species of fish found primarily off the Atlantic coast of the USA.

SFPA Sea Fisheries Protection Agency. The institution charged with enforcement of fishery regulations in Ireland.

single-rig A vessel employing an otter trawl, towing just one net.

spawn The eggs of marine and freshwater animals dispersed within aquatic ecosystems.

Stock Book The annual report produced by the Irish Marine Institute. It contains assessments of every coastal and offshore commercial fishery in Irish territorial waters.

TAC Total allowable catch. Set by fishery managers, the maximum allowed catch for a specific fishery.

trawling The fishing method of a vessel dragging nets under propulsion. Nets can be demersal or mid-water.

twin-rig A vessel employing an otter trawl, towing two nets.

UN United Nations. The global institution of 192 member states (as of 2011) that provides various forums and instruments for many activities, including fisheries management.

UVC Underwater visual census. This is a technique where researchers snorkel or scuba dive on set transects whilst counting fish. They can scale these results upwards to estimate the entire populations of fish species in the region.

VMS Vessel monitoring system. A satellite tracking system used by fisheries managers and coastguards to monitor the position of boats, including fishing vessels, at sea.

VPA Virtual population analysis. A method used to estimate the whole fish population by measuring and predicting the deaths within that population in a single year.

whiting Whitefish species related to the cod. Widespread in the Atlantic.

WWF World Wildlife Fund for Nature. An environmental NGO.

year class The section of a population of fish born in the same year.

1. Uncertainty in fisheries management: an opening for fishers' knowledge?

1.1. No more Cod

"[...] as long as I've been fishing and my father and my grandfather before that [...] You know, they catch that bottom fish we call it and those were the breeding fish, the mother fish we call it and definitely that's what's after happening." [Hearn in Neis, 1992, p. 159].

David Hearn was a fisher in Petty Harbour, Newfoundland and in the quote above was describing an occurrence he believed was a grave threat to the sustainability of cod populations in the fishery he operated in. He was part of an inshore fleet of fishers who made their living by using a handline¹ fishing gear. He was describing the threat from a minority of fishers in his fishery. Specifically, he was worried about the effect on future cod stocks in the region by those using gillnets². It was his belief that this apparatus only targeted the larger cod living on the sea floor. These larger fish were termed "mother fish" as they were the cod that contained the most spawn³ and were thus the mothers of the fish that would one day populate the fishery, replacing those of the current generation. Handlining was not a threat to the fishery in his opinion, as demersal⁴ fish were not attracted by baited hooks. He claimed they were only interested in eating benthic⁵ species such as crab. The fish attracted to the handlines were mid-water cod that rarely contained much spawn and thus were not as crucial to the fishery as the spawning mothers. If removal of the larger mothers by gillnet fishers continued, David predicted that cod populations would decrease to a level where it would be impossible to make a good income from fishing for them [adapted from Neis, 1992].

David was not alone in his thinking. Other fishers in the 1970s and 1980s began to worry about changes in the profile of Newfoundland's northern cod⁶ population. Some of these shared his opinion that gillnets removed

¹ See glossary: handline.

² See glossary: gillnets.

³ See glossary: spawn.

⁴ See glossary: demersal.

⁵ See glossary: benthic.

⁶ The northern cod is the name given to the population of Atlantic cod (*Gadus morhua*) off the coast of Newfoundland, Canada.

mother fish [McCay, 1976], but others had different concerns based on their own experiences in the fishery⁷.

At the same time as these concerns were being expressed by the inshore fishers of Newfoundland, Canada's federal government had extended its responsibility for the management of groundfish⁸ stocks to 200 miles offshore, including the northern cod of Newfoundland. The government's Department of Fisheries and Oceans (DFO) became responsible for collecting data on the health of the northern cod population, estimating the total stock and setting a total allowable catch (TAC) for the fishery [Hutchings, *et al.*, 1997]. Scientific advice, provided by the Canadian Atlantic Fisheries Scientific Advice Committee (CAFSAC), became the central instrument of fisheries management. In 1982 the DFO were able to predict a TAC of 400 000 tonnes for the northern cod and a long-term sustainable yield⁹ of 550 000 tonnes [Kirby Task Force on Atlantic Fisheries, 1982; Finlayson and McCay, 1998]. According to the DFO, the future sustainability of the fishery was secure and there was little reason to worry about northern cod populations¹⁰.

However, the position of the DFO was not one the inshore fishers of Newfoundland deemed to be accurate. As their worries about the effects of

⁷ Many believed that the bait discarded by the handline fishery helped to attract the cod, keeping them well fed and healthy. They worried that if handlining was replaced by gillnetting and trawling⁷, fishing methods that do not require bait, this source of support to the cod population would disappear [Berkes, 1987]. Further criticism from inshore fishers was aimed at the activities of offshore trawlers, which they perceived as so effective at catching the cod that the fish did not even have a chance to migrate inshore to spawn [Hutchings, *et al.*, 1997; Kurlansky, 1998].

⁸ See glossary: groundfish.

⁹ See glossary: long-term sustainable yield.

¹⁰ . It should be noted here that the DFO certainly realised that northern cod stocks had declined and that they were being fished unsustainably. From a record 810 000 tonnes in 1968 landings had dropped to just 139 000 tonnes in 1977 [Sinclair, 1996]. This decline was not attributed to the local fleet, but blamed on an influx of European vessels into the Newfoundland cod grounds [Sinclair, 1996; Lear, 1998]. By 1974, the fisheries of North America were being frequented by over a thousand European vessels, more than triple the size of the whole Canadian fleet [Roberts, 2007]. The DFO believed that once these foreign vessels were removed from the fishery the remaining Canadian vessels would be able to operate sustainably. The DFO's advice was therefore instrumental in the Canadian government's declaration of an exclusive economic zone (EEZ) to 200 miles offshore in 1977. This declaration excluded all non-Canadian vessels from the immediate fishery. When landings increased in the early 1980s to 230 000 tonnes [Sinclair, 1996], it appeared that the DFO's scientific management was working.

gillnetting and trawling, especially by the offshore fleet, increased and their disagreements with the DFO figures continued, they decided to take action. In 1986 the handline fishers of Petty Harbour were amongst a group of Newfoundland fishers to set up the Newfoundland Inshore Fisheries Association (NIFA). As the DFO were a governmental body, in 1989 NIFA actively sued the Canadian government in the hope of achieving a ban on the practice of demersal trawling, the practice they believed so harmful to the northern cod population. Despite actions such as these the DFO continued to set what NIFA believed to be optimistically high TACs [Neis, 1992; Kurlansky, 1998]. From the mid-1980s the worst fears of the Newfoundland inshore fishers were realised. The newly expanded fleet was unable to catch the quota of northern cod it had been allotted. Landings of the Newfoundland northern cod, which had rebounded to 270 000 tonnes in the 1980s, began to decline rapidly and by 1992 these landings had decreased to well under 50 000 tonnes [Sinclair, 1996].

This extremely rapid, near total decline, took many scientists by surprise and the position of the DFO was rapidly reversed. On the DFO scientists' advice that local cod populations were on the verge of total extinction, Canadian Minister of Fisheries and Oceans, John Crosbie, announced a total moratorium on the fishing of the northern cod stock in July 1992, instantly putting the fishers of Petty Harbour and thirty thousand of their colleagues out of work [Kurlansky, 1998]. Little hope now existed for the inshore fishers of NIFA whom had warned the DFO that the fishery was in decline. A survey conducted in the winter of 1994-95 in one Newfoundland fishing community showed that over 95% of the males who had been involved in the fishing industry remained unemployed two years after the closure of the northern cod fishery [Sinclair, 1996]. The fishery was in ruins.

Despite the dramatic collapse the DFO believed that the fishery could recover due to the introduction of the moratorium. Two years was chosen as the timeframe for the closure, because data produced by the DFO projected that stocks of the spawning northern cod would increase six-fold by 1994 to 600 000 tonnes [DFO, 1992; Hutchings, *et al.*, 1997]. Yet by 1994 cod stocks had hardly recovered at all, and this was still the case well into the 21st century. In January 1994, Brian Tobin, John Crosbie's

ministerial successor, announced an indefinite extension of the moratorium. The cod as a commercial fish was finished in Newfoundland [Kurlansky, 1998; Roberts, 2007].

It would be unfair and simplistic to say that the northern cod populations collapsed to near extinction without scientists trying to halt the problem. Many scientists within the DFO and independent of the Canadian government disagreed with the high TACs being set, believing them to be unsustainable [Steele, *et al.*, 1992; Hutchings, *et al.*, 1997]. George Winters of the DFO directly criticised his own organisation's policy in an unpublished report of 1986 [Winters, 1986]. He believed that the failure of the inshore fishery could be explained by heavy overfishing caused by TAC recommendations that he thought too high. These recommendations were in his opinion based solely on unreliable catch data. Scientists like Keats, *et al.* [1986] were amongst a coterie of non-government scientists to challenge the DFO's data and policies. Their vessel-based studies showed that the catch data used to calculate the TAC vastly underestimated actual landings, meaning that the stock size had been overestimated. They suggested future TAC should be set from data produced by research vessels if the population of northern cod was to be fished sustainably.

It is also overly simplistic to say that all fishers in Newfoundland were warning of the potential depletion of the northern cod stock. The assessments of the DFO were not criticised until 1989 by the offshore fisheries sector. Their criticisms only emerged as the DFO dramatically reassessed its stock assessment, cutting TAC dramatically. The offshore fleet was primarily owned by onshore food processing companies who believed it was in their interest to keep landings as high as possible [Finlayson and McCay, 1998]. This position may well have influenced comments by some of their trawler skippers to the press, such as:

I've been fishing northern cod for eight years and I tell you there are more fish now then [sic] there were eight years ago [...]. [Cox in Finlayson, 1994, p. 108]¹¹

¹¹ This quote is from Finlayson [1994, p. 108] but the author acknowledges it to be from an non-accredited article in the St John's *Evening Telegram*, February 24th, 1990, p. A1.

However, despite the existence of contrasting scientific opinions and fishers who did not warn of cod stock depletion, the result was the same. One of the world's most historical and famous fisheries, a fishery managed by scientists and the government, had collapsed with little sign that it could recover. The inshore fishers of Newfoundland had actually warned of the collapse, but the managers had chosen not to listen.

One of the primary aims of this thesis is to ascertain whether the insights of fishers (like those operating in Newfoundland) should become part of fisheries science and management. If this can be confirmed, then the further aims are to state or suggest how these could and should be integrated. Before considering the aims it is first necessary to understand whether any such assessment and integration has already begun. This foundation is provided in section 1.2.

1.2. Are we now landing fishers' knowledge?

As part of the fallout from events like the collapse of the northern cod there has been a growing call in research circles to listen to fishers such as those of NIFA, who may be able to inform scientists of ecological changes which they are unaware of. The expert insight of fishers that some academics are championing is often called 'fishers' knowledge'. Fishers' knowledge is commonly considered to be the information fishers accumulate whilst performing their day-to-day fishing operations [Neis, 1992; Pálsson, 1995]. It includes their knowledge of changing environmental conditions and of fishing techniques [e.g. Johannes and Yeeting, 2001; Stanley and Rice, 2003]. Evidence shows that to a certain extent these calls are being heeded and that some fisheries managers and scientists are now actively engaging with fishers' knowledge. In this section, some of this evidence is reviewed in order to assess to what extent the knowledge of fishers has been integrated.

One example of where fishers' knowledge has become a trusted source in fisheries management is in the policy of the Alaskan Eskimo Whaling

Commission described by Johannes, *et al.* [2000]. In this case the recognition of the need for using fishers' knowledge in the management of the fishery was made when indigenous Alaskan whalers disputed the management recommendation of traditional scientists within the United States authorities and the *International Whaling Commission (IWC)*. A zero catch quota for the Alaskan bowhead whale had been introduced by the IWC as they believed the population to be critically endangered at between 600 and 12 000 individuals. The indigenous whalers contested that this estimate was wildly wrong and believed in actual fact the population of bowheads was in all likelihood far higher. The whalers showed the scientists that because they lacked knowledge of the bowheads' behaviour that their methodology for estimating the population of the species was at least partially compromised¹². The scientists were able to acknowledge that their data was not complete and agreed to work more closely with the whalers via the setting up of a bowhead co-management scheme. The population counts of the bowhead are now almost exclusively provided by methodologies informed by knowledge of the whalers.

The example of the Alaskan Eskimo Whaling Commission shows clearly that fishers' knowledge can be accepted and accommodated by a natural science community which currently dominates fisheries management. However, this example of smooth absorption of fishers' knowledge still appears to be a fairly isolated case. Other examples show that fishers' knowledge is valuable in a number of scenarios, but also show that it has not yet become part of mainstream fisheries management.

Johannes, *et al.* [2000] again provide a number of these examples. In the Western Province of the Solomon Islands they were able to experimentally prove the assertion by local fishers that healthy baitfish populations are

¹² United States government scientists constructed their population estimates from counts made by observers stationed on the ice next to the open water during spring. They assumed that whales needed access to this open water to breath and would not venture beyond the ice. Indigenous whalers however knew from their experience that whales were not limited to the open water because they knew of breathing holes made by the bowheads beyond the ice from which the scientists were observing. The local whalers also knew that the whales could use air pockets that had built up below the ice to breath. They were able to show scientists evidence of bowheads 100 miles beyond where scientists believed their geographical limit to be [Johannes, *et al.*, 2000].

essential in the diet of fish important to the nearshore sustainable fishery. In a further study of the knowledge of elder fishers in Kiribati they were able to identify the final remaining spawning run of the endangered bonefish.

However, despite the success of finding and recording fishers' knowledge in these two cases, it was not used by the respective fishery managers¹³. In depth studies conducted by a group of researchers in Newfoundland also show that fishers had an intimate knowledge of the northern cod fishery before and after the collapse described in section 1.1. Several studies have documented the knowledge of the Newfoundland fishers over a period exceeding ten years [Neis, *et al.*, 1999b; Davis, *et al.*, 2004; Murray, *et al.*, 2005; Davis, *et al.*, 2006; Murray, *et al.*, 2006; Murray, *et al.*, 2008a]. Yet, even with this collection of a significant amount of knowledge from fishers, no obvious formal framework has developed to integrate this knowledge into DFO policy or into management decisions for the Newfoundland fishery [Neis and Murray, 2009b]. This would seem indicative of the global situation. Despite an increasing number of studies by academics on the merits of fishers' knowledge [see chapter 2], this knowledge does not seem to have been widely accepted as a valid source of ideas for fisheries management.

The question to be asked then is can fishers' knowledge ever be incorporated as part of the fisheries science mainstream or does the very nature of this newer approach preclude it from having this opportunity? Is the approach so at odds with that of the population ecologists who currently dominate fisheries scientists that it will have to be positioned as a challenge to that paradigm?

¹³ In the Solomon Islands, baitfish populations are currently believed to be very low by local fishers, but the government has not protected the species. The species has continued to be exploited heavily by commercial tuna fishers who use the baitfish to attract and keep tuna in their nets. Local inshore fishers believe that the lack of baitfish could cause the sustainable fishery to collapse. In Kiribati the final spawning run of the bonefish (important as a fishery species) was immediately afforded protection by local fishers, but was not given formal protection by national fishery managers. Only the continued goodwill of the fishers, born out of their own necessity for keeping bonefish populations healthy, keeps the run protected [Johannes, *et al.*, 2000].

There are certainly those who believe privately that local stakeholders have nothing to add beyond what traditional biological scientists already know. Walley [2002, p. 276] highlights her experience working alongside a fellow scientist in Tanzania. Whilst researching at the Mafia Island Marine Park, she came into conversation with a visiting researcher about the impacts of dynamite fishing¹⁴. He was sceptical that it could have had much effect as he had seen good corals at his field site. When she informed him that she had heard from local residents and fishers that dynamiting was seen as having had a negative effect on fishery yields during the last decade, he protested, "But people here don't even know the coral is alive. How could they possibly know the effect of dynamiting on marine life!?" [Anon. in Walley, 2002, p. 276].

Yet, there are few self-published accounts which contain direct criticism over the use of fishers' knowledge in marine science. What is perhaps more notable is a relative absence of literature that directly calls for fishers' knowledge to be part of the paradigm. Whilst Johannes, *et al.* [2000] note that there is sizeable movement supporting participatory governance of fisheries, where stakeholders are consulted by marine managers before decisions are made, they also highlight that little of this literature refers to the use of fishers' knowledge as a companion or replacement for the data produced by those practising population ecology. It is also of interest that there is caution regarding the validity of the use of stakeholder knowledge amongst those who would be considered as reformists in fisheries management (*i.e.* not stalwarts of population ecology). Jentoft, *et al.* [1998] cast doubts on the extent to which this participation should be encouraged. They warn that excessive participation from stakeholders and too great a role for their opinions in policy formation and management may be problematic.

One problem they highlight is that resources would be stretched by this inclusion, and could potentially be diverted from the scientific research which they deem to be important. A second problem they envision is regarding the nature of knowledge contributions. Their worry is that only certain stakeholders interested in gaining power would get the chance to

¹⁴ See glossary: dynamite fishing.

contribute their knowledge and any resultant participatory governance would not be truly representative of stakeholder communities.

The answer then to whether fishers' knowledge can ever be incorporated in or alongside a population ecology paradigm must be sought through analysis of the existing literature and through the fieldwork carried out for this thesis. If it is discovered that fishers' knowledge is at odds with the current paradigm of population ecology, it should also be possible in this analysis to ascertain whether a challenge to the existing paradigm is valid. If a challenge is valid, will that challenge be revisionist or revolutionary towards the status quo?

One of the reasons that fishers' knowledge has been seen as problematic is its qualitative nature. Population ecology is dominated by almost exclusively quantitative data, but fishers' knowledge is by nature mostly qualitative. Their knowledge, often described as anecdotal, is seen as hard to summarise for publication in the predominantly statistical reports of most fisheries management bodies and therefore is often ignored or omitted [Johannes, 2003; Johannes and Neis, 2007]. Soto's [2006] in-depth analysis of fishers' knowledge literature identifies a dichotomy in the publications of fisheries scientists, between their portrayal of fishers' knowledge and of traditional science. Their criticisms of fishers' knowledge are rarely delivered directly, but often implied is its inferiority to science, usually through accusations of it being unscientific due to its rarely quantitative nature. Criticisms have occasionally been overt and direct as can be seen in a report published by The Fishermen and Scientists Research Society (FSRS). Despite recognising "the value of incorporating fishers' knowledge", researchers for the FSRS conclude that it is neither "sensible [n]or desirable" to formulate fisheries management policy "based on unreliable information, opinion, or hearsay" [Zwanenburg, *et al.*, 2000]. Highlighted by Soto [2006], this example shows the reluctance of even those fisheries scientists who recognise the existence of fishers' knowledge to consider changes to the heavily quantitative scientific methods they are comfortable with.

From the few fisheries scientists who have engaged fully with fishers' knowledge, the criticism of their colleagues for not engaging in the same manner has usually been harsh. Johannes [2003] criticises fisheries scientists for often paying only "lip service" to knowledge provided by the fishers. He believes that fisheries scientists often find the social science methods used in the collection of fishers' knowledge to be unpalatable, due to the fact that the resource users often lead the interviews that elicit the knowledge. For these university educated researchers, he believes they cannot take seriously research led by stakeholders without the same levels of formal education. Whilst Soto [2006] notes that some researchers have put this down to an "attitude problem" amongst biological scientists, she also highlights that others have sought to explain the apparent short-sightedness of those not engaging with fishers' knowledge. Baelde [2003] explains this surprising lack of engagement as not an attitude problem, but as the result of a socio-cultural barrier. For him, it is the historic situation in which fishers and scientists have struggled to communicate at all that is actually the barrier preventing scientific engagement with fishers' knowledge. This is a socio-cultural barrier that can be crossed according to some, with the catalyst being the failure of the population ecology paradigm. As traditional fisheries science has failed to control fish stocks sustainably Mackinson and Nottestad [1998] believe that a change in attitude is possible. They are of the opinion that a mutual respect can be fostered between fishers and scientists, where fishers' knowledge is used as a management tool alongside more quantitative scientific data.

It would be unfair to say however that hitherto fisheries managers have not tried to cross the socio-cultural divide and engage with fishers. Sometimes these moves have even been described as efforts to engage with fishers' knowledge, but a closer look shows that maybe what is being advertised as fishers' knowledge is actually something else.

Perhaps the most prolific method with which fisheries managers have attempted to collect information from fishers is through asking the fishers to collect quantitative scientific data on their behalf. The Sentinel Program in

Canada¹⁵ is one of the earliest examples of this and has been followed by similar programmes in Scotland¹⁶ and the Netherlands¹⁷.

Whilst it can be argued that these attempts to engage fishers in data collection can be part of accessing fishers' knowledge, it must also be said that it need not be the limit of collaborative research with fishers' knowledge. The data that fishers collect in projects such as the Canadian Sentinel programme can only represent a minority of the knowledge that they hold from their experience in the fishery. Arguably this empirical data is outside the comfort zone of fishers anyway, as it is not the sort of information they would collect and utilise on an ordinary day in their respective fishery. Beyond this artificially constructed knowledge, fishers have a far wider body of knowledge that cannot necessarily be empirically expressed either through its direct delivery or via interpretative methods. Johannes, *et al.* [2000] support the position that fishers' knowledge is generally anecdotal and must be interpreted outside of the traditional scientific methods of fisheries management. They ask whether biologists will be able to accept this scientifically softer information as a valid data source that can be used, or whether they will continue to treat it with disdain.

More innovative approaches towards closing the socio-cultural gap between fishers and scientists have been attempted, such as turning fishers' knowledge into a 'language' that the latter understand. Multidisciplinary researchers in Canada have attempted to turn some of the fishers' qualitative knowledge into a semi-quantitative output. Their efforts

¹⁵ In the Sentinel Programmes fishers and scientists are surveying the stocks together with the fishers carrying out the duties of measuring the size of fish caught and of logging the following: gears used, fishing effort, fishing site, total weight of each species caught [Parsons, *et al.*, 1998]. Since 1998, 4 of 5 sets of scientific data detailing the abundance of cod stocks in the Gulf of St. Lawrence have come from the Sentinel Fisheries Program [St. Lawrence Global Observatory, 2011].

¹⁶ Funded by Scottish fisheries managers Dobby, *et al.* [2008] have implemented a tallybook scheme within the fleet targeting anglerfish. In the tallybooks the trawler skippers record the following on a haul-by-haul basis: location, duration, depth, gear and the actual catch (both landed and discarded fish). The data from the tallybook scheme is used to better estimate the total stock of anglerfish. Management regulations, such as quota restrictions, are then based upon this stock assessment.

¹⁷ The F-project in the Netherlands captures high resolution data on plaice and sole catches [Johnson and van Densen, 2007].

have proved successful in transforming anecdotal information into maps and charts that show trends in the distribution of cod populations and their migrations [Murray, *et al.*, 2006; Murray, *et al.*, 2008a]¹⁸. Further Canadian efforts have attempted to create rules for describing the behaviour of herring shoals. Based on fuzzy variables, these rules allow quantitative outputs to be elicited from qualitative understanding [Mackinson, 2001]¹⁹.

Is fishers' knowledge simply a methodological problem, where because of the socio-cultural barrier it has been hard to find common ways to collect and express data? With the fishers and biological scientists speaking different languages, is it just the case that fishers' knowledge has been lost in translation? It is likely that where fishers' knowledge is already quantified, or where it can be quantified using novel methods, that this may be the case. However, for some there is a belief that fishers' knowledge is more than just quantifiable ecological information.

Neis, *et al.* [1999b] outline that fishers' knowledge can include operational data on fishing gear usage and boat capabilities, or it can be socio-economic. For instance, Murray, *et al.* [2006], in addition to showing biological aspects, were also able to show changes in boat size in the Newfoundland cod fishery after their interviews with fishers. Most importantly perhaps, Neis, *et al.* [1999b] also identify that fishers' knowledge sometimes cannot be quantified, but at the same time is novel and relevant to management. An example would be their description of the "colleague effect", where boat captains upgraded their fishing equipment for prestige reasons rather than through a desire to increase their actual fishing effort. This would be important information for a manager to have, but could not be expressed statistically or in a chart.

¹⁸ In a series of papers the Canadian researchers were able to identify ecological characteristics of the fishery, such as the existence of two separate populations of cod. Until this discovery scientists had considered all the cod in the region of study to belong to the same population. They were also able to identify seasonal migrations of these cod [Murray, *et al.*, 2006; Murray, *et al.*, 2008a].

¹⁹ Mackinson [2001] interviewed fisheries scientists, fisheries managers and both commercial and indigenous fishers regarding distribution and behaviour of herring and asked them to offer possible explanations to account for their observations. He found the responses of those involved in science and management to be very different from those who fished, but using heuristic rules written in natural language he showed relationships between attributes influencing herring and descriptors of shoals. *E.g.* "IF weather bad (storms and high winds), THEN relative shoal depth **bottom** AND nearest neighbour distance of shoals **high**."

It is this knowledge which is not quantifiable that shows little, if any, evidence of having entered the paradigm of scientific fisheries management. However, there are those that believe adding fishers' qualitative knowledge could add a whole new dimension to fisheries management. Stanley and Rice [2003] ask why fishers' "scientific skills" cannot be added to management? They suggest that to rely on fishers simply as data collectors and resources of knowledge is a mistake and that we must also use the ideas that they have for the future of fisheries management. These ideas also constitute part of their knowledge and could be used for formulating hypotheses, designing research and interpreting results. Very few examples of this deployment of fishers' knowledge have been witnessed. Perhaps the exceptions would be stock assessment of silvergray rockfish in the Canadian groundfish fishery provided by Stanley and Rice [2003]²⁰ and Johannes, *et al.*'s [2000] description of the management of bowhead whale populations in Alaska.

Why have the biological scientists and fisheries managers been unwilling hitherto to allow fishers to exercise this qualitative knowledge, and reluctant in many cases to even include their quantitative knowledge? Is the answer simply the socio-cultural barrier that prevents full understanding between the fishers and scientists? There are suggestions that there is an entrenched power relationship between 'us' the scientists and 'them' the fishers. This would certainly seem to be the case in Walley's [2002] example of Tanzania where the biological scientist takes an Orientalist²¹ view of the local stakeholders as 'the other', possessing an inferior knowledge compared to what he has learned in his Western academic institution.

'Fishers knowledge' is not always the terminology used to describe fishers' experience. Often descriptors such as "indigenous" and "traditional" are

²⁰ A monitoring programme for the silvergray rockfish in British Columbia, Canada was designed by a local skipper, because biological scientists could not formulate a methodology that would not involve overexploitation of the fishery itself. The skipper also suggested an interpretation of the results that he was shown, which did seem to explain the science, (in this case that the rockfish were not one individual population, but several).

²¹ Orientalism is described by Said [1985] as the portrayal of indigenous populations by Western colonialists as the 'other'. The 'other' being inferior to Westerners and often portrayed as savages.

used and can be problematic, especially in developing nations. Walley [2002] believes the perceptions of “traditional ecological knowledge”, “indigenous knowledge” and similar descriptions linking fishers’ knowledge to non-Western society are partially to blame for fishers’ knowledge being ignored in management. She believes that part of the reason this knowledge is often seen as inferior by centralised managing bodies is due to inherited Westernised perceptions that see the knowledge as part of the past and primitive. In reality the knowledge is more of a duality, with a combination of knowledge inherited from traditional experience and that actively sourced externally by residents in the modern era²².

Where fishers’ knowledge has been limited to the ecological, it may also have been looked down upon by biological scientists. The scientists see themselves as experts in biology and it is likely that many of them consider there is little that fishers can teach them about their own discipline. This is why Davis, *et al.* [2004] consider that socio-economic knowledge must be included as part of fishers’ knowledge. Considering this scope of fishers’ knowledge means that scientists and fishers will have to interact, as biological scientists do not ordinarily possess socio-economic knowledge about a fishery. They believe that this sort of interaction leads to a more inclusive, sincere and thus effective management that to this point in time has rarely existed.

Full participation for fishers would also appear to be problematic. Silver and Campbell [2005] say that for fishers’ knowledge research to be of equal standing it must pervade all stages of research and management implementation. However, in reality they say it is more likely that the fishers will be included in the early stages of research, but left out towards the end when the actual management decisions are made. This resonates with Johannes [2003, p. 119] and his belief that fishers are often only paid “lip service”.

²² She demonstrates this through citing the case of Mafia Island, Tanzania, where the women have gained fisheries knowledge through catching octopus and shellfish on the rocks, whilst the men have more varied knowledge dependant on which fishing gear they employ. The men also sourced fishing expertise from outsiders in efforts to modernise their fishing practices for the best catch per unit effort (CPUE). See glossary: CPUE.

There is a worry that until these apparent prejudices are removed, then the epistemic power of science will continue and that the qualitative opinion and reflection within fishers' knowledge will continue to be trumped by science. Degnbol, *et al.* [2006] liken this to the scenery of fisheries management being "painted with a hammer". They say that fisheries science must open its doors to new approaches and new disciplines. That is not to say that scientists cannot continue their traditional approach. Fishers' knowledge has the potential to rebalance the power, bringing new insight to fisheries management and new solutions to problems within fisheries. If scientists can find a way to redress the balance through full acceptance of fishers' knowledge, Wilson, *et al.* [2006] say that they should do this with care. This kind of knowledge is not something that is just "sitting on a shelf" where it can easily be found. Fishers' knowledge is a community product and to engage with it properly scientists must also engage with the community of fishers properly.

When answering this section's question, "are we now landing fishers' knowledge?" it is hard to answer definitively. Efforts certainly have been made to collect it and it is probable that some of it has been 'landed'. However, the key point is that it is as hard to tell how much has been 'landed' or how well it is being 'landed', as the actual issue of what exactly fishers' knowledge is and how it should be collected remains highly ambiguous. This thesis takes on the task of formally identifying some of this ambiguity so that any integration of fishers' knowledge can be more accurately assessed.

1.3. Research questions

The real challenge is to discover whether fishers' knowledge, such as that which could perhaps have prevented the collapse of the northern cod if harnessed, can be integrated into science and management programmes. Until it is part of the knowledge referenced by policy-makers it will have little chance of stopping such fishery declines. Given that fishers' warnings were not heeded during the Canadian collapse, and given the suggestion in section 1.2 that to-date there has been a reluctance to engage with fishers' knowledge by decision-makers in the fisheries management community, it seems on the face of it that this may not be possible. To further investigate

this challenge significant discussion in this thesis will be orientated towards assessing whether actors within the epistemic community agree with any findings made here that show fishers' knowledge to have positive utility.

To find ways to reduce the ambiguity over the integration of fishers' knowledge highlighted at the end of section 1.2, and to better probe the ideological challenges to the integration, it is advantageous to design and pose research questions that are consistent with the objectives of this thesis: to find the value of fishers' knowledge and methods for its effective application. The questions (Q¹ to Q⁴) are as follows:

Q¹ Is fishers' knowledge more than just a theoretical concept? Does it really exist and can it be discovered?

If the answer to Q¹ is found to be 'yes' then this thesis will also ask the following three questions:

Q² Can fishers' knowledge be reconciled with fisheries management? Does it have the potential to add value to the discipline and change the current paradigm that is dominated by information produced by population ecologists?

Q³ Can fishers' knowledge be more than a source of information to be accessed and used solely by academics primarily practicing social sciences? Can fishers' knowledge be collected practically and presented in a format that is understood by biological scientists as well as other interested parties? Do methods exist (or can they be formulated) to translate qualitative knowledge into a quantifiable output?

Q⁴ Is the use of fishers' knowledge in fisheries management not just useful, but vital? Without fishers' knowledge will the widely acknowledged deterioration of global fisheries (and marine ecosystems) continue? Without fishers' knowledge will it be impossible to enforce any marine legislation aimed at conservation due to it being impossible to know what will be compatible with fishing industry interests?

These questions provide guidance throughout this thesis and are revisited in detail in section 6.2, where they are answered as definitively as possible.

Introduced in the following section are the methods that can be used to start providing answers to these research questions.

1.4. How can fishers' knowledge be landed?

Due to the location of this research, the fishers' knowledge that is discovered here will allow conclusions to be drawn on the state of certain sections of the Irish fishery. These results should have value for both assessing the fishery in question and also for informing management of said fishery, but it is important to note that these results are not the focus of this study. The focuses of this thesis are the methods with which the fishers' knowledge is collected, interpreted and mobilised. Fishers' knowledge has not yet entered the mainstream of fisheries science and fisheries management, despite what would appear on the surface to be some fairly attractive characteristics; a long and continuous history of the fishery, a data set approved by fishers (who have so far often been unimpressed by the efforts of fisheries scientists) and a knowledge-base that is always available (which is not the case in data-poor fisheries where fisheries scientists are not operating). This thesis will investigate whether it is a methodological issue that is preventing fishers' knowledge entering the fisheries management mainstream.

It would be logical perhaps for the study to try and use fairly quantitative, scientific methods. These are the methods that that have previously been accepted by the fisheries scientists who currently dominate fisheries management. If such methods could be used to access fishers' knowledge they may be the most likely to be accepted. However, this research will deliberately be using methods that are more familiar to the field of social science, rather than biological science. This is for a number of reasons:

Firstly, the scientific elements of fishers' knowledge are already well documented in some studies and by some researchers. As mentioned in section 1.2, programmes already exist where fishers are employed directly in collecting scientific fisheries data (e.g. the Sentinel fisheries). Other research has also used fairly quantitative interviews to assess the correlations between fishers' assessments of fisheries, and scientists' own

assessments. For instance, work by Daw [2008] in the Seychelles and Catlin [2008] in the Solomon Islands compared fishers' perceptions of fish populations to those assessed using scientific techniques²³. Less explored is how qualitative research may work within the fisheries science mainstream. The possibility that it could add a desirable new dimension to fisheries science and management makes it worth investigating here.

Secondly, fishers often believe that the science does not mimic what they see on a day-to-day basis in the fishery. The case of the inshore fishers targeting the northern cod in Newfoundland [see section 1.1] is typical of a number of cases where fishers have disagreed with scientific results. When the results are not accurate fishers become very sceptical of the methods²⁴.

Even some attempts to engage directly with fishers and their knowledge seem to be failing. This is perhaps because scientists, with the continued hope that they could elicit high quality quantitative data from fishers, are repeating the mistakes of the past. Dobby, *et al.* [2008] got Scottish fishers who targeted anglerfish²⁵ to record their catch volumes, catch locations, duration of hauls, and depth of hauls in "tallybooks". They soon found however that many fishers who had volunteered for the tallybook scheme dropped out²⁶ and that for others much of their data was incomplete. Although programmes like this do communicate successfully at first with fishers, it seems they fail to gain their long-term acceptance. Whether this

²³ Both Daw [2008] and Catlin [2008] used a combination of semi-structured interviews with fishers and underwater visual census (UVC) by marine biologists to look for correlations between fishers' views of fish stocks (or catches) and results produced scientifically. See glossary: UVC.

²⁴ This scepticism is illustrated by Pálsson [1995] in his description of research into the Icelandic trawl fishery. He outlines attempts by natural scientists to try and capture the trawler captains' knowledge by organising annual experiments in which they spend time on the fishers' boats. The experiment is called the "trawl rally". It involves following the same trawl lines with identical gear year after year. Results are then compared in order to try and draw conclusions about the state of the fishery and ecosystem. He finds that the captains believe the attempts by scientists to connect with the industry do not capture the true experience of fishers. The skippers criticise the scientists for "isolating themselves on particular ships" and say that if they were boat captains "they would have been fired long ago". These fishers would prefer a more intuitive and holistic approach, allowing for different kinds of fishing gear and greater temporal and spatial flexibility. They would prefer perpetual experimentation, often based on hunches.

²⁵ See glossary: anglerfish.

²⁶ The study started at the beginning of 2006 with 37 vessels volunteering to take part. By mid-2007 this had dropped to just 12 [Dobby, *et al.*, 2008].

is because fishers do not believe the data to be relevant, or because the data is not utilised in their favour, or because they lose interest in the project, is a cause for speculation. This speculation will be addressed in this research.

Third and finally, quantified data is simply not the language of fishers. Fishers tend to communicate through narratives, which are constructed from many different anecdotes and biographical stories [Johannes and Neis, 2007]. The enquiry of fisheries scientists has rarely dealt with data that consists of sections of prose, or is a non-quantifiable event which cannot be linked to a specific geographic coordinate and definitive time. Fishers' language and thus knowledge is certainly different to its scientific counterpart, and it is this difference that means it must be treated differently. Fisheries scientists may appreciate the fishers' anecdotes for being amusing, but unfortunately they seem unable to upgrade these anecdotes to the status of information essential to scientific understanding of fisheries. New methods are required that challenge the prejudices of scientists and the institutional structures in which they are housed [Finlayson, 1994]. Research experiences that are not based purely on quantitative science must be brought to the table. Interpretation of the anecdotal and biographical has more in common with the social sciences. Methodologies common to that field may add new value when it comes to research involving fishers.

Compared to other disciplines (although not the only guilty party), fisheries science seems to have been overly top-down in its approach. Top-down methodology has the potential to cause resentment amongst fishers who may then ignore any recommendations of, or fisheries regulations based on, the offending research.

At its most innocent, top-down methodology still has the potential to undermine research by alienating fishers. New research techniques like the satellite tracking described by Johnson [2008] and live video feeds detailed by McElderry, *et al.* [2008] have in some cases angered fishers. Monitoring such as this can be seen by the fishers as an attempt to control them without engaging them. Constant compulsory inspections of their landings

(to calculate catch data) and the new surveillance technologies perpetuate the idea of fisheries science as a kind of “Big Brother” [Gad and Lauritsen, 2009], rather than as a partner in fisheries management.

Methodology

This study uses qualitative interview methods common to socio-economic research that are generally considered more appropriate for dealing with anecdotal or biographical information. Whilst this is necessarily a very different approach to the quantitative statistical data produced by fisheries science and the population ecologists, it is important to not go too far in the other direction. The language of fishers is similarly not the language of biological scientists. Just as fishers can find it hard to understand quantitative scientific reports, scientists may not understand verbatim anecdotal and biographical information. As Johannes, *et al.* [2000] inform, most fisheries scientists have been educated in graduate schools or universities where teaching is purely biological and quantitative. Not always do they have the social skills or attitudes required for considering or interpreting fishers’ knowledge.

This is not to say that it is unnecessary to change the outlook of these fisheries scientists who have limited scope. However, it is likely advantageous that a middle ground is sought. It remains necessary to use quantitative and qualitative techniques when appropriate [Johannes, *et al.*, 2000], but results that can be understood by both fishers and biologists are essential.

Therefore, this research avoids using techniques that may be seen as the extremes of sociology, such as ethnography and participation observation. Whilst ethnographic work such as Walley’s [2002] can produce excellent insights for assessing fisheries or fisheries management, the results it produces are perhaps too lengthy and too hard to extract in this case. A broader goal of this research is to produce a repeatable methodology which could be applied beyond individual case studies. Not only do results need to be communicable to a variety of fishers, fisheries managers, biological scientists, members of the public, economists and politicians; it may be necessary on occasions for the methodology itself to be implemented by a

non-sociologist. Not all of these have the patience or skill to deal with ethnographic data. An attempt is made in this research to present fishers' knowledge in a format that is concise, highly accessible and easy to interpret.

Detailed later in this chapter is the emerging variety in the approach to conducting fisheries science [see section 1.5]. A focus of this research is on where these approaches meet, as it may be where fishers' knowledge needs to position itself if it is to be accepted. Caddy [1999] is considering this more broadly when ascertaining that going forward fisheries management must be "wide-use" (*i.e.* the management must be useable not just by biologists, but by all stakeholders, such as fishers). He says that this can be achieved by using interdisciplinary techniques. Likewise, this research considers the ability of new multidisciplinary techniques to display or transform fishers' knowledge.

Whilst the methods used in this thesis are designed so that they have the potential to be compatible with existing scientific approaches, it is not forgotten that it was perhaps the reluctance of fisheries scientists to consider other approaches to fisheries management that caused the cod collapse documented in section 1.1. Considered, is the possibility that the solution to the problem of managing fisheries sustainably may involve research or outputs that are not always compatible with existing scientific approaches. Therefore, the ideology of the emergent field of transdisciplinarity [see Hirsh Hadorn, *et al.*, 2008] influences the methodology used here. In the thesis' Irish case study [see chapters 3 and 4] and in chapter 5's institutional analysis attempts are made to fully understand the complexity of any problems encountered. Attention is paid to specific geographic or sociocultural issues encountered, and if the answer to a problem can only be found through referencing practical (rather than scientific) knowledge then that is made clear in the findings.

To meet the methodological challenges posed in this sub-section, this study takes inspiration from research where fishers' knowledge has already been successfully collected and even integrated. With twenty years of research into fishers' knowledge undertaken, the opportunity to learn lessons from

previous studies should not be wasted. Instead it should be built on and added to where deemed appropriate, so some methods are replicated. For instance, studies conducted by Neis, *et al.* [1999b], Johannes and Yeeting [2001], and Hind, *et al.* [2010] show that targeting elder respondents can be advantageous, because they can identify crucial ecological information not known to younger fishers. Additionally, easy to interpret visual outputs have been produced by those using qualitative interviews which involve a mapping element [see McKenna, *et al.*, 2008; Murray, *et al.*, 2008a]. Both of these methods are considered in this research. There is no reason to try and gain intellectual capital simply by finding new methods for collecting fishers' knowledge when usable methodologies already exist. It is necessary however to find out why these methods have not already permeated the mainstream of fisheries science. Efforts are made to see whether these outputs could communicate the knowledge of fishers to scientists and other interested parties as they are, or whether they need refining to do so.

The study goes further than simply trying to refine and discover methodologies. It assesses whether a standard approach for collecting fishers' knowledge is possible. It may not necessarily document rigid methodologies for field research, but it does attempt to address, where appropriate, how barriers in the current fisheries management have prevented fishers' knowledge from being collected and utilised in the discipline.

To ensure that this research is considered legitimate by fishers it does not follow the top-down methodologies of some previous research. Instead it involves fishers from the start and on their terms using bottom-up methodologies. McCay [2002] warns against bringing theories and models to a study without first investigating events such as locale and actors. By considering these it should have ensured that all stakeholders were represented in the study. Once identified it is important that stakeholders are allowed to participate in research [Chuenpagdee, *et al.*, 2004].

Whilst the positive relationship between researchers and fishers could be crucial to the success of this research, it is just as crucial to avoid some of

the pitfalls of social research. As Johannes [2003] says, some practices of the researched are useless or worse when it comes to environmental sustainability. Social researchers have a tendency to be uncritical of these practices. It is important to treat all results critically by trying not to romanticise traditional practices and by comparing fishers' knowledge to existing research and other case studies.

1.5. Changing paradigms: is there space for fishers' knowledge?

To understand the debate around fishers' knowledge it is necessary to situate it within the wider context of changing fisheries management. Therefore, before answering some of the research questions posed in this chapter it is important to discuss why they cannot be addressed in isolation. Fishers' knowledge is not the only alternative source of information to that collected by traditional fisheries science. A number of other approaches to gathering fisheries data are emerging, as are a number of alternative management methods which may also have an impact on what information is needed by fisheries policy-makers. Each of these could contribute to making the questions asked in this thesis irrelevant by overshadowing the concept of fishers' knowledge. Contrastingly, each could change the fisheries management landscape so that fishers' knowledge has more chance of being noticed. To fully comprehend how they could impact my research it is necessary to understand the paradigm currently dominating the fisheries sector, its apparent 'crisis', and the reactions to that 'crisis'.

Scientific fisheries: a paradigm in 'crisis'

As late as the end of World War II the industrialisation of economic activities such as agriculture and manufacturing, which had occurred during the latter half of the 19th century and the formative years of the 20th century, had not reached the age old profession of fishing. This changed dramatically post-war as a rapid industrialisation of almost all fishing activities occurred. The successful industrialisation of the fisheries led to previously unimaginable increases in fish landings through the 1960s and 1970s [Templeman, 1966; Lear, 1998; Wright, 2001].

Parallel to the industrialisation of the world's fisheries, a standardisation in the methodology by which these fisheries were managed arrived. Before the 1950s, fisheries management was not necessarily a global movement and only really manifested itself at a local level. Even this local management was only documented in a minority of fisheries. Where it was documented, it was often evident that a new management regime was set up to respond to a problem (or even crisis) in the fishery. For example, in the case of the Lofoten Island cod fishery in Norway, Jentoft [1985; 1989] describes how a management regime was enacted when fishers complained that the fishery was overcrowded²⁷. Another example details how the New Zealand Maoris prevent overexploitation of their fisheries [Bess, 2001]²⁸. It seems that in the majority of examples elsewhere, with fishery landings reaching record highs, very few people considered management of fisheries (as a resource) necessary. This cavalier attitude towards this natural resource is probably not unconnected to early scientific advice. The most respected scientific advice, until the mid-20th century, decreed that there were no physical limits to fisheries. The following quote was delivered to fishers by the renowned evolutionary biologist, Thomas Henry Huxley:

I believe that it may be affirmed with confidence that, in relation to our present modes of fishing, a number of the most important sea fisheries [...] are inexhaustible. [Huxley, 1884]

This was a common view until the middle of the 20th century, as can be seen in Harold Innis' celebrated work, *The Cod Fisheries: the History of an International Economy*. The book tells the story of a resource whose limit is not so much its abundance, but rather the rate at which it can be caught by the fleets of competing nations [Innis, 1940].

²⁷ Gillnetters were fighting for space with longliners. In response the Norwegian government allowed fishers to set up their own management committee. This committee, containing both gillnetters and longliners, was able to successfully resolve the gear conflicts by dividing the fishery into areas of exclusivity for each gear [Jentoft, 1985; 1989]. See glossary: longliner.

²⁸ Since as early as the start of the 19th century, and in all likelihood a lot earlier, the Maoris of New Zealand have been practising fisheries management. It is not known whether this was in response to noted problems in their fishery, but it is known that the management regime's main focus was to ensure that the fishery was not over-exploited. The Maori fisheries are managed by the village chiefs under authority of the gods. Any fishers breaking management rules are at the mercy of the gods and often have their personal possessions confiscated as punishment [Bess, 2001].

It is generally accepted that the watershed for fisheries management was the 1950s; specifically the publication in 1957 of Beverton and Holt's *On the Dynamics of Exploited Fish Populations* [Hilborn, 1994; Mangel and Levin, 2005]. For the first time in history data was starting to show that in some fisheries landings were starting to decrease. The problem was so widely recognised that come the 4th *International Congress of the Sea* in 1951 a number of countries were producing reports on the evolution of the overfishing problem [Gillis, 1951; Sarraz-Bournet, 1951]. Throughout the 1950s and 1960s an increasing number of studies appeared that blamed excessive fishing activities for a decline in populations of fish²⁹. Beverton and Holt [1957] introduced some of the first tools with which these populations could be analysed.

Hilborn [1994] notes that much of the work done in fisheries science in the latter half of the 20th century is simply an elaboration of their work. They proposed models for measuring natural mortality and fishing mortality of fish populations, as well as for their recruitment and growth. They also looked at more complicated dynamics within fisheries. Further models went on to show how impacts on year classes³⁰ of fish would affect recruitment within the fishery [Beverton and Holt, 1957; Hilborn, 1994]. The most celebrated of their contributions was their catch equation. This equation allowed fish populations to be estimated through calculation. Virtual population analysis (VPA), as this became known, was the pillar of a new paradigm [Pauly, 1993].

As population ecology models became the day-to-day tools of fisheries scientists, they sought to improve and refine them. The early days of the new paradigm were impeded because of the difficulty of the techniques that had to be employed [Pauly, 1993; Hilborn, 1994; Mangel and Levin, 2005].

²⁹ For instance, studies by Fairbridge [1952] and Murphy [1966] showed an acute drop in landings in the respective fisheries of the New South Wales tiger flathead and Pacific sardine. Both fisheries had already collapsed to levels that could not be exploited commercially.

³⁰ See glossary: year class.

However, a new generation of fishery scientists, often highly skilled mathematicians, were able to streamline the new methods³¹.

The paradigm of population ecology has remained firmly established in the 21st century and studies continue to be published that are influenced by the early population models³². Dominance of the paradigm is evident when looking at almost any national or regional fisheries management plan. The TAC recommendations of the Canadian CAFSAC and DFO are a classical example of fishery management regulations built on population ecology data. The Common Fisheries Policy (CFP) of the European Union (EU) is also managed using the central methods of the scientific paradigm [Jensen, 1999; Daw and Gray, 2005].

With a dominant paradigm now in place for over fifty years it would be reasonable to assume that the world's fisheries have remained sustainable. Healthy fish stocks should have been delivered by management policy based on data processed by population ecology models. If we assume that fishery managers have observed the precautionary principle³³, then they will have responded to the fishery declines recognised by science over the last half century by installing limit reference points (LRPs)³⁴ to prevent further declines [Caddy, 1996]. This has simply not been the case.

Reports of fishery decline are now far more numerous than they were when Beverton and Holt's *On the Dynamics of Exploited Fish Populations* was first published. Despite a sustained period of what was seen by many fisheries scientists as the optimum format for fisheries management (*i.e.* one based purely on science) there has been very little evidence to show increases in fish populations. Often, quite the contrary is true. The following

³¹ For instance, Silliman [1967] was able to apply the "analog-computer" technique to the work of Ricker [1954], and that of Beverton and Holt [1957]. Taking the example of the Atlantic cod he was able to simulate modelled exploited fish populations for the species. He concluded that the process was low on cost, fairly rapid, and provided good visibility of results during calculation of data fields that included fishing mortality and stock recruitment.

³² Ratner and Lande's [2001] study on the harvesting of Chinook salmon in Oregon is amongst these, as is McClure, *et al.*'s [2003] research on salmonid in the Columbia River Basin.

³³ See glossary: precautionary principle.

³⁴ See glossary: LRP.

quote from a renowned fisheries scientist perhaps best qualifies the underwhelming results of fisheries science:

It is rather discouraging to realize that forty years ago, Beverton and Holt (among others) were saying that yields in [...] trawl fisheries could be improved if fishing effort were reduced: the scientists of today are saying the same thing, and yet we still have not found ways to do it. [Hilborn, 1994, p. 260]

A number of studies have been published that model the possible full extent of the recent decline in global fishery stocks. Populations of large predatory fish are now at 10% of their pre-industrial levels [Myers and Worm, 2003], many of the world's top marine predators are threatened by extinction from fishing pressure [Myers and Worm, 2005], and catch records show that global fishery landings have on average been decreasing by 700 000 tonnes per year since the late 1980s [Watson and Pauly, 2001].

Most damning to the paradigm though is the total failure of certain fisheries despite their monitoring by scientists, such as for the Peruvian anchoveta [Castillo and Mendo, 1987] and the northern cod [see section 1.1]. Both fisheries have shown little sign of recovery. Collapses such as these have led people to question the effectiveness of the population ecology paradigm.

Responses to the 'crisis': new (or old?) thinking on fisheries management

With a paradigm potentially in crisis, one can currently discern a debate about the future of fisheries management. A significant part of this debate is now advocating moving beyond the traditional population ecology model. To date however, the cases for reform are relatively fluid and there is no evidence that reformists have settled on what the alternatives to the population ecology paradigm would be. Further, the magnitude of any reform is up for debate. It is questionable at this stage whether reformists are looking for a wholesale paradigm shift away from population ecology or whether they are looking to simply modify the existing paradigm.

Defenders of the population ecology paradigm: let the science speak!

There are certainly experts who believe that a paradigm based on population ecology should continue and that the well documented collapse of several fisheries should not lead to the abandonment of the paradigm. In other words, there is a vigorous debate defending the very idea that fisheries management should remain governed by hard scientific data and assessments. According to these accounts science should remain in the driving seat, because essentially it has not really failed. Rather, what has failed is political willpower and public understanding of such science.

Citing the example of the collapse of the Newfoundland northern cod fishery, Hutchings, *et al.* [1997] attribute the population collapse not to the failure of scientific advice, but to non-scientific influences that prevented the following of that advice. Their study showed that the Canadian DFO, the political entity that set the TACs for the northern cod, had failed to enact a number of the recommendations that the scientists of CAFSAC had been making since 1986. Hutchings, *et al.* [1997] discern that the DFO was influenced by political bias and was thus incapable of making fishery management decisions true to scientific advice. In this account the problem does not lie with fisheries science, but rather with the political and public acceptance of such science when it presents bad news.

Daw and Gray [2005] acknowledge that the European CFP, also heavily reliant on population ecology, has been seriously limited in applying scientific advice by political deficiencies. They criticise in particular the ministers from EU member states responsible for making the final decisions on fisheries management, highlighting that they often fear creating fishery regulations that would be unpopular with those who elect them. However, Daw and Gray [2005] are also amongst a growing number of academics who additionally highlight deficiencies in the population ecology paradigm itself.

Building a stronger population ecology paradigm

One of the deficiencies identified by Daw and Gray [2005] is the self-acknowledgement by population ecologists that fisheries information

collected to date is quite simply often inaccurate. Acknowledgment of such inaccuracy shows that at the very least the supporters of traditional science-based fisheries management are today often open to admitting weaknesses in their data. Regarding the collapse of the northern cod stock in Newfoundland, many believe that the major reason for scientists failing to predict the collapse was that assessment errors meant the existing population of the species was vastly overestimated. The Canadian assessments had been based purely on catch data, for which accuracy was contested and history limited [Keats, *et al.*, 1986; Walters and Maguire, 1996]. Further research has shown that stock assessment can often have error margins of up to 50% [Walters, 1998].

Deficiencies have also been highlighted in the methodology of the data collection. These can be errors in the models used to estimate populations, such as those used to calculate fishery recruitment [Pauly, 1994; Punt, 1997]. It can also be that there are faults in the methods actually used in field research. Pálsson [1995] agrees with the fishers he is researching in criticising Norwegian trawl surveys³⁵ conducted by scientists as non-representative of reality in the fishery.

The response to the perceived paucity and low quality of the data from the population ecology community has been for many of its members to call for an expanded and strengthened scientific paradigm. Whilst they want to continue using science and data-driven models to produce the information to underpin fisheries management, they admit they do not always have enough or the right sort of information for this. This has led to rather inevitable calls to collect data from fishers themselves, or to develop alternative indicators. While innovative, such demands should be seen as essentially reformist in that they are still working within the paradigm of population ecology.

³⁵ Stock assessments are often based upon fisheries catch data. Sometimes this represents fish landings from actual trawlers, but it is also obtained from controlled catch experiments onboard specialised research vessels. It should be noted that the kind of criticisms made by the Norwegian fishers are known to scientists, but that they still generally believe linear trawl surveys to be an accurate research technique for making meaningful biomass estimates [e.g. Lordan, *et al.*, 2007, pp. 2, 6].

In developed countries, where fisheries statistics have often been collected since the 1950s, there are calls for new data sets to help with stock assessment or recruitment studies for certain species [see Devries, 1997]. However, in the developing world, where fisheries management is often nascent, data can be non-existent for many fisheries. In such nations there has been a high demand for new fishery management tools (e.g. population modelling software) in the new scientific institutions charged with managing their fisheries [Mahon, 1997].

Critiques of the population ecology paradigm from within

Some scientists however, have identified what they see as intrinsic weaknesses in the existing science, and call for these to be addressed. Two of the major criticisms are firstly that fisheries management has so far been focused on single species. It has assumed fisheries tend towards population equilibrium. There is a growing argument that these assumptions by the traditional paradigm reveal that it is too simplistic³⁶. Secondly, a growing number of fisheries experts have also promoted science that is based on the precautionary principle. Initially this was always employed by scientists through setting TACs below the maximum sustainable yield (MSY), but more recently it has taken an approach independent of stock assessment and population ecology [Walters and Maguire, 1996]. There is now a feeling that the best way to protect a fish population is to prevent it from being fished at all. This can be achieved by the placement of marine protected areas (MPAs) where fishing is not

³⁶ It has been argued that the concept of a single-species fishery is a blinkered approach, because the stock of that fishery becomes simply the total number of that species in an anthropogenically designated region. Booke [1999] argues that by doing this management ignores genetic diversity within a species. He believes that efforts must be made to identify genetic markers within species and then implement management to protect these. Further criticism is advanced by Mangel and Levin [2005] who also believe a model accounting for only one species is too simplistic. In reality, fish live in ecosystems where they interact with multiple species of fish and marine organism. They believe that it is impossible to manage one fish stock without considering stocks of all other species in an ecosystem. Caddy [1996] goes further. He says that it is dangerous to manage fisheries based on the assumption that there is a finite population where the fish population can be judged to be in equilibrium. This is a criticism of models which try to measure population, such as those using MSY. He suggests the results of models should be taken with a "pinch of salt", implying that scientists should use them only as a guide to ascertain whether fisheries management is having positive results for fish populations. In summary, these critiques work within traditional population ecology, but the reforms they urge do push that paradigm close to its limit.

permitted³⁷. In other words the precautionary principle, when applied to fisheries, has in concrete terms become an argument for no-take MPAs within a spatial approach towards fisheries management and for systematic downward revision of TACs.

Reforming the paradigm with fishers' data: How reformed?

There is perhaps one further scientific stance as to how the population ecology paradigm could be reformed. Some scientists are clearly frustrated at the slow pace of reliable data for fisheries management in data poor fisheries, especially where stock assessments are often not available [Mahon, 1997; Kelly and Codling, 2006]. They have thus theorised that scientists should make management decisions based on faster appraisals, perhaps drawing more upon personal experience than complete data sets [Kelly and Codling, 2006]. Mahon [1997] believes this can be achieved by immediately implementing sensible management policy that the practitioner thinks will result in a sustainable fishery. Put differently, one substitutes expert discretion and knowledge with practical knowledge from fishers and others to cover data gaps or uncertainty, at least for a while. This is a practical application of the precautionary approach. Data can then be collected after the imposition of a management ruling to see if adjustments need to be made to policy.

Is there a role for fishers and their knowledge in this modified scientific paradigm and is this the same thing as the concept of fishers' knowledge? In fact, a review of the suggested changes [see section 2.4] would seem to show little room created for any genuine participation from fishers in regards to how and for what reasons data should be collected. There would also appear to be no role for fishers in processing and interpreting this data. It can therefore be said that it is also unlikely that fishers will have input into fisheries management decision-making. The one element of this paradigm

³⁷ Scientists have become more vocal in their support of MPAs as they negate the need to calculate MSY for each species in order to protect all fish of all species [Walters and Maguire, 1996; Roberts, 1997]. It is essentially seen as a safer and easier approach to fisheries management. Scientists hope fish populations will totally recover from fishing pressure in these refuges. As fish populations increase they hope some fish will begin to leave the MPAs so that they can then be exploited by the fishery. Growing evidence supports this hypothesis [see Russ and Alcalá, 1996; Russ, *et al.*, 2004].

where fishers can perhaps have a role is as regards the data collection. They become data collectors in effect, which is to say they are information gatherers or retrievers, rather than a group whose knowledge is being respected as such.

With data paucity identified as a major problem, and marine scientists in relatively short supply, the fishers could become widely involved in collecting the data needed to model fish populations. In this scenario fishers could collect data as they performed their standard activity of trawling or they could keep log books of their operations in the fishery that could then be shared with scientists [see Dobby, *et al.*, 2008]. There is currently, within the community of fisheries management scientists, a fascination with developing near real-time data inputs and management approaches using new technologies. These include monitoring boat activity by satellite using the Vessel Monitoring System (VMS) introduced by the EU [Johnson, 2008] and even via live video feeds from deck [McElderry, *et al.*, 2008]. The rationale of this approach is to view fishers as guardians and repositories of information.

It should be obvious this is not the same thing as them being guardians and repositories of knowledge as such. This reformist paradigm of fisheries management science would thus understand the question of fishers' knowledge as essentially a pragmatic exercise in harvesting and controlling a greater volume of data, which less technical traditional fisheries management would have been unable to access. Fishers become data collectors and providers. However, as we will see, a more radical and alternative perspective on fishers' knowledge is possible.

If the above trends in fisheries management thinking constitute the current reformist school of thought in fisheries management, it is also crucial to explain and describe the rise of radical critiques of traditional fisheries management, including those who have challenged the very centrality of science in the process.

Management through markets: Enter the economists

For example, some critics believe that the fisheries management paradigm does not just need to be modified, but instead shifted away from practitioners who focus solely on population ecology.

One of these approaches has radically different principles to that practised by biological scientists over the last sixty years. A new breed of fisheries scientist is making the case for a format of fisheries science based not on ecological considerations, but on economic ones. Given the historical difficulties of measuring biological sustainability in a fishery, De Alessi [2008] asserts that it would be more prudent to look at other measures of sustainability in fisheries management. He believes that it is easier to assess the health of a fishery by comparing its current economic performance to its historical one. Beddington, *et al.* [2007] document an ideal situation in which a fishery is not managed to achieve MSY or ESY, but where it is managed so that more precautionary catches can provide greater economic yields whilst permitting fish populations to grow. To help achieve this they endorse the idea of individual transferable quota (ITQ) that guarantees individual fishers a certain portion of the catch. The idea is that the fisher can then make rational choices about when and where they fish instead of just fishing intensively to gain as large a share of a collective TAC as possible. As fish populations increase, then the managers can then increase the ITQs.

Creating instruments such as ITQs under economic fisheries management is seen as giving economic property rights to the fishers. Since the mid-1980s, ITQs have been adopted widely as a fisheries management measure in countries including New Zealand, the USA, Canada, Iceland and Australia [Eythórsson, 1996]. In New Zealand and Iceland it became the system for almost all fisheries management. Pro-ITQ advocates in the Icelandic scientific community believed the system to have many long term

benefits, both ecological and economic³⁸. For those who promoted ITQs to the Icelandic government they were not seen as a privatization of the fishery, but as one of the best fisheries management systems in the world. It would make the fisheries more efficient, benefit the nation's economy and provide higher and more secure income for fishers [Eythórsson, 1996]. In addition, the ITQ system would provide fishers with the fisheries property rights that they desire. With a property right they could act as businessmen and women as well as hunters. A saleable asset is a desirable possession for many modern fishers.

However, the existence of pure neoliberal approaches to fisheries management existing in practice, as detailed above, has been questioned. Mansfield [2007], for example argues that neoliberal fisheries management will always exist alongside traditional, state-orientated management approaches. Privatisation of commercial fisheries may be possible, but at the same time there is no guarantee that privatisation will deliver sustainability. In the case of Alaska, Mansfield [2007] notes that the managers felt able to privatise the Alaskan pollock fishery with confidence that the population would remain sustainably fished, but she also describes how they felt that they had to create complimentary top-down legislation to protect the Steller sea lion³⁹.

In some ways the neoliberal paradigm of fisheries management is certainly more considerate of fishers as it considers their motives, at least in the limited sense of their economic profit motives. It puts their economic goals on a level with scientists' ecological goals. Grafton, *et al.* [2006] document a series of success stories where fishers have worked with policy makers to reduce TACs in response to fishery declines they have noticed. In these

³⁸ Eythórsson [1996] identifies six perceived benefits of ITQs. 1) The creation of private property rights encourages long-term sustainable harvest. 2) Transferability will lead to equilibrium when the most efficient vessels buy out the least efficient. Maximum economic efficiency will exist in the fishery with no excess capacity. 3) Increased efficiency will deliver stocks and fishing effort of maximum size leading to much improved resource rents. 4) Increased resource rents can be used to invest in related industries or taxed for profit. 5) Market prices paid for quotas will increase. 6) As profits will be higher fishers will be able to bargain for better wages.

³⁹ Habitats of the Alaskan pollock and Steller sea lion overlap and it was thought that trawling was disturbing both the feeding and breeding grounds of the sea lion. To compensate for this managers set up MPAs where trawling was forbidden with more stringent regulations employed during breeding season [Mansfield, 2007].

documented cases the fish stocks have resultantly increased, as has profitability, (e.g. New Zealand rock lobster fishery). However, the mixed success of ITQs raises questions as to whether neoliberal economic management as a process really involves the genuine participation of fishers. In the case of Iceland, where the application of ITQs has been almost total, Eythórsson [1996] describes the creation of a “feudal fishery”⁴⁰.

In summary, there may be examples where fishers have contributed knowledge within the economic management paradigm, but there are also cases where whole nations of fishers have not just been removed from participation in fisheries management, but also removed from the fishery. In these latter examples there is no opportunity for fishers to contribute knowledge, so as a potential paradigm for fisheries management it would appear to lack equality for stakeholders. Pálsson [1998b] believes the answer may lie beyond thinking of fish as a commodity, as is the case in both population ecology and economic neo-liberalism. He instead describes the sea as an “aquarium” with a finite number of fish that you can remove.

Ecosystem approaches: A new departure (or more of the same)?

Another proposed shift in the fisheries management paradigm would appear to have roots in the dominant population ecology paradigm, but at the same time distances itself significantly from the statistical models of that approach. Roberts [1997] notes that it builds on the idea of how MPAs and reserves have emerged as a response within scientific management to the perceived failure of population ecology. This is the ecosystem-based fisheries management (EBFM), which Pikitch, *et al.* [2004] argue is a new direction for fisheries management. It essentially reverses the order of management priorities so that management starts with the ecosystem rather than a target species. By protecting a whole ecosystem, rather than just target species within a fishery, the fishery is automatically afforded protection. In this scenario there is little need for the traditional fisheries

⁴⁰ Here the ITQs became concentrated in the hands of a few larger commercial firms who had more buying power, enabling them to buy up almost all the ITQs. The result of this has been to leave a majority of the fishers unemployed. The fishers no longer have access to the profits of the fishery, just to the wages paid by the few commercial operators who won the ITQs. The fishers are the “tenants” and the commercial companies “the lords of the sea”.

science of population ecology. EBFM is the most recently proposed paradigm shift and at this stage it is not entirely evident whether it will involve the participation of fishers in a substantive way. For example, Pikitch, *et al.* [2004] describe a new paradigm that has similar disciplinary values to the population ecology paradigm, where scientists create coercive management policy that fishers would just follow. In contrast, Shackeroff, *et al.* [2009] offer an alternative vision with scientists who see ecosystems as “peopled landscapes” where fishers don’t just interact with the ecosystem, but are part of it. Their preference is for an interdisciplinary approach that would involve a higher degree of people participation (*i.e.* inclusive of fishers). The nature of the involvement of fishers would be similar to that of a softer approach based on interdisciplinary science.

Towards interdisciplinary fisheries management

A final approach does not eschew natural science; instead it attempts to reconfigure the traditional scientific paradigm through integrating practices from other disciplines that have not always been associated with fisheries research. Some scientists have begun to acknowledge that following a narrow methodology closes potential paths of success in fisheries management [see following quote]. They seem to be arguing for what may be best described as a ‘softer’ science.

[...] I do not think it is in the interests of promoting better science that only one or two ‘best’ methodologies or one paradigm should be allowed into print. With respect to new ideas, as for evolutionary processes in general, new and promising lines usually develop from the primitive members of a phylum, not from those that have already reached their high point of evolutionary development! [Caddy, 1996, p. 229]

Degnbol, *et al.* [2006] see the need for a science that does not exclude practitioners of any discipline. Not only this, but they say that fisheries science does not need or want a multitude of disciplines contributing individually, rather it needs and wants them to contribute to the paradigm as a whole working together. This is the strongest call for a new interdisciplinary paradigm. It is likely, due its interdisciplinary nature, that the paradigm would not just consider top-down scientific and governmental opinion in its management decisions, but also bottom-up community-based inputs [Caddy, 1999].

In a review of several recent publications, Symes [2006] shows excitement about a revolution in fisheries science through the introduction of social science to the discipline. He believes specifically, that as social scientists have entered the discipline they have addressed the issue of governance in fisheries. Social scientists are strong proponents for participatory governance, a format of governance that would inevitably shift the incumbent scientific paradigm. Under the scientific paradigm, fisheries have become almost ungovernable due to rising tensions between scientists, politicians and fishers themselves. Compliance towards fishing regulations has been one of a number of problems with top-down, directive governance. Participatory governance would deliver a more inclusive management paradigm, involving experts from a number of disciplines and the stakeholders themselves. It would not take power away from fisheries managers, but it would open up decision-making power to stakeholders beyond the scientists [Jentoft, 2007].

Symes [2006] notes the only danger of moving the paradigm in this direction would be its final destination. With so many disciplines and actors involved in management, the unique advantages of these disciplines may be lost in the search for a common perspective on management. Hartley and Robertson [2006] highlight New England, USA as an area in which the application of an interdisciplinary paradigm has begun. Funded by the US government, the Northeast Consortium is a council set up in 1999 to conduct fisheries research in the Northwest Atlantic. The consortium has focussed on cooperative research practices in the fishery. It has succeeded in increasing fisher and industry participation in research and has also brought them closer to scientists in terms of dialogue. Koeller [2008] introduces psychology to fisheries management in order to propose a kind of holistic interdisciplinary management paradigm in which all become managers, not just disciplinary experts and key stakeholders. He suggests that when we start to worry about the future health of ecosystems we are motivated by fear. He concludes that as we all fear, then we are all responsible for management and can all have our say. He outlines that in this totally interdisciplinary paradigm, marine scientists could continue to collect the data they always have alongside those from other disciplines.

By introducing social scientists, the paradigm would introduce different types of data, perhaps even qualitative information, collected from the people that interacted with the environment. This would certainly include fishers. The paradigm would still be able to use the fishers to collect scientific data, such as described by Dobby, *et al.* [2008], but it would also open up the possibility of accessing the deeper knowledge of fishers by introducing sociological and ethnographic methodologies. This is certainly an aspect of data collection that has been seen as lacking by some fisheries scientists. They believe that fishers hold a great deal of information about the environment that has not been discovered by the methods used so far in marine science [Johannes, *et al.*, 2000]. Johannes [1998] noted that this could be a particularly useful source of data for fisheries management in developing world fisheries, where often a paucity of scientific data prevents any effective management from occurring.

What isn't addressed perhaps when speaking about interdisciplinary research in marine science is the degree to which social science perspectives could be accepted by the dominant communities of population ecologists who have traditionally managed the world's fisheries. Would the natural scientists be able and willing to accept input from a social science community that has little history of involvement in marine management? Sceptics may say that the acceptance of social scientists by natural scientists is unlikely, as it could challenge the dominance of their work and may even lead to their elimination from the management process.

Beyond science: Postmodern critiques of fisheries management

The perspectives offered in the previous subsection would suggest that a transition to interdisciplinary science need not be highly dramatic, and might only concern itself with new forms of data as compliments to those that currently exist. This is perhaps because commentators such as Johannes (himself fully trained as a natural scientist) are still well connected to the field of natural science. This fact may predispose them to a position which is still sympathetic of the interests of natural scientists who have worked in the field their whole lives.

However, a further group of more radical interdisciplinary revolutionaries exist, who question not simply the primacy of natural science, but also its validity. Ludwig [2001] is amongst the cheerleaders of this position. In a paper, citing the case of fisheries management, he calls for an entirely new approach to fisheries management.

We need to change our approach to complicated environmental problems. There are no experts on these problems, nor can there be. Instead, we should establish and maintain a dialogue among the various interested parties. In principle, that includes all of us. [Ludwig, 2001, p. 763]

He is amongst a group of commentators [e.g. Ozawa, 1991; Funtowicz, *et al.*, 1999] who criticise natural scientists and other perceived experts (e.g. economists) for not realising their own limitations. He says that they must neither assume that their data is correct nor their methods valid, also noting that their work can be compromised by the fact that they do not always share the same ethics or values as the stakeholders whom their work affects. His conclusion is that environmental problems cannot be solved without the participation of those affected and importantly notes that it may be only these affected stakeholders who have the sort of local knowledge actually needed to solve the problems.

Criticising the management of scientists as purely based on physics, Delord [2006] argues that ecological knowledge need not be accrued top-down. The paradigm can evolve so that it can also be provided bottom-up. According to Pitcher and Haggan [2003] the minds of fisheries science experts may be incapable of accessing bottom-up knowledge as their cognitive maps do not allow them to think, or even put themselves in the shoes of other stakeholders. If the cognitive maps of scientists are only allowing them to follow a single path of fisheries management, and that turns out to be invalid, then the future of the fisheries they aim to protect could be severely compromised.

Ludwig [2001] states that affected stakeholders should be active and influential (*i.e.* equal) participants in environmental management. In the case of fisheries management, the affected stakeholders (possessing local knowledge) include the fishers themselves. Pálsson [1995] is supportive of this view in the fisheries context, arguing that we must move away from the dualism of separating science and the practice of fishing by uniting

producers and scientists, participants and observers, or traditionalists and modernists. The reason for doing this he concludes is that no actor can bring everything needed for management to the table, as each actor has different knowledge.

Using discourse analysis, Corbin [2002] found that during the collapse of the northern cod in Newfoundland fishers were excluded because their knowledge was seen as too colloquial. Without the fishers' knowledge to support it, the scientists' information was filtered by managers as it was too technical for the majority of them to understand. Politicians and fish plant owners (respectfully motivated by winning votes and making profit), despite having the least knowledge of the cod fishery's sustainability, were able to lobby the managers in less technical language. Therefore, they often had more of an input into management policy than the scientists themselves.

The modern approach to fisheries science receives further criticism for omitting various stakeholders from fisheries discourse altogether. Beyond the commercial fishers, there are the indigenous fishers (e.g. native populations in Canada, Norway and Greenland). Some postmodern critiques of fisheries management and science highlight the fact that indigenous fishers have far greater histories of the marine environments they inhabit than non-indigenous fishers in the same region. Not only that, but they were utilising fisheries before the collapses attributed to modern fisheries science and consequently they may well have knowledge of how fisheries were formerly exploited sustainably. Postmodern critics are asking for the rights of indigenous fishers, such as the Eastern Canadian Mi'kmaq and North Norwegian Saami [Davis and Jentoft, 2001], to be considered. Of equal importance is their simultaneous request to consider using indigenous techniques and philosophies to manage fisheries, as in the case of the Gitxaala and the Ts'msyen peoples' management of the British Columbian salmon fishery [Menzies and Butler, 2007]. Additionally, women have a long history of involvement and contact with fisheries, yet their views are rarely considered by fisheries scientists [Bavington, *et al.*, 2004]. The consequences of excluding them from fisheries policy debates could include omission of the gendered, social and health dimensions associated

with their knowledge. Such omissions are often associated with fisheries management failures.

A final perspective that should be mentioned regarding a potential shift in the nature of fisheries management is considered by Collet [2002]. He suggests that we should re-tailor the concept of fisheries as a “commons” to be exploited by humankind and asks us to take a more ethical approach. The existing paradigm of population ecology and the suggested paradigm shifts towards economics, or management by ecosystem, have all to some extent put humans above nature, whether by seeing nature as a commodity or as being something that can be controlled and managed by man. This perspective seems to be the one that has most in common with the previously mentioned approaches suggested by social scientists for whom qualitative evaluations are normative. It marks a point of departure which is far away from that set by the traditional population ecology perspective that emerged so dominantly in the post-war era.

The space for fisher’s knowledge

The discussion in this section shows the complex landscape that fishers’ knowledge is entering. A thesis that ignored this complexity would be limited, as its theoretical findings might be easily made valueless by the realities of the fisheries paradigm. It is not enough to simply demonstrate the value and utility of fishers’ knowledge in the remaining chapters. Additionally required will be attention to how fishers’ knowledge will have to interact and compete with the other forms of fisheries information, especially those that seek to invalidate it.

The actual research of fishers’ knowledge introduces a number of questions about who has the power to decide the direction of fisheries policy. Particularly relevant to this thesis are who decides what knowledge or data is acceptable as a foundation for fisheries management, and what knowledge or data do/will they choose? As Frank Fischer [2000] writes, with the rise of neopositivism the democratic ideal has begun to disappear. Especially in the environmental field, technocratic experts have become the *de facto* advisors to Western governments on issues of public interest. He calls these expert communities “knowledge elites”, who because of their

privileged role in advising government double as “policy communities” [Fischer, F, 2000, pp. 20, 22]. The positivist, technical language of these groups can then act as a barrier to the participation of lay citizens unversed in such a dialect, and what appears on paper as a democratic debate simply becomes the more or less unfiltered transformation of the elite’s knowledge and advice straight into binding legislation or policy. Yet, like many of those operating in the competing disciplinary approaches outlined in this section, Frank Fischer [2000] is an advocate for a society where lay citizens can also be seen as experts in their specialist areas of operation, who should therefore be able to take part in so called public debate and policy formation (*i.e.* democracy). Not only does he support the idea of “specialised citizens” participating in governance [Fischer, F, 2000], but also of a “postpositivist alternative” in which knowledge does not have to be empirical and absolute, but where epistemological relativism is acknowledged and other types of lay, local and practical knowledge can be referenced to solve policy problems.

In the remaining chapters, especially in the institutional analysis of chapter 5, Fischer’s ideas about whose knowledge should inform environmental policy are a key foundation of debate, as are those of Maarten Hajer. The discussion in this section shows that it is likely institutional reform will be necessary if fishers’ knowledge is to become part of mainstream fisheries management, and this will only be possible through the deliberative policy analysis that Hajer and his colleagues describe in various publications [Hajer, 1995, pp. 280-83; Hajer and Versteeg, 2005; Hajer, *et al.*, 2009, pp. 146, 67]. The regular marginalisation of qualitative information and the top-down requisite for anecdotal information to be quantified where possible [see section 1.2 and all of the later chapters in this thesis] is a result of operating in the bounded technical network of fisheries scientists. For a primarily qualitative source of information like fishers’ knowledge to become integrated continual interaction with a number of actors is needed to catalyse a shift in ideology. A narrative would need to be established where policy-makers can identify institutional bias, taking it into account (and mitigating it) when evaluating which knowledge they should choose. Whether such deliberative policy analysis is possible (and what form it would take) is also a key consideration in the later chapters of this thesis.

1.6. Summary: chapter 1

In this chapter an outline of fisheries management and its performance to date was given. Also introduced was the concept at the heart of this thesis - *fishers' knowledge*. Its marginal position compared to that of hard natural science data was discussed, and reasons for this were given.

After highlighting a crisis within the dominant scientific community (triggered by at least the partial failure of their methods), it was speculated as to whether the fisheries paradigm would transform and allow fishers' knowledge to become a more mainstream concept. It was noted that if the paradigm was to be re-modelled, fishers' knowledge would not be the only alternative vying for inclusion in the new paradigm.

It was assessed that nascent attempts to include fishers' knowledge in fisheries management had so far been isolated and that they had barely registered with the established fisheries management institutions.

Four research questions were laid out to underpin this research through providing the starting points to answer the question of whether further attempts should be made to mainstream fishers' knowledge, and if so, what form those attempts should begin to take. Strengths and weaknesses of previous fishers' knowledge research were identified, and they influenced the setting out of an approach that would be used in this research to give it the greatest chance of discovering the best utility for fishers' knowledge.

1.7. Thesis structure

The questions posed and issues raised in this first chapter are answered (where possible) and discussed in five further chapters:

In **chapter 2** the introduction to fishers' knowledge in chapter 1 is expanded upon in detail through a wider review of the literature produced by those primarily conducting fishers' knowledge research. I will trace how fishers' knowledge has been perceived historically and I will also identify how those who research it envision it being used in future fisheries science and management. I find that there are two main schools of thought in fishers'

knowledge research. One challenges the authority of the population ecology described in this chapter, whilst the other looks to compliment it.

Then, in **chapters 3 and 4**, I will use the results of a case study in the Galway Bay and Aran region of Ireland to investigate precisely how the integrations of fishers' knowledge proposed by the researchers in chapter 2 could take place. I will do this by analysing the perceived quality of fishers' knowledge in the region's industrial fisheries and then commenting on any actual or likely institutional responses to it. In chapter 3 I find that whilst fishers' knowledge might partially support Irish scientists' fisheries stock assessments, it may not do so in a way that convinces them to permanently integrate it into their operations. However, in chapter 4 I find that if Irish scientists and fisheries managers began to consider and integrate ecological and operational dimensions of fishers' knowledge, then they may be able to design policy that facilitated better biological and socio-economic sustainability in regional fisheries. Chapter 3 will also include an outline of the methodology used during fieldwork.

In **chapter 5** I will integrate the Irish case study findings of chapters 3 and 4 into a broader analysis of the institutional landscape of fisheries science and management, where I will critically assess whether integration of fishers' knowledge is actually politically possible. In a complex institutional landscape I find that there are both opportunities for and challenges to such integration. The greatest opportunities (and challenges) perhaps lay within the existing scientific community, which has implications for the two approaches to fishers' knowledge research identified in chapter 2 (and the actual researchers within each).

Finally, in **chapter 6** I will evaluate the conclusions of the first five chapters and shape them into an overall argument of how fishers' knowledge could contribute to fisheries science and management in the future. This argument will partially be made through answering the research questions asked in section 1.3. I will conclude by stating how my research contributes to the overall body of fishers' knowledge research and by noting what implications it may have for future work in the field. My summary shows that there is a future in fisheries management for both fishers' knowledge and

those who research it, but likely only if fisheries institutions broaden their worldviews to consider new types of input and new scales of information. It is also found that it is possible that fishers' knowledge will need to partner with EBFM to become integrated into mainstream fisheries science.

2. Understanding fishers' knowledge: the origins of the concept and their significance for fisheries management

This chapter examines the origins of the concept of fishers' knowledge. Also explored are the various academic approaches to fishers' knowledge. Rather than being just a straightforward review of existing literature on fishers' knowledge, offered is a novel classification of previous research in the field. I argue that a previously unrecognised distinction can be made between two dichotomous traditions of fishers' knowledge research. One of these is *reformist* and can be considered as complimentary to traditional fisheries science. The other is *radical* and can be seen as a direct challenge to quantitative biological research. All true fishers' knowledge research is located at varying intervals between these poles.

Sections 2.1 to 2.3 show the evolution of the concept of fishers' knowledge. In each section the concept of fishers' knowledge is defined as it was perceived at the time, the disciplinary background of those publishing is investigated, and the methods used to collect and then mobilise the knowledge are highlighted. The argument made in section 2.1 is that the first wave of fishers' knowledge research was a series of historical studies carried out by amateur historians and biologists. Section 2.2 outlines a second wave of fishers' knowledge investigation that was (and often still is) characterised by ethnographic studies that examine indigenous, local, ecological and tacit knowledge. A third wave studying fishers' knowledge is described in section 2.3. This newer tradition applies a more structured, sociological approach to industrialised fisheries.

The final two sections of the chapter (before the summary) are an exercise in determining what fishers' knowledge is, and what it is not. In section 2.4 a warning is made to conventional fisheries scientists that a recent trend to package some quantitative data collected by fishers as fishers' knowledge is not an accurate representation of what fishers know. It is suggested that this apparent fourth wave of fishers' knowledge research should not get precedence over wider-ranging studies into fishers' experiences. By breaking down the constituent parts of fishers' knowledge and analysing

each, section 2.5 argues that fishers' knowledge can either be a reforming force within fisheries management or a more radical pressure that calls for fundamental changes in how fisheries science is done. This distinction is used in chapters 3 to 6 to assess the feasibility and possible outcomes of each approach.

2.1. The origins of fishers' knowledge: historical studies

I am over twenty years connected with the [fishing] trade in almost all capacities, both as fisherman, curer, and exporter of fresh fish. About ten years ago the Congested Districts Board⁴¹ introduced [large] boats to Teelin [...] and about 1898 twelve Teelin boats came to Downings Bay early in August, and met with a record season. Without exception these boats from they began to fish returned loaded with prime herring [...].

Well, sir, about 1900 a decided change for the worse began [...] boats from all parts of Scotland and the Isle of Man came to Downings, to meet with disappointment.

But each year for the past five years it has been gradually dwindling down till these last two winter seasons, when it resulted in complete failure. The early summer fishing looked like being a success at first, but now, like the autumn, it seems as if it has seen the best of its days.

Over 150 large boats came from Scotland in May, 1905 and worked all May and June, with the result that out of this large fleet only about ten boats cleared themselves, and the others went away poorer than they came; [...].

One thing I am certain of: The increase of boats and buyers has not increased the catches, but quite the reverse; so people can use their own judgement. A good fishing sprang up at Burtonport and Rosbeg last winter, and I firmly believe that so long as only small skiffs fish these waters they will hold good; but let large boats get a while working there and I will guarantee the Rosses waters will soon be swept as clear as the Downings. [Anon., 1905 in Conaghan, 2003, pp. 148-49]

The documentation of knowledge attributed to fishers is not new, as can be seen in the anonymous quote recounted by Conaghan [2003]; a story told by a fisher from Donegal, Ireland. It is a story representative of fishers' knowledge, for the narrative clearly demonstrates that fishers possess an experienced-based knowledge that has the potential to impact on fisheries management. Referencing this Donegal example, it can be hypothesised that an increase in fishing effort led to a collapse in fishery landings of herring from Downings Bay. It is reasonable, based on this implication, to theorise that a management plan could have been formulated to promote recovery in the fishery, advocating reduced landings or less fishing effort.

⁴¹ See glossary: Congested Districts Board.

This inference is produced purely from the knowledge of one fisher without any input from fisheries scientists, (who may not even have been working in the region in 1905). If the fisher had been heeded, the case for a local management plan for the herring fishery would have been compelling.

This Irish example is not an isolated case. The assertion by the renowned biologist Thomas Henry Huxley⁴² in 1883 that the North Sea herring fishery was inexhaustible [see section 1.5] was made in response to local fishers' convictions that the herring stocks were diminishing [Sims and Southward, 2006]. However, within ten years of this statement a number of Huxley's contemporaries were listening to Scottish fishers who had similar complaints about herring declines in a Scottish estuarine fishery on the Clyde [Thurstan and Roberts, 2010]. His contemporaries on the Fishery Board of Scotland contradicted his assertion, and instead chose to agree with the knowledge of fishers who had expressed concerns to them, pronouncing a bleaker future for herring fisheries. They concluded that some trawl operations were causing fishing mortality at levels that would cause the fishery to decrease in biomass [Ewart, *et al.*, 1888, p. 120].

Whilst these examples show that fishers' knowledge was documented in the early days of fisheries science and management, the documentation does not appear for the most part to have been undertaken by the scientific community. Without the detective work done by Hutchings, *et al.* [2002] and Murray, *et al.* [2008a] the beginning of scientific research into fishers' knowledge may have been lost to the annals of history. Their publications, detailing the historical collection of data relating to the cod stocks and migrations in the Gulf of St. Lawrence, Newfoundland, uncovered the pioneering work of W. A. Munn, a local Newfoundland merchant who was also an amateur natural historian.

Although he did not overtly label his research as such, Munn [1922] effectively carried out (certainly as far as documented research goes) the

⁴² Huxley was a key scientific reformer in British history. As president of the Royal Society from 1883-85 he persuaded the British government of the value in forming policy from scientific findings. He was also a friend of Charles Darwin and the main advocate for his theory of evolution [Bibby, 1959]. It was in his role as Inspector of Fisheries from 1881-85 that he commented on the North Sea herring fishery.

first study based explicitly on fishers' knowledge. His study relied entirely on intensive questioning of local fishers from which he was able to identify traits in the life cycle of the local cod population, including its migratory patterns. The results drawn from the study were based entirely on the qualitative observations of fishers.

Munn's [1922] study remained the primary source of knowledge on Gulf of St. Lawrence cod stocks well into the 20th century and also formed the basis of a similar stock survey by Thompson [1943]. Scientific research by fisheries specialists was almost non-existent in the region; the cod fishery in Munn's time would have been what is now termed 'data poor' by fisheries scientists. This is significant as later examples in this chapter show that it is often under these conditions that fishers' knowledge has come to the fore. Indeed there is great irony here, as after a strong start in the region in terms of importance, fishers' knowledge was quickly marginalised and replaced by the 'data rich' fisheries science which went on to oversee the collapse of the northern cod. Section 2.3 shows that it was only after this collapse that fishers' knowledge began to come back into vogue, and be recognised as a source of information that could have saved the species commercially [Neis, *et al.*, 1999b; Murray, *et al.*, 2008a].

Arguably, the publication of Templeman's [1979] study of cod stocks, based entirely on a fish tagging study conducted by fisheries scientists, marked the end of the first wave of fishers' knowledge research [Murray, *et al.*, 2008a]⁴³. It was an era when just a few fisheries historians dominated fisheries research, often getting their information directly from fishers. Since then, heavily quantitative, biological studies became *de rigueur* in management of commercial fisheries, with mainstream researchers showing little appetite or respect for fishers' knowledge.

⁴³ The lack of influence of this first wave of fishers' knowledge research on mainstream fisheries science is shown diagrammatically in figure 2.2. The contrasting inspiration of this first wave on third wave practitioners, such as Murray and his colleagues, is shown in the same figure.

2.2. The discovery of fishers' knowledge by ethnographers

During the period where fishers' knowledge was only considered by natural historians, it was never self-consciously acknowledged as a concept. This only happened in the late 1980s and even then it was mostly in isolation from mainstream fisheries science. The first to make this acknowledgement were those practitioners who commenced the second wave of fishers' knowledge research. For the most part they were ethnographers who had become aware of fishers' knowledge through their exposure to the artisanal and subsistence fisheries of the developing world. The key figure, and essentially a pioneer in this re-emergence, was Robert Johannes⁴⁴.

In two works, (the first an account of sixteen months spent living with indigenous fishers [Johannes, 1981], the second an essay [Johannes, 1989c] in a self-edited collection of anthropological essays⁴⁵ [Johannes, 1989a]), Johannes is the first to specifically identify an experience-based knowledge within fishers. He attributes to them a knowledge of the marine environment in which they work. In these predominantly narrative works he described his own experiences researching fishers in Palau. He was amazed at the volume of knowledge that the Palauan fishers held about certain species that could be of interest to fisheries scientists and managers. His account was entirely qualitative, but did have the potential to describe quantifiable events. One example of this was an account of the

⁴⁴ Unlike some of his fellow ethnographers, Robert E. Johannes (1936-2002) started as a biological marine scientist specialising in the effects of the cyanide fishing and the aquarium trade for live fish. He is considered as one of the first interdisciplinary scientists in marine science because of his adoption of an approach that merged scientific ecological knowledge with traditional knowledge systems of indigenous populations. At first criticised for his move to the non-commercial fisheries of Palau, he was later lauded by colleagues for this bottom-up approach. His 1981 book about his experience in Palau, *Words of the Lagoon*, is now seen as a classic within the field of marine science. The value of his work is perhaps best summed up by the Palauans he worked with who said he was, "the first [fisheries researcher] who ever asked us about our knowledge; the others only told us about theirs" [PEW Environment Group, 2009].

⁴⁵ Even in this book Johannes is the only author to focus exclusively on the marine environment. Of six case studies in the edited collection, four are from terrestrial ecosystems: the desert of the Kalahari, botanical landscapes in South America, the farmlands of Yap Island and the rice fields of Sierra Leone. Of the other two, one example is predominately terrestrial with only limited mention of freshwater and marine ecosystems: coastal New Caledonia. Only an example from Palau, Micronesia [see Johannes, 1989c] is entirely dedicated to describing stakeholder knowledge in a marine environment [Johannes, 1989b].

timing, location and behaviour of spawning for the mojarra⁴⁶ fish. These were lifecycle characteristics that were previously unknown to fisheries scientists [Johannes, 1981; 1989c].

Although their studies were similar to that of Munn [1922], neither Johannes nor his fellow pioneering ethnographers seemed to reference this or similar studies [this lack of influence is represented in figure 2.2]. Therefore, their work should really be considered as an independent discovery rather than a rediscovery of fishers' knowledge. Where had this group come from?

It is likely that they were a product of a wider movement, not in the natural sciences but in social science that commentators have since called the "ethnographic turn" [Culyba, *et al.*, 2004]. At this stage, behaviourism and modernisation theories were fashionable in developed countries⁴⁷. From the mid-1970s however, a change occurred in social research where a niche course of investigation developed alongside the mainstream positivism, again because of external influences. The modernist agenda, rather than continuing to be seen by all as a panacea, started to be perceived as a problem. Within developed countries it was blamed for poverty creation and a widening gulf between rich and poor [Purcell, 1998]⁴⁸.

A few researchers recognised that broad positivist studies were not always sensitive to social and cultural issues, and they started to develop policies that allowed for a new strand of research to develop. Escobar [1991]

⁴⁶ See glossary: mojarra.

⁴⁷ Western states that housed a large majority of the world's research institutions, were engaged in a process of industrialising their colonial partners in what they perceived to be an undeveloped Third World [Purcell, 1998]. Resultantly, the science of the time was dominated by similar ideals with a focus on measuring growth and development quantitatively with positivist methodologies. For instance, those sociologists engaged in the early analysis of non-Western peoples did not engage with these societies from the inside in an effort to discover their intricate workings. Instead, they focussed on making general assessments of issues such as cultural evolution, integration of social institutions, and racial hierarchy within wide populous groups [Purcell, 1998].

⁴⁸ The same accusation came from developing nations, where despite efforts by Western donors and experts to bring indigenous people into the global economy, poor health and living conditions persisted for the most marginal individuals in society [Escobar, 1991; Agrawal, 1995b].

identifies that new overseas assistance programmes mandated consideration of such issues and therefore provided opportunities for a new generation of ethnographic researchers to emerge. Often these ethnographers remained marginal to a mainstream social science community that maintained faith in its positivist research methods. However, they developed new outlets for publishing studies based on bottom-up observational studies of indigenous people. They used participatory methods and often relied on extended periods of fieldwork [Culyba, *et al.*, 2004]. Their results often criticised the effects of the external Western management and they took a postmodern or post-colonial approach that put stronger faith in traditional non-materialist modes of management [Crow, 1997].

The ethnographic turn was not limited to the development sector. Western knowledge also became the *de facto* information source for environmental management [Agrawal, 1995b]. This often resulted in unsustainable development, where ecosystems were destroyed for global capital gain at the expense of local communities. A nascent environmental movement recognised this fallacy and helped to formulate and enact policies⁴⁹ which allowed local people to extract resources sustainably and profitably [Purcell, 1998]. During enactment of the new policies, ethnographers were employed to identify the needs of indigenous communities. They soon realised that it was necessary to first understand indigenous knowledge before such needs could be measured. As they resultantly came to understand traditional environmental management techniques, they showed admiration for these processes which often promoted sustainability. It is therefore likely that the ethnographic turn was the inspiration of Johannes and his contemporaries who were the first marine ethnographers.

This recognition of a traditional, and importantly sustainable, environmental management was acknowledged by Dahl [1989]. Working at the same time as Johannes (and clearly an admirer of his work), he cited Barrau's [1956] research into the land-based agriculture of New Caledonia as amongst the few case studies, to that date, which had considered the value of

⁴⁹ *E.g.* The *National Environmental Policy Act* of the USA in 1969.

stakeholders' experience-based knowledge. Dahl [1989] translated this work on local agricultural systems to the neighbouring marine ecosystems. His reviews of the literature, documenting fishing practices in New Caledonia, found that the island people had historically practised their own system of fisheries management. They practised banning fishing for six months per year, based on their knowledge that fishing too intensively could cause the fishery to become seriously depleted. This unwanted scenario would have led to the undesirable situation of nutrient deficiency within the community. Their belief was not based on quantitative measurements of fish stocks, but on many years of simply observing the fishery. The style of study unveiled by Dahl [1989], and similarly by Johannes [1981; 1989c], is indeed ethnographic and seems to confirm the ethnographic turn as the route of the second wave of fishers' knowledge research.

Yet, in truth, the literature on fishers' knowledge has remained limited in volume and is still developing conceptually. The initial publications of Johannes [1981; 1989c] acted as the seeds for a slight increase in the volume of research into fishers' knowledge in the last decade of the 20th century, but still relatively few scholars seem to have been involved in comparison to other areas of fisheries research. The majority of investigation in the second wave was of case studies of individual locations, which continued to be those in the developing world. The following examples illustrate how these case studies attempted to define fishers' knowledge further.

A significant portion of the work which documented fishers' knowledge during the early 1990s is collated in a couple of primarily ethnographic anthologies. Freeman, *et al.* [1991] brought together a number of examples from traditionally managed marine ecosystems in their *Adaptive marine resource management systems in the Pacific*, whilst Dyer and McGoodwin's [1994] *Folk management in the world's fisheries: lessons for modern fisheries management* offered contributions from those focussing on the issue of folk management in fisheries. Fishers' knowledge may not be the outright theme in either book, but it was still highlighted in each. In a journal paper of the same period, Gadgil and Berkes [1991] were able to

summarise the common ground between the publications that were describing the emergent fishers' knowledge concept: the underlying knowledge which drove fisheries management in the cases described was the stakeholders' own.

In an example from the Yap State, Federated States of Micronesia, fishers were aware that new methods of fishing by flashlight were disturbing fish spawning, compromising the sustainability of the fishery through preventing future year classes from being produced. In response, a new management plan looked to return to usage more traditional methods of fishing that were known to be sustainable [Smith, 1991]. Another study showed that knowledge accrued through instruction from senior fishers led to all fishers in the village of Buen Hombre, Dominican Republic, fishing with a conservation ethic. From this education they knew that fishing small fish could stop a species from having the chance to reproduce [Stoffle, *et al.*, 1991].

A final example from these compendiums represents one of the first attempts to look at a fishers' knowledge on a larger scale. A meta-study by Ruddle [1991] took a systematic approach to look for commonalities in this knowledge between Venezuela, the Pacific Basin, and the Virgin Islands. He identified the components of local knowledge in each geographical location to include understanding of fish behaviour, the physicality of marine ecosystems and fish habitats, marine fauna nomenclature, ecological models, and conservation⁵⁰.

The channels for publishing research on fishers' knowledge widened through the late 1990s. No longer was ethnographic research confined to

⁵⁰ Ruddle [1991] describes how indigenous taxonomies are often more complex than those from Western science. This is because they have extra divisions based on knowledge of behaviour variation within a species at more local geographical levels. Looking at Palau, he shows that fishers separate a fish of the same species by its size, biting style, diet, physical appearance, smell and taste. Similar divisions are described by him in the Solomon Islands, where marine organisms are named after the habitat in which they dwell, what they feed on, where they shelter, how they escape, the manner in which they spawn, the size of fish school that they swim in, and the time of day at which they are most active. He then describes the Cha-Cha people of the Virgin Islands who name shark species after the type of food they ingest and the manner in which they capture it.

being published in the qualitative outlets of social science, as mainstream fisheries science journals had started to house second wave authors. Additionally, discovery of fishers' knowledge was no longer the only or even primary concern of those riding this wave. Within their immediate field of contemporaries they had already acknowledged the empirical existence of fishers' knowledge and had instead moved on to analysing firstly, how it was accrued and secondly, of what it was constituted.

Accruing fishers' knowledge

Lane and Stevenson [1999] identified fishers as a classic example of Drucker's "knowledge worker". Research from disciplines beyond fisheries science has shown that in whatever workplace an individual works they accrue knowledge during their daily tasks at work. Not only can this improve their own performance, but it can be used to aid operations and efficiency of the wider workforce as a whole [Drucker, 1994; 1999]. Pálsson [1995; 1998b] says this is equally true of fishers. For example, junior deckhands gain knowledge such as crew control skills, attentiveness, and self-confidence from their skippers.

Fishers' knowledge is either accumulated overtly as a conscious knowledge [Reber, 1989] that is easily codified and recognisable to those of all expertise, regardless of the historic and geo-spatial situation in which it is produced [Stanley and Rice, 2003; Witt and Zellner, 2007], or covertly as a tacit knowledge [Witt and Zellner, 2007]. Polanyi [1962] described this tacitness as a concept where, "we know more than we tell." This is an idea he also developed and defined as a knowledge comprised of skills and competencies achieved through human interaction [Polanyi, 1966]. He described it as knowledge of which its owners are not consciously aware, but which constantly influences their thought processes and actions. Tacit knowledge is hard to codify and can be unrecognisable to those not acquainted with it [Russell, 1910].

Daw [2008] situated this in a fisheries context as a non-scientific knowledge, which he and Berkes [1993] described as a system of beliefs, knowledge, practices and perceptions held only by fishers. This is backed up by the theory of Audi [2003] who said that sometimes we must "know

how” before we can “know that”. The act of “knowing how” is an attribute that is increasingly attached to fishers’ knowledge with both Neis, *et al.* [1999a] and Stanley and Rice [2003] having made the case that what fishers know is not something they set out to know, but simply a product of how they operate. Pálsson [1998a] adds most colour to the understanding of tacitness in fisheries recalling a quote from the skipper of an Icelandic fishing boat:

It’s so strange, when I get there it’s as if everything becomes clear. I may not be able to tell you exactly the location, but once I’m there it’s as if everything opens up. [Anon. in Pálsson, 1998a, p. 62]

Fishers’ tacit knowledge is the underlying knowledge that informs their fishing tactics [Pálsson, 1998a], whether this be when and where to fish, what species to fish, or how best to fish.

Further to this, fishers’ knowledge is accrued by individuals living in unique lifeworlds [Hamlyn, 1970; Goldman, 1999; Pálsson, 2000]. They are often isolated on boats out at sea where they play very specific roles and their knowledge is therefore a highly individual product [Murray, *et al.*, 2006]. It is only when socialising occurs between colleagues and generations that a more aggregated group knowledge is created [King, 1997; Murray, *et al.*, 2005; Murray, *et al.*, 2006]. Due to the production level of the individual, fishers’ knowledge can reveal information about a locality at the micro-scale [Long, 1992; Mackinson and Nottestad, 1998; Fischer, J, 2000; Murray, *et al.*, 2005]. Additionally, it gives the knowledge temporal scale that is not present in scientific knowledge where knowledge is either collected systematically at intervals (e.g. annually) or even more sporadically (e.g. when there is a one-off biological study), [Pálsson, 1995; Fischer, J, 2000]. Fishers have long careers through which to amass this knowledge and due to their constant engagement in activities at sea they are likely to observe any long-term historical changes [Johannes, *et al.*, 2000; Johannes and Yeeting, 2001]. At the same time, this constant presence on the water allows them to accumulate knowledge in real-time [García-Allut, *et al.*, 2003]. Johanne Fischer [2000] perhaps paints the clearest picture of the value of fishers’ knowledge for describing spatial and temporal phenomena when she contrasts it with scientific knowledge. Whilst she identifies that scientists appear to have the potential to accumulate greater volumes of

knowledge through the global reach their advanced equipment and substantial budgets afford them, they still do not have extensive enough resources to continuously generate local knowledge like fishers can.

Constituent parts of fishers' knowledge

In analysing how fishers' knowledge has been considered to have been accrued, it has already been shown that fishers' knowledge can be labelled as tacit, local, and historical. Earlier in this chapter it was also designated as traditional and indigenous. In fact it can be all of these or none of these and more. What has been referred to mainly as 'fishers' knowledge' so far in this thesis is rarely given this name in published literature. As table 2.1 shows, many names have been assigned to the concept in various publications.

Sometimes publications have made a case for fishers' knowledge having some of the attributes highlighted in table 2.1, but not others. For instance, a number argue that only indigenous fishers can have fishers' knowledge. They see it is a traditional source of information based on ancient techniques where it is only passed from generation to generation of fishers in a specific locality [see Berkes, *et al.*, 1995]. However, others believe that the drivers of knowledge remain dynamic and as they change then so does the makeup of fishers' experiential knowledge [see Murray, *et al.*, 2005]. Not only does the nature of fishers' knowledge change, but also the methods by which fishers accumulate it. Pálsson [1995] describes how fishers have widely embraced high-tech solutions to fishing in recent decades, such as the use of sonar for locating shoaling fish. Fishers' knowledge is never stationary and is constantly evolving.

There has been a tendency to see fishers' knowledge as a purely ecological construct. Indeed, Berkes and Folke [1998] view humans as integral parts of ecosystems, so it is natural that fishers who interact with nature more than most are so knowledgeable about marine ecosystems. A number of studies focus purely on what fishers can reveal about the environment, including Huntington's [2000] examination of whale and herring fisheries and Gerhardinger, *et al.*'s [2009] of the groupers in Brazil.

Table 2.1. A review of how selected literature perceives fishers' knowledge. Each text has been analysed to see whether it includes ecological, socio-economic, operational/management, local and traditional/artisanal/indigenous aspects of knowledge in its broader definition of fishers' knowledge.

Descriptor used for 'fishers' knowledge'	Publication					
		Ecological	Socio-economic	Operational/Management	Local	Traditional/Artisanal/Indigenous
fishers' ecological knowledge	Neis [1992]	x	x	x	x	x
fish harvesters' ecological knowledge	Murray, <i>et al.</i> [2008]	x	x		x	x
fisher knowledge	Silver and Campbell [2005]	x	x	x	x	x
	Stanley and Rice [2003]	x		x	x	x
fisherman knowledge	Suuronen, <i>et al.</i> [2010]	x		x		
fishermen's knowledge	Helvey [2004]	x	x	x	x	
	McCay, <i>et al.</i> [2006]	x		x	x	
	Scholz, <i>et al.</i> [2004]	x	x	x	x	x
fishers' data	Dobby, <i>et al.</i> [2008]	x				
fishers' ecological knowledge	García-Allut, <i>et al.</i> [2003]	x	x	x	x	x
fishers' experiential knowledge	Shephard, <i>et al.</i> [2007]	x	x		x	
fishers' knowledge	Johannes, <i>et al.</i> [2000]	x		x	x	x
fishers' local ecological knowledge	Silvano and Valbo-Jørgensen [2008]	x			x	x
human capital [attributed to fishers]	Pinkerton and Weinstein [1995]	x	x	x	x	x
indigenous ecological knowledge	Hamilton [2005]	x		x	x	x
knowledge [attributed to fishers]	Johannes and Yeeting [2001]	x		x	x	x
	Neis, <i>et al.</i> [1999b]	x	x	x	x	
	Pálsson [1995]	x	x	x	x	x
	Pomeroy and Berkes [1997]	x		x	x	x
local ecological knowledge	Mackinson [2001]	x	x		x	
	McKenna, <i>et al.</i> [2008]	x			x	x
	Scholz, <i>et al.</i> [2004]					
	Wilson, <i>et al.</i> [2006]	x	x	x	x	
local fishers' knowledge	Hamilton, <i>et al.</i> [2005]	x		x	x	x
localized knowledge	Breschi and Lissoni [2001]		x		x	x
traditional ecological knowledge	Berkes, <i>et al.</i> [1995]	x		x	x	x
	Catlin [2008]	x	x	x	x	x
	Lavides, <i>et al.</i> [2010]	x		x	x	x
traditional knowledge	Huntington, <i>et al.</i> [2000]	x			x	x
	Moore [2003]	x	x	x	x	
	Huntington, <i>et al.</i> [2004]	x			x	x
traditional local knowledge	Soto [2006]	x	x	x	x	x

More progressive however is the view of the ecosystem as part of a social world, which due to its social nature cannot only be populated by ecological knowledge. Neis and Felt [2000b, p. 20] and Murray, *et al.* [2005] describe fishers' knowledge as a socio-ecological product, reflecting both social and

ecological experiences within fishers' lifeworlds. The experiences beyond the ecological include those of fishing culture, fishing operations, institutional actions, labour processes, technology, accounting, and market conditions [Pálsson, 1995; Neis, *et al.*, 1999b; Murray, *et al.*, 2005; Murray, *et al.*, 2006]. King [1997], for example, heralded "folk management" based on fishers' knowledge in Belize's lobster fishery. His qualitative study of the artisanal fishers at Caye Caulker showed that fishers' knowledge was not simply of local ecology, but also comprised detailed knowledge of good management practice. He found that fishers passed their knowledge of harvesting practices and the nature of territorial access to the fishery from generation to generation. This had resulted until recently in a sustainable fishery existing since at least the 1920s⁵¹.

As fishers' knowledge is accumulated in individual lifeworlds, the mechanism of constructing it as a socio-ecological product is highly heterogeneous. Murray, *et al.* [2006] emphasise the dynamic nature of the environments fishers occupy, where ecological conditions, institutional interactions and fishing practices are constantly changing. The site of knowledge accumulation is specific to a certain place and moment in time, meaning each fisher has different ecological, socio-economic, and operational knowledge. For instance, fishers who use different gears and operate in different localities will likely have different knowledge of the same fish stock, as was seen in the previously mentioned example of the collapse of the northern cod in Newfoundland, Canada. The fishers who warned of collapse (but were ignored) were operating closer to shore and using traps and handlines, whilst those who appear to have had no knowledge of the impending collapse were fishing offshore with gillnets and demersal trawls [Finlayson, 1994]. The dynamic heterogeneity of fishers' knowledge is described even more emphatically by Crona [2006] in the fisheries of south Kenya, where she found that knowledge was not only

⁵¹ With regards to harvesting practice, overall lobster populations had been controlled by a policy of not harvesting undersize lobsters for commercial purpose. Overall effort in the fishery had also been limited traditionally with access to fishing grounds generally restricted to direct descendants of former fishers. Fishers had found this system to be effective for generations and had continued to observe a healthy lobster fishery. However, fishers had recently remarked that lobster populations were decreasing due to traditional management laws breaking down with commercial harvesting of undersized lobsters having started, much of this by fishers who wouldn't have previously been granted access rights [King, 1997].

shaped by which fishery they worked in and the gear a fisher used, but also by how long they had lived locally, whether they could swim, their religious beliefs and worldviews, the length of time they had been in the fishery, and the degree to which they received economic subsidies.

From the analysis in this and the previous subsection, the definition of fishers' knowledge I deem most accurate is: **Fishers' knowledge is a heterogeneous socio-ecological construct built from an individual fisher's experiences in his or her lifeworld. The knowledge can be qualitative (i.e. anecdotal/narrative) or quantitative (i.e. information) as well as conscious (i.e. overt) or unconscious (i.e. tacit).** This is the definition I use in chapters 1 to 5 and it is summarised in figure 2.1. In chapter 6 a more complex conceptualisation is advanced.

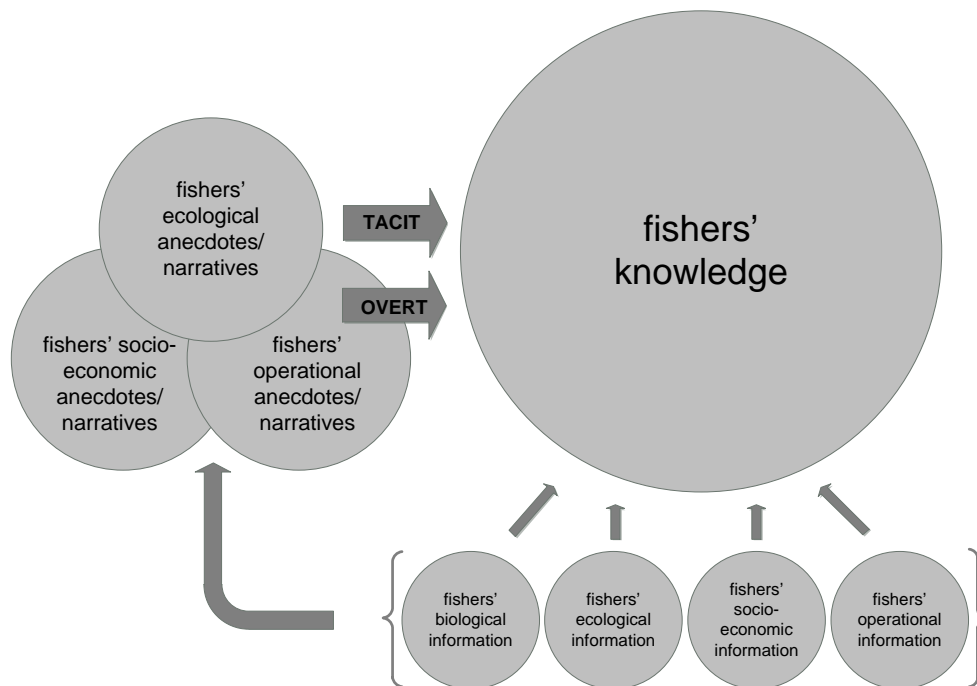


Figure 2.1 The construct of fishers' knowledge.

As ethnographers found out more about how fishers' knowledge was accrued and constituted, they again tried to find trends by scaling up their research, as they had done with their knowledge discovery case studies. Bavinck's [1996] case study of the Coromandel Coast, Tamil Nadu, India

analysed several hamlets along a stretch of coastline, attempting to link management policy based on fishers' knowledge from different locales. He found that a certain type of fishing gear was banned in the region because of criticisms drawn from fishers' experience of using and observing that gear⁵².

Berkes, *et al.* [1995] took a further step up in scale by trying to find commonality between multiple case studies. Considering two marine ecosystems; traditional Indonesian inshore polyculture pond management⁵³ and the "integrated corporate real-estate" of Marovo, Solomon Islands⁵⁴, they found that in both cases, fisher or stakeholder knowledge manifested itself within a belief system based on ancient concepts of the ecosystem. Knowledge had been developed through trial and error, with the goal of both the respective communities being to achieve maintenance of their local ecosystems; something they had done since time immemorial. As intended, both were judged to have a high level of socio-ecological sustainability.

⁵² The fishing gear called the 'kachaavalai' was a snail net baited with waste and its operation was very lucrative as snails landed could be sold directly to urban restaurants for high prices. However, local fishers not involved in the kachaavalai fishery were highly critical of it as in their opinion the waste bait adversely effected the behaviour of other fishery species (making them harder to catch). The fishers of the Coromandel Coast believed that the smell of the kachaavalai bait was unattractive to smaller fish species and caused them to leave the area. They also believed the smell attracted sharks which then preyed on some fishery species. This downside was further compounded by the fishers' additional belief that the removal of snails was also causing other fishery species not to migrate to the region. They believed that the gurgling sound of the snails had attracted some fishery species and that other species had also migrated to the area to directly prey on the snails [Bavinck, 1996].

⁵³ Indonesians, including those from Bali, developed a three tier system for production of rice, fish and vegetables. In the first stage of nearshore fields they would channel river waters to grow rice and fish. Waste from this system would then feed a second stage, where shrimps and vegetables were grown in ponds amongst coastal mangroves. Shrimp from this system would then be exported to the third stage, the traditional inshore fisheries of the open sea [Berkes, *et al.*, 1995].

⁵⁴ The Marovo system involves communities having ancestral rights of management for a whole connected system, from the top of the watershed to coral reefs out at sea. This fits very closely with modern concepts of ecosystem-based management championed by new generations of Western environmental scientists. The Marovians would manage upland forest, coastal beaches, open sea and coral reefs based on the environmental experiences of their ancestors, creating a sustainable environmental zone in the process [Berkes, *et al.*, 1995].

A criticism that could have been levelled at those researching fishers' knowledge since Munn [1922] is that they had only focussed their research on the data-poor fisheries of the developing world, when perhaps research was more urgently needed in the industrial fisheries of the developed world where stock collapses were becoming increasingly common.

This criticism though would be premature. Most of the academics of the second wave, although initially researching in the developing world, were based at institutions in the developed world. Having gained experience overseas they were quick to look for examples of fishers' knowledge closer to home. The connection between subsistence and artisanal fisheries of developing coastlines with commercial ones seems to have been made via the stepping-stone of First Nations'⁵⁵ and Inuit fisheries within developed world nations, especially in Canada and Scandinavia. For instance, Berkes [1998] found that the Cree people of James Bay in the Canadian sub-Arctic had a fishers' knowledge of the marine species they targeted. They were aware of both the behaviour of the fish and the techniques required to prevent overexploitation of stocks. Firstly in this case, they knew where best to catch whitefish, but then secondly they knew that as soon as they saw a drop in catch per unit effort that they should relocate their fishing operations⁵⁶.

With this thesis primarily focussed on helping to solve the crisis in industrial fisheries, it is important to assess whether the second wave then investigated whether trawler fishers had a fishers' knowledge that could be used by fisheries managers. The lack of a parallel literature in developed world fisheries was clearly a concern for Johannes, *et al.* [2000] and in a seminal paper they made an argument for fishers' knowledge studies to be

⁵⁵ See glossary: First Nations.

⁵⁶ Cree fishers' knowledge meant that they knew where best to fish whitefish based on seasonal events. They knew that fish are best harvested in spring where the ice is melting on the edge of bays. In August they moved the fishery to sites of spawning aggregations and in early autumn they re-focused their fishing effort to specific depths over sand-gravel beds that were perceived to be the best fishing location at that time of year. The use of this knowledge meant that fishing remained a productive activity for the Cree. Elder Cree managed the younger Cree fishers by responding to environmental feedback they saw. They insisted on relocation of the fishery as soon as they saw catches declining. This ensured that the fishery was sustainable for future dynasties of Cree and that knowledge of how to manage the fishery was also passed from generation to generation [Berkes, 1998].

undertaken in these regions where biological science currently dominates. They outlined two further examples from developing world fisheries and three from those fished by First Nations or Inuit people to try and promote the consideration of qualitative anecdote from fishers in industrial fisheries research.

They made their case for doing this by highlighting cases in which fishers' knowledge uncovered crucial information that fisheries biologists had missed. In examples of a tuna bait fishery in the Solomon Islands and a bonefish fishery in Tarawa Lagoon, Kiribati, the authors highlighted how data collected only from fishers' anecdotes could help prevent fishery declines if acknowledged [Johannes, *et al.*, 2000]. In the case of the bonefish, fishers' knowledge actually demonstrated that its use could stop the actual extinction of a species [Johannes and Yeeting, 2001]⁵⁷. The three remaining case studies were used to illustrate how fishers' knowledge was the best source of knowledge for estimating Arctic whale populations, because the limited experience of marine scientists with this species meant that they often underestimated total numbers. Two further cases related to beluga whale prevalence and distribution in Canada; firstly in the southeast Baffin region and secondly in Hudson Bay. In both cases, Johannes, *et al.* [2000] detailed how and why First Nations fishers held more knowledge of their hunting grounds than fisheries scientists, and why this made it better knowledge with which to document and manage the fishery⁵⁸. They drew a similar conclusion for the knowledge of Inuit hunting bowhead whales in Alaska, where fishers identified the range and timing of whale migrations to

⁵⁷ Both the example of the tuna bait fishery in the Solomon Islands and the bonefish of Tarawa Lagoon are covered in more detail in section 1.2.

⁵⁸ In the southeast Baffin region, scientists believed there to be an absolute population of five hundred belugas that were being hunted by the Inuit at the rate of one hundred per year. This intensity of hunting would not be sustainable. However, according to the Inuit this population was actually being constantly replaced by newly arrived whales. They claimed to know this because they could recognise the different markings on the individual whales, which they said the scientists did not. Indeed, scientists have had to reconsider their initial findings after satellite tracking data of belugas has added weight to the arguments of the Inuit. In Hudson Bay scientists believed there to be two separate beluga stocks, which were perceived to be so desperately depleted that they considered them critically endangered. This finding was based on the assumption that all whales left in October before the bay froze. It is this assumption that was challenged by the Inuit and Cree Indians who said that they regularly encountered beluga over the winter and that there was in fact a substantial population unknown to science [Johannes, *et al.*, 2000].

be wider and longer than as defined by science⁵⁹. This final case is described in greater detail in section 1.2.

Having witnessed publications of papers (such as this call by Johannes, *et al.* [2000]) in mainstream fisheries science journals, an optimist would be allowed the temptation to state that the definition of fishers' knowledge, and its use, has become part of the orthodoxy. However, it is still hard to find published research about fishers' knowledge in developed fisheries. In existence are only a very limited number of publications where fishers' knowledge is considered as a stand-alone knowledge in this region. It must be concluded that the very idea of fishers' knowledge is far from mainstream.

Pálsson's [1994; 1995] studies describing Icelandic fishers are some of the first in the developed world. He described them as experts with such a great knowledge that their boats and fishing gear became simply an "extension of the person", and that the environment they fished in was as recognisable "as their fingers". With this in mind he theorised that fishers' knowledge could produce an assessment of fish migrations and stock [Pálsson, 1995]. Also amongst the early fishers' knowledge researchers focussing on the developed world was Neis [1992], who went a step further than theory and actually utilised her qualitative interviews (alongside those of others) to collect knowledge from fishers, enabling her to get a better picture of the inshore northern cod fishery in Newfoundland. Amongst her findings was that trap and handline fishers held the view that lost and discarded nets continued to fish on the ocean floor, therefore leading to increased mortality in the fishery. They believed thus that a ban in the use of these nets would make the fishery more sustainable [McCay, 1976; Neis, 1992].

Crucially though, unlike the ethnographers of the second wave, neither Pálsson [1995] nor Neis [1992] considered fishers' knowledge to be a stand-alone information source for managing fisheries. Both went on to say

⁵⁹ The example of the bowhead whales in Alaska is covered in more detail in section 1.2.

that it must be partnered with further knowledge sources. No contemporary research seems to have been published about industrial fisheries where fishers have managed an industrial fishery themselves with decisions based entirely on data produced from their own knowledge. A different approach has been taken to researching these fisheries and is described in the following section.

2.3. Fishers' knowledge goes mainstream? The application of the approach to developed industrial fisheries

Even with the growth of the fishers' knowledge research in the subsistence and artisanal fisheries of the developing world and First Nations, it must still be considered that the debate was marginal. Fishers' knowledge was not being mentioned in publications by state employed fisheries scientists as the end of the 20th century approached. Since then though, there has been increasing evidence that a new breed of fisheries scientist has started to study fishers' knowledge in industrialised fisheries. These scientists can be considered to be part of a third wave and the commencement of their research can be traced to as early as the 1990s.

They have drawn some inspiration from the ethnographic work of the second wave [represented in figure 2.2], but its practitioners would not consider themselves ethnographers. At the same time, the background of those in this third wave is not necessarily that of traditional marine scientists who are rooted in the biological sciences alone. This new group of practitioners appears to utilise some of the ethnographic techniques of the second wave, but marries them with other methodologies from the social sciences. Some of their early work was quite abstract, but it has quickly become dominated by more practical approaches. Their work can be broadly defined as applied sociology.

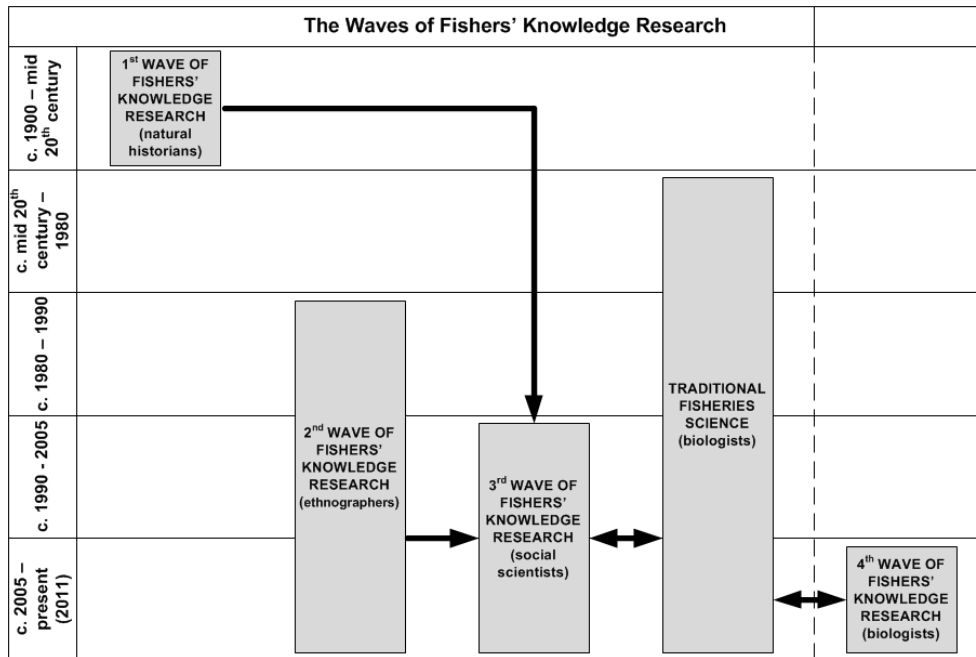


Figure 2.2. Timeline showing the four waves of research into fishers' knowledge. Shown (in brackets) are the primary group of practitioners working in each wave. The arrows represent the influence of one wave upon another. Where the arrow is unidirectional, influence is only referenced by practitioners in the wave that the arrow points to. Practitioners in the wave from which the arrow emanates show little or no acknowledgment of the wave they have in turn influenced.

Where Robert Johannes was the pioneer of fishers' knowledge research in developing world and First Nations' fisheries, Barbara Neis holds the comparative role in industrial and commercial fisheries. She was the first to prominently identify the link between developed world fisheries and research into fishers' knowledge in the developing world and First Nations. She gave credence to the techniques used by ethnographers to identify detailed ecological knowledges in coastal communities [Neis, 1992]. However, whilst making the case for these techniques to be mimicked in more modern fisheries, she always described them as supplementary to biological studies, not as a stand-alone alternative.

Her view was of fishers' knowledge as a companion; a mainly qualitative anecdotal knowledge to confirm or contrast with the quantitative data of fisheries science; particularly also as a knowledge to fill gaps where fisheries science remained data poor. This was echoed by Pálsson [1995], who although a believer that fishers' knowledge could be more accurate than that of fisheries scientists, said that scientific knowledge and experience-based knowledge were complimentary sources of wisdom.

Neis [1992] illustrated how fishers' knowledge could fill the data poor areas of perceived data rich fisheries which weren't always identified by fisheries scientists. Her example was that of the northern cod collapse in Newfoundland, [see section 1.1].

She acknowledged the extensive nature of the stock assessment data in existence for the offshore cod fishery, collated by the DFO, but summarised that this information alone was not enough to base sustainable management of the fishery on. Missing was the knowledge of the inshore fishers who knew that spawning stocks were crucial to conserving the fishery and that they were in decline. Neis [1992] made a case therefore that fishers' knowledge could be included alongside scientific knowledge to give a more holistic format of fisheries conservation. It is not expressly written by the pioneers of this applied sociology, but there seems to have been an attempt to eschew some of the qualitative extremes of ethnography, particularly techniques such as participation observation. Many fields of research moved towards interdisciplinary approaches in the latter half of the 20th century as scholars noted the benefits of broader approaches [Klein, 1996]. It is likely that Neis and her contemporaries were applying these principles.

From the beginning, Neis and her colleagues have seen the uncertainty in fisheries science not as something to criticise outright, but as a justification for the equal consideration of fishers' knowledge research by fishery managers. She states that like fishers' knowledge, scientific knowledge is also a socio-ecological construct and is therefore not as certain as some fisheries scientists suggest [Neis and Felt, 2000b]. Scientists, like fishers, are subject to a variety of social and ecological influences and their knowledge resultantly possesses the same heterogeneity. McGoodwin and Neis [2000] reference literature on the sociology of science when outlining a belief that is seen in much of the writing of the applied social scientists researching fishers' knowledge. This belief is that, because of the lack of certainty in fisheries science, its inability to predict stock collapses, and the success of 'non-scientific' approaches in medical and agricultural fields, fishers' knowledge deserves symmetrical treatment to its scientific counterpart.

Along with other scholars based in Canada, Neis has been responsible for much of the literature of the third wave. The following are examples of this body of work. As the research in this region matured it retained its preference for finding qualitative and anecdotal results, but it also began to formalise and quantify them.

Neis, *et al.* [1999b] investigated which techniques, both qualitative and quantitative, could be used to capture, process and then describe fishers' knowledge through fieldwork they conducted in Bonavista and Trinity bays, Newfoundland. They used a semi-structured interview technique to engage with the fishers; the aim being to elicit any knowledge of the natural environment that respondents may have accumulated at any stage throughout their fishing careers [Neis, *et al.*, 1999a; Neis, *et al.*, 1999b]. A key part of their interviews was to have them conducted by scientists (often in pairs) who had expertise in the social and biological sciences. This allowed them to add socio-economic description to the previous ecological findings of Neis [1992] for the regional cod fishery.

They analysed the interview transcripts of respondents and found that they had further information on seasonal location of the species, on the direction and timing of migration, and of spawning habits [Neis, *et al.*, 1999b]. In this case the fishers' knowledge confirmed the findings of fisheries scientists; that spatial and temporal variations in cod populations are attributable to the fact that there is more than a single cod stock in the region. However, fishers' observations additionally suggested that these variations may be due to the size structure of the cod populations. The interviews showed that inshore fishers differentiated cod by their colour, size, depth inhabited, diet, and reproductive behaviour and could explain the times and directions of the migratory behaviour of fish for each of these categorisations [Neis, *et al.*, 1999b].

Although they gave most weight to their biological findings, perhaps the most interesting conclusion in their paper was the extension they gave to the scope or breadth of fishers' knowledge. Maybe surprisingly for individuals who are more used to researching socio-economic issues than ecological ones, the ethnographers who researched fishers' knowledge in

the second wave had sometimes overly focussed on reporting fishers' ecological knowledge. This was changed by Neis, *et al.* [1999b] who with their new approach based on the applied social sciences started to report operational and socio-economic knowledge that complimented biological knowledge. Operationally, they found that the fishers of Newfoundland had started to fish further offshore to maintain the same levels of cod landings⁶⁰. Another finding was that fishers in their later career had larger engines, bigger vessels and more nets than early career fishers. Realisations such as these caused the team of Canadian researchers to continue to adapt their research and with it, their interview structure. They started to focus on socio-economic and operational fishers' knowledge as much as they did on their respective ecological knowledge [Neis and Murray, 2009a].

This cross-disciplinary approach is perhaps exemplified best through their case study of 'Jack', a fisher who had operated in the Canadian waters of Newfoundland and Labrador for the majority of the latter half of the 20th century and during the start of the 21st. Murray, *et al.* [2006] found that Jack clearly had a detailed knowledge of the behaviour and status of various fish stocks (*e.g.* cod, snow crab, shrimp), but that a great deal of his knowledge was expended on making his fishing operation more efficient and profitable. To make his fishing operation more streamlined Jack had decided to move to a larger and more powerful boat, giving him and his crew access to the more abundant, therefore easier to catch, cod stocks further offshore. At the same time Jack had been decreasing the economic risks to his crew and himself. Not only had he implemented a formal share-system for his crew, but he had diversified his fishing gears and licenses to gain access to

⁶⁰ Interviews with fishers told Neis, *et al.* [1999b], that fishing effort had increased over a number of decades as skippers had upgraded their boats and nets and that a decline in CPUE in the inshore fisheries was a result of this increased fishing effort. The inshore declines meant that fishers needed to fish further offshore to maintain the same CPUE.

a wider range of marketable species⁶¹. All these actions were designed to give himself a better chance of surviving in a fishery which he knew was going through ecological and socio-economic flux. Scholars were increasingly enforcing the view of fishers' knowledge as a socio-ecological construct consisting of amongst other things; information about fish behaviour and biology, vessel setup, management policy, and global fish prices [Neis and Felt, 2000b, p. 20; Murray, *et al.*, 2005; Murray, *et al.*, 2006].

The influence of the Canadian work appears to have spread to other developed regions. Applied sociologists in the USA and Europe have often cited Neis and her contemporaries when outlining similar understandings of fishers' knowledge. Some of these published their early contributions in a notable compendium of primarily sociological fishers' knowledge research called *Finding Our Sea Legs* edited by Neis and Felt [2000c]. These included Purps, *et al.*'s [2000] study of brown shrimp fishers in Germany, Maurstad's [2000] of north Norwegian fishers' knowledge that could be used in management, and Ames, *et al.*'s [2000] account of the historic knowledge of fishers in Maine, USA. In a further interview-based study, McCay, *et al.* [2006], found that the fishers in the United States fisheries of New England and the mid-Atlantic had an experience-based knowledge of the operational capabilities of fishing gear, the state of fish stocks (e.g. Atlantic cod, yellowtail flounder) and the ecology of the ecosystem they operated in.

They concluded, like their Canadian peers, that of all the fishers' knowledge they identified it was again not the ecological knowledge that was richest,

⁶¹ Jack traditionally caught cod in the 1950s and 1960s, as it was all his family could catch where they were fishing and it was also all they could sell. However, these cod landings became scarce and unreliable so he got a larger boat with more technologically advanced longlining gear to exploit the cod fisheries further offshore. In the 1970s he upgraded again to get a larger boat with trawling capabilities. He applied for licences to catch new species so that his financial exposure was not only to the cod market. His new boat, gear and licenses meant that he could now also catch shrimp and then later snow crab. In his opinion this gave him protection against both biological collapses of species, and collapses in price of a species. If one species became biologically or financially unviable he could switch to another [Murray, *et al.*, 2006].

but actually the operational knowledge about fishing gears⁶². This was attributed to the fishers being more interested in this than in fish stocks and biology [McCay, *et al.*, 2006]. Maurstad and Sundet's [1998] study on the coast of Finnmark, Norway showed that fishers had excellent spatial knowledge of the spawning grounds of cod species. However, a parallel study showed that the location of their fishing operations was just as much controlled by their social knowledge of which fishers were allowed to access each section of the local fishery as it was by any ecological knowledge [Maurstad, 1997].

Moore [2003] showed that the methodology for collecting qualitative fishers' knowledge does not always have to be administered via interview. He used a questionnaire to discover the knowledge of nephrops⁶³ fishers in the Clyde Sea, Scotland. His study specifically focussed on an area where fishers' ecological knowledge and operational knowledge overlapped, by focussing on the issue of whether grey seals and common, or harbour, seals interact with their fishing gear. The fishers' ecological knowledge uncovered was not necessarily that detailed, with few distinguishing between the species of seal. Again however, fishers' operational knowledge came to the fore. Respondents were able to describe several types of damage to gear caused by seals, which were accessing their nephrops catching devices to prey on a bycatch⁶⁴ of demersal fish species⁶⁵.

A final finding raised by this study was that another area could also be considered fishers' knowledge; that of fishers' opinions on, or ideas for, fisheries management. Of the respondent fishers in the Clyde Sea, 88% thought that seals had at least some negative impact on their fishing

⁶² It was found in this study that scientific studies conducted to try and find ways to reduce discarded fish, such as that of scup in the inshore longfin squid fishery, were simply replicating work already done by fishers. Therefore, when scientists conducted gear experiments, it was often fishers who acted as advisors, drawing on their own knowledge of various fishing gears [McCay, *et al.*, 2006]. See glossary: scup.

⁶³ See glossary: nephrops.

⁶⁴ See glossary: bycatch.

⁶⁵ *E.g.* Fishers described how haddock and whiting, where the tails had been sticking through the mesh had been stripped of their skin. Fishers knew from other experiences with seals that skin-stripping is typical of how they consume fish [Moore, 2003].

operation and their respective ability to achieve a sustainable livelihood. As a result of this belief, over 75% of fishers supported a cull of seals [Moore, 2003].

The finding that fishers' knowledge could have a direct use in formal fisheries science was supported by a number of others researching commercial fisheries. Neis, *et al.* [1999a] highlighted several implications of their findings for the future of fisheries science and management by identifying several qualities of fishers' knowledge. Firstly, they concluded that fishers had unique information on fish stocks. Fisheries management is most often associated with stock assessment and fisheries science cannot always provide enough data on these stocks, so any additional source of information could be useful to managers. Secondly, they discovered that the reason fishers often changed the location they fish in was because of changes in abundance and distribution of different species. Both are probably due to overall, and possibly permanent, alterations in the benthic ecology. These are all changes which fisheries science has historically struggled to monitor. Therefore, again this knowledge could be collected by scientists to influence management. Finally, they assessed the implications of their interview data from a social science perspective and summarised that they could create fishers' knowledge frameworks. These may consist of shared assumptions, terminology, and arguments of fishers. By measuring the change in these over time the effectiveness of fisheries management for socio-economic purposes could be ascertained.

Stanley and Rice [2003] took the argument a step further and asked, "why not add their scientific skills to the mix while you're at it?" It was their belief that fishers' knowledge should not just be perceived as a data source, but as a skills base that is just as capable of forming research hypotheses and designing fieldwork methodologies as traditional marine science is. It has already been shown that fishers in New England, USA could have helped devise ways to measure discards⁶⁶ of non-target species in a fish landings [McCay, *et al.*, 2006]. Stanley and Rice [2003] introduce two further cases where fishers' knowledge first, acted as the background for design of a fisheries survey and then second, actually designed the methodology. One

⁶⁶ See glossary: discards.

of these was a study to estimate the biomass of a shoal of widow rockfish in British Columbia, Canada. Experienced fishers identified the behaviour of the shoal⁶⁷, and then hypothesised that the shoal could be representative of a larger regional population of widow rockfish. Finally, they selected the sites for the survey. From the results, an estimate of the shoal size and potentially of the wider population of the species was possible.

What the applied sociologists researching developed fisheries have clearly proven is the existence of a fishers' knowledge that is comparable to that discovered by ethnographers in smaller-scale fisheries. Although it is early days when it comes to attempting to understand the implications of the existence of fishers' knowledge in modernised industrial fisheries it has been possible, as it was in the case of the smaller scale subsistence fisheries, to actually apply this to real-world management.

The first case of effective management based partially on fishers' knowledge in a commercial fishery may be the Maine soft shell clam fishery exemplified by Hanna [1998]. She described how fishers' knowledge and formal scientific knowledge were generated side-by-side in the coastal region⁶⁸. Key to the success of management here was identifying the areas where fishers' knowledge was lacking, or scientific knowledge was lacking, and using one to strengthen the other. There were recorded instances of where each knowledge system had contributed to both the collection of data and to management⁶⁹.

⁶⁷ Regularly formed each winter off British Columbia's central coast, the shoal was primarily widow rockfish and was off the benthos at dusk. Years of experience confirmed that it was predictable in its occurrence [Stanley and Rice, 2003].

⁶⁸ The harvesting knowledge of fishers was developed during repeated exposure to an inter-tidal environment and included knowledge of ecosystem structure, preferred clam habitat, cause of mortality, and within-year variability.

⁶⁹ The knowledge of harvesters has been particularly useful in actually locating the resource, often found in siphon holes in the mud. The harvesters on the ground were therefore often the best situated to assess the size of the clam stock. However, the knowledge needed to assess whether the assessed size of the stock is sustainable could be more complex. Scientific research aided this process by assessing the effects of factors such as predation rate on the population size. Feedback of fishers could then be used to take management decisions. Harvesters were the first to see when predation on clams increased, as they saw increased numbers of crab shells (the clams' main predator) on the inter-tidal mudflat. With this knowledge scientists could make recommendations to fisheries managers on whether harvesting of clams needed to be cut back [Hanna, 1998].

Further examples include other small management projects at specific local sites, as well as larger scale undertakings to spatially upgrade the use of fishers' knowledge in management. Included in the smaller scale undertakings would be the orange roughy fishery in Ireland described by Shephard, *et al.* [2007]. As part of a larger project to create a management plan for the species informal discussions were had with many of the fishers targeting the species. The goal of the scientific research was to acquire their experiential knowledge of the fishery. Knowledge of variation in landings, fish distribution, and catch seasonality was acquired which then helped to inform the process of scientific data collection on research vessels. The result of the project was the creation of a multilinked framework that connected the fishers to other stakeholders.

At a larger scale the earliest example of fishers' knowledge being acknowledged in regional management legislation seems to be in Norway. Here, the extension of the national *Planning and Zoning Act* in 1989 required stakeholder knowledge of fishing grounds to be considered when planning effluent discharges of coastal factories [Maurstad, 2002]. Further regional projects to identify sites for marine protected areas in the UK [Edwards, *et al.*, 2009] and California, USA [McClintock, *et al.*, 2009] have also relied on collecting fishers' knowledge to identify where these protected areas may be best placed.

The existence of these examples though is far from proof that fishers' knowledge is now mainstreamed as a qualitative and quantitative socio-ecological construct. The volume of research by applied sociologists does not extend much beyond what is documented here. There is no great weight of evidence that fishers' knowledge has been adopted as a concept in national or multi-national fisheries science and management programmes; a belief shared by no less than some of the dominant researchers in the third wave [Neis and Murray, 2009b]. With the research so far suggesting that fishers' knowledge could be a substantial aid to the sustainable management of fisheries, why is this? Potential answers to this question are first introduced in section 2.5 and then elaborated on and discussed in further chapters.

2.4. Fisheries dependent data: a red herring for fishers' knowledge research

Until very recently it would not have been necessary (or actually possible) to document a potential fourth wave of fishers' knowledge research. In this latest wave the research is not being done by fisheries historians, ethnographers, or applied sociologists, but by biological scientists of the scientific mainstream. A raft of new studies has begun to emerge about commercial fisheries whose goal is much narrower than discovery and understanding of fishers' knowledge.

This fourth wave of studies do not consider the qualitative, anecdotal, often tacit fishers' knowledge that excited the ethnographers of the second wave and applied sociologists of the third. Instead they focus entirely on quantitative information collected from (or by) fishers. Rather than drawing on the whole experience of an individual fisher, using techniques such as the career interviews employed by Neis, *et al.* [1999a], they instead have tended towards using log books or other statistical recording devices to accumulate what may more accurately be termed 'fishers' information', rather than fishers' knowledge.

The title and content of Dobby, *et al.*'s [2008] *Improving the quality of information on Scottish anglerfish fisheries: making use of fishers' data* provides a good example of this emergent genre of publication. Official fisheries science data for two species of Scottish anglerfish, the white-bellied anglerfish and the black-bellied anglerfish, was considered to be poor, because the catch data it was based on was suspected imperfect⁷⁰. Better data was needed to make TAC recommendations for the fishery going forward. Dobby, *et al.*'s [2008] study tried to improve data quality by using a different technique to get the necessary knowledge direct from the fishers of the species⁷¹. The results however are purely quantitative and are

⁷⁰ The data was considered to be poor as the quota for anglerfish was very low and thus easily filled. Resultantly, much of the actual catch was above quota and therefore discarded at sea or landed illegally and not reported [Dobby, *et al.*, 2008].

⁷¹ They gave each fisher tallybook sheets where they could record landings for each haul of both discards and kept fish. They also recorded other details of the haul such as depth, duration, gear used, and location. The results clearly showed a different result to the official fishery landings, with greater catches reported in the tallybooks. They were thus deemed at least partially successful in their findings.

simply fishers' data (alternatively, fishers' information) as the study's title implies. Without a qualitative element to the research's methodology it is clear that none of the tacit knowledge of fishers, often revealed through anecdote, has been discovered. This approach seems less interested in discovering how fishers' knowledge is accrued and more interested in producing an end product that is ready-recognisable to fisheries scientists and managers.

It may be unfair to highlight Dobby, *et al.*'s [2008] study as part of a fourth wave of fishers' knowledge research that is assessed as limited in its scope. After all, they neither explicitly use the term 'fishers' knowledge', nor reference any of the work from the first three waves [this lack of connection is displayed in figure 2.2]. Their work is independent and could be considered to be part of a new school of research into fishers' data. However, the reason it should be exemplified is because literature of this type is being connected with the term 'fishers' knowledge' and shows signs of perhaps becoming the accepted approach to engaging with fishers' experience in mainstream fisheries science [this potential connection is also shown in figure 2.2].

At a recent conference in Galway, Ireland (entitled *Fishery dependant information: making the most of fisheries information*) two consecutive sessions using the term "fisher knowledge"⁷² showcased a number of studies that were indeed dependant on fishers' contributions. Some of these were certainly recognisable as either part of the second or third wave [see Curtis, 2010; Wise, *et al.*, 2010], but the majority of the sessions were dominated by quantitative papers, which like Dobby, *et al.* [2008], required fishers to generate defined information rather than recount their own experiences [see Haukeland, 2010; Jankovský, *et al.*, 2010]. This conference was convened by mainstream fisheries scientists from national fisheries science and management bodies in Ireland, the USA and Norway, as well as by the Food and Agriculture Organisation (FAO) of the United Nations (UN). If the above sessions represent their perception of fishers'

⁷² The sessions were titled *Application of fisher knowledge in scientific assessments and fishery management*.

knowledge, then it is likely that this is how it is currently considered in the scientific mainstream.

Evidence that this is becoming the viewpoint of the scientific mainstream is further solidified with another explicitly named representation of “fishers’ knowledge” in *ICES Insight*, the official magazine of the International Council for Exploration of the Sea (ICES), the North Atlantic’s main fisheries science institution. A recent Danish study used barely qualitative inquiry with the express intention of being able to easily quantify fishers’ perceptions. Described by Johannesen [2010], the study asked fishers responding “yes” to the question, “Has the abundance of cod changed since last year?” to say whether that change was, “much less”, “less”, “no change”, “more” or “much more”⁷³.

Not only may the fourth wave become how fisheries scientists consider fishers’ knowledge, but also how fisheries managers do the same. ‘Sentinel’ programmes have been set up where fisheries scientists have employed fishers, not as fishers, but as scientists to collect data for fisheries assessment. One such case is the Canadian one of Newfoundland, where after the collapse of the northern cod the DFO hired unemployed fishers to take part in tagging programmes and catch experiments [Murray, *et al.*, 2005; Murray, *et al.*, 2008a]. The sign that this is now official policy for fishers’ knowledge collection was given by the Canadian Minister of Fisheries and Oceans, who described the Sentinel survey programme as an attempt to “try to blend the traditional knowledge of fishermen with the objective rigour of scientific data gathering” [Hon. B. Tobin in Stanley and Rice, 2003].

Why then has an increasingly dominant literature evolved as an apparent fourth wave of fishers’ knowledge research when it generally fails to capture much of the fishers’ experience that second and third wave scholars thought could be so useful in aiding fisheries management? It may

⁷³ These answers were then scored from -1 to 1 and converted into an index to be compared to official catch data produced by fisheries scientists. The study confirmed that fishers and fisheries scientists had comparable knowledge, as a positive correlation between 2002 and 2008 suggested that, “fishers and scientists may not be as far apart on some things as we believed” [Johannesen, 2010].

simply be because of a confusion of nomenclature. The nature of the programmed content at the previously mentioned conference in Galway along with that of policy publications by fisheries managers (such as that by Morgan and Burgess [2005] of the FAO) are evidence of a parallel research and literature in fisheries dependent data. This refers to any information that relies on the practice of fishing for its collection. Fishers' knowledge relies on the same activity for its accumulation, and fishers' information is itself a constituent part of fishers' knowledge, so it is perhaps unsurprising that these similar research fields have started to overlap.

The career worlds of traditional ecological scientists are also starting to overlap increasingly with the applied sociologists of the third wave who were not previously part of fisheries science. The ethnographers of the second wave rarely mixed with fisheries scientists, as they were based in separate university departments and research organisations during an era of lesser interdisciplinarity. The aforementioned Galway conference is evidence of this increased mixing, with social scientists sharing the floor in the same session as primarily ecological scientists. Social science is also being introduced to fisheries biologists through broadened undergraduate study programmes and higher level teachings. With this increased exposure it is now more likely that some ecological scientists will start to adopt social science techniques. However, their academic background is still different to that of career social scientists and therefore it is also natural that they may apply the techniques of social science in a different manner to an ethnographer, anthropologist, sociologist or geographer. With all of the numerical bias of modern fisheries science, it is unsurprising that they are engaging with the more quantitative techniques of social science.

Additionally, the engagement of the fourth wave with the third wave scientists appears superficial. Reading of fourth wave texts uncovers no apparent reference to the third wave. If no inspiration is taken from previous research this fourth wave is then not a fourth wave at all. It is a completely different direction of research that should not be considered in this thesis. Fisheries dependent data is different to fishers' knowledge. This is evident from the fact that it includes data that relies only on the existence of fishers as opposed to on their actual experience, such as Global Positioning

System (GPS) records and VMS tracks from trawlers [Johnson, 2008]. It would be fair, considering the heavy reliance on repetitive collection of specific fields of quantitative data in this wave, to assert that its practitioners have confused fishers' information with fishers' knowledge. They have simply collected the former.

This thesis though must highlight the existence of fisheries dependent data, as it is important that the continuing confusion between it and fishers' knowledge is eliminated. If fisheries dependent data and fishers' knowledge are seen as interchangeable terminology by fisheries scientists and managers, then potential progress towards better fisheries management made in the second wave and third wave will be lost.

Fisheries dependent data collected by traditional fisheries scientists will probably capture overt data better than the fishers' knowledge research would, but that is its sole focus. This advantage appears to be seriously compromised by the lack of a mechanism to capture the bulk of fishers' experience. Primarily, this approach relegates information that can't be codified [Berkes, 1993; Stanley and Rice, 2003; Daw and Gray, 2005; Murray, *et al.*, 2005; Murray, *et al.*, 2006], therefore omitting anything which is tacit. The reliance on codified data also means that data must be aggregated to the group level, which means the temporal and geographical uniqueness of fishers' knowledge is also lost [Johannes, *et al.*, 2000; Murray, *et al.*, 2005; Murray, *et al.*, 2006; Daw, 2008].

Finally, and less excusably, the studies in the fisheries dependent data literature seem to only rarely focus on non-ecological experience of fishers' [see Dobby, *et al.*, 2008; Johannesen, 2010]. Socio-economic data is easily codified in certain circumstances, so there is no reason for its omission. It can perhaps be put down to the fact that the biological scientists engaged in this approach lack socio-economic training and are therefore less likely to consider it in their studies.

These limitations reinforce a case for excluding fisheries dependent data as the discourse that should describe fishers' knowledge going forward. With this eliminated however, there is no accepted approach to collecting fishers'

knowledge within mainstream fisheries science. The penultimate section of this chapter considers what the accepted approach could be.

2.5. Discourses of fishers' knowledge and their implications

A previous critique of fishers' knowledge research by Holm [2003] stated, that whilst fishers' knowledge should be a source of information that was significantly different to that collected by fisheries scientists, those researching it were constraining it by trying to transform it into a hard science format (*i.e.* one that was less qualitative and less anecdotal). He said that if fishers' knowledge research was true to what it was studying, then it would be a "radical" challenge to the existing fisheries paradigm, yet the only thing that was actually "radical" about fishers' knowledge research was how it "decontextualised" fishers' experience. He states that far too often fishers' knowledge researchers are overly concerned with replicating the scientifically provable results of population ecology.

However, his interpretation is one correctly deconstructed by Neis [2003] for not considering the differing objectives and networks of influence in which fishers' knowledge researchers operate. Firstly, he fails to identify the nuanced differences between the biological results produced by fishers' knowledge researchers. Some of these are not decontextualised at all, and are indeed present as a radical challenge to population ecology [see Johannes, *et al.*, 2000]. Secondly, he forgets to consider that some of the researchers he criticises, work in interdisciplinary teams which include quantitative biologists and must therefore produce some data common to that discipline [Neis, 2003]. Finally, he seems to completely ignore those who are more concerned with the socio-cultural content of fishers' knowledge [Neis, 2003]. The analysis in this chapter shows that there is a heterogeneity in the field of fishers' knowledge research to which Holm [2003] does not give credit.

In sections 2.1 to 2.3 it is shown that fishers' knowledge has been developed as a concept over a considerable timescale by a series of researchers from three traditions; historical biology, ethnography and applied sociology. The latter two of these have played by far the most

important role in defining the concept. Minor differences exist in how fishers' knowledge is defined from publication to publication, as would be expected of a nascent academic literature, but what noticeably adds heterogeneity are the fundamental differences rooted in how those who research it would like it to be utilised. There is a pronounced and dichotomous divergence apparent between the goals of those promoting it as a valuable source of information for fisheries science and/or management. The two alternative approaches can be defined as follows:

1. **Reformist fishers' knowledge** does not seek to challenge the top-down paradigm of population ecology described in chapter 1. It seeks instead to act as a complement to it. Instead of challenging the validity of statistical quantitative approaches [such as that described in section 2.4] it augments these with qualitative data. Where appropriate it seeks to render qualitative data into a quasi or fully quantitative form. Its view of science and the state is relatively benign and trusting. Generally speaking, this is the course that applied sociologists in the third wave see for fishers' knowledge.
2. **Radical fishers' knowledge** in contrast offers a critical approach to traditional state-led fishery management approaches and consequently seeks to challenge these. In this approach neither the state, nor its scientists, are assumed to know what is always best when managing a fishery. Instead it supposes that fishers have accurate knowledge both to identify what to manage, when and how, as well as the capacity to perhaps self-manage their fishery if they are either let, or, if the state enables them. This approach would be hostile to the primacy of using hard scientific data in making management decisions. This is an approach more likely to be taken by the ethnographers of the cultural turn and second wave.

It should be noted that whilst individual examples of fishers' knowledge research tend to be located further towards one or other of the reformist

and radical poles, most is located somewhere on an inbetween spectrum [see figure 6.1].

The examples illustrated in sections 2.2 and 2.3 show that both approaches lead to a significantly expanded collection of a knowledge that is the fishers' own, uncovering both covert and tacit facets of it. Also, in both approaches (especially the reformist) some of this knowledge has definitely been absorbed into the science that informs fisheries management. However, the connections between reformist or radical fishers' knowledge and scientific knowledge are rarer still than examples of where fishers' knowledge has been adopted as the sole source of information for fisheries management. Each has only a tentative foothold as regards to becoming a common source of data in mainstream fisheries research. It is possible that neither approach will survive, as the proponents of each may not be able to convince policy makers that the fishers' knowledge they promote is worthy of a permanent roll in informing fisheries management. What is certain though is that both cannot survive. If radical fishers' knowledge becomes mainstreamed, then it requires the demise of the population ecology approach that reformist fishers' knowledge seeks to work hand-in-hand with. Taking into account case study results presented in chapters 3 and 4, chapter 5 will partially seek to evaluate which, if either, approach to fishers' knowledge is likely to succeed in becoming an accepted fisheries science, and for what reasons.

2.6. Summary: chapter 2

In this chapter a review of the literature on fishers' knowledge shows that it has been conducted by natural historians, ethnographers and applied social scientists. Latterly, biological scientists have started to collect quantitative data directly from fishers and this approach competes with the existence of the previous fishers' knowledge that has been based on the qualitative anecdotes and narratives of fishers.

Yet, the most important division discovered in this chapter is a dichotomous one between 'radical' and 'reformist' fishers' knowledge researchers. The former see fishers' knowledge as a direct challenge to biological fisheries

science, which they believe it can replace. The latter see fishers' knowledge not as a challenge to the established science, but as a compliment.

3. Can fishers' knowledge be part of existing fisheries science on the west coast of Ireland?

In chapters 1 and 2 it was shown that in a number of locations there have been and continue to be attempts to integrate fishers' knowledge into the mainstream of fisheries management, either through complementing or replacing fisheries science. In this chapter and the next, through a case study, it is determined whether Irish fishers operating in a commercial fishery also have knowledge that could be used to manage fisheries.

The reason for conducting a case study as part of this thesis was not simply to see if fishers' knowledge is present in Ireland. Although fishers' knowledge research has been minimal in the country so far⁷⁴, to simply complete a basic audit of such knowledge would contribute little to any integration project for the information source. It would act only to reiterate the established belief in its existence [reviewed in chapter 2]. Instead, the purpose here was to try and answer Q³ and Q⁴ by evaluating which elements of fishers' knowledge, if any, are likely to be seen by the epistemic community as valuable information for assessing and managing fisheries. Where ethnographers and applied social scientists see a diverse and varied fishers' knowledge, more powerful natural scientists may see little that can help them in their day-to-day activities.

The research in this chapter and chapter 4 was part of a real-world project commissioned by primarily biological fisheries scientists who were inexperienced in dealing with fishers' knowledge research. Their reaction to the study's results provided insight into whether they might see value in fishers' knowledge as an information source. Further dissemination of the findings to an extended range of actors (e.g. civil service employees, academics, fishing industry officials) allowed analysis of how other influential communities rated the same information. As the discussion in chapter 5 will show further, these important actors and institutions have the political power to fully integrate fishers' knowledge as part of fisheries

⁷⁴ Shephard, *et al.* [2007] engaged fishers in the Irish fishery for orange roughy to see how it had developed and what strategies they had for fishing it. However, the fishers' knowledge collected was mainly used to inform further scientific surveys, rather than being used as a major output of the research in its own right.

science. If they find the results to be robust and applicable, then they may indeed move to do just this.

After outlining the details of the case study in section 3.1 and the methodology used to complete the fieldwork in section 3.2, an evaluation is made in section 3.3 of the ability of fishers' knowledge to meet the needs of population ecologists. Can it reproduce their hard data sets, and more importantly, can it fill the gaps that they acknowledge exist within them? Previous discussion in this thesis shows that this group of scientists have often been sceptical towards fishers' knowledge. This is partially because they have struggled to believe that ethnographers and applied social scientists could collect data that met natural science standards, and more so because they think that non-scientists like fishers could not have the same knowledge that they have as trained scientists. If fishers' knowledge research could help to produce analysable data sets then it is likely that it would have an increased chance of integration into fisheries science. However, even if it can produce these, will they be of the quality expected by experienced natural scientists?

The final section before the chapter summary, 3.4, assesses the overall value of Irish fishers' biological knowledge to national and regional fisheries scientists and institutions interested in fisheries science. While it is found that Q³ cannot be answered definitively (as the collected information may not be enough to convince Irish scientists of the need to integrate fishers' knowledge into their scientific surveys) some cases are identified in which it could be rendered more acceptable to natural scientists. A suggestion is made for how fisheries scientists should consider this data. It is concluded that it may lead to not just better fisheries science, but also to the formation of a better relationship between fishers and scientists. Both outcomes are arguments for integrating fishers' knowledge into fisheries management.

3.1. Case study: Galway Bay and the Aran Islands

The fieldwork conducted for this thesis was part of a wider ranging project called the *Irish Fishers' Knowledge Project*. Commissioned by the Marine Institute, the actor tasked with conducting fisheries science (and some

management) in Ireland's territorial waters, the aim of the project was to develop a methodology that engaged fishers as stakeholders and accessed their knowledge, especially its tacit elements. A further aim was to assess whether the methodology could be adopted by the Marine Institute themselves so that they could make fishers' knowledge research part of their permanent activities [Flynn, 2008].

This project provided the ideal opportunity to answer the research questions outlined in section 1.3 and re-stated in table 3.1. Conducting a new case study in a nation where fishers' knowledge research was at best nascent allowed for a practical investigation of Q¹; not just a review of existing examples like those in chapter 2. More importantly, the fact that the project included partners not just from academia, but also from national fisheries science institutions and fishing industry bodies, meant that Q² to Q⁴ were also answerable. The position of the research alongside and between these actors allowed for a first hand evaluation of how they perceived fishers' knowledge, both practically and politically. This was a rare opportunity to establish whether the obstacles and opportunities for fishers' knowledge [debated later in chapter 5] did actually exist.

The case study of Galway Bay and the Aran Islands was chosen for a number of reasons. From a practical perspective it was an ideal location, as it was in close proximity to the National University of Ireland, Galway (NUIG). The academic team working on the *Irish Fishers' Knowledge* project was based at this institution. There were more compelling criteria however, that meant this was not just a decision of convenience.

Firstly, the biological states of some of the fisheries in the case study region were acknowledged as scientifically uncertain. Scientists from the Marine Institute were unsure of both the stock size and behaviour⁷⁵ of some species [MI, 2010]. From the scientists' perspective this was an ideal chance for them to fill some of the gaps in their own data.

⁷⁵ For instance, the Marine Institute are unsure about the geographical distribution of some nephrops populations and have been unable to explain the response of herring stocks to changes in ocean salinity and temperature.

Table 3.1. Research questions outlined in chapter 1.

Q1	Is fishers' knowledge more than just a theoretical concept? Does it really exist and can it be discovered?
Q2	Can fishers' knowledge be reconciled with fisheries management? Does it have the potential to add value to the discipline and change the current paradigm that is dominated by information produced by population ecologists?
Q3	Can fishers' knowledge be more than a source of information to be accessed and used solely by academics primarily practicing social sciences? Can fishers' knowledge be collected practically and presented in a format that is understood by biological scientists as well as other interested parties? Do methods exist (or can they be formulated) to translate qualitative knowledge into a quantifiable output?
Q4	Is the use of fishers' knowledge in fisheries management not just useful, but vital? Without fishers' knowledge will the widely acknowledged deterioration of global fisheries (and marine ecosystems) continue? Without fishers' knowledge will it be impossible to enforce any marine legislation aimed at conservation due to it being impossible to know what will be compatible with fishing industry interests?

Secondly, the same scientists identified that the region's most commercially significant fishery (that for nephrops⁷⁶) was potentially party to ecologically unsustainable levels of discards and bycatch. Discards in nephrops fisheries have been perceived as too high; recently found in one study to have accounted for 43% of total fishery landings [Catchpole, *et al.*, 2005]. The official discard figure of 25% that they had for one nephrops fishery in the study region was seen by them to be a potential underestimation, as it was below that in similar fisheries elsewhere. They were unsure of their own survey data [MI, 2010, p. 301] and they also had reason to believe that fishers were deliberately under-reporting their discards. This has happened in other Irish fisheries where fishers have perhaps been dishonest in an attempt to improve their negotiating position when lobbying for increased quotas. By showing how well their fishery is performing in its elimination of the environmentally damaging discards, fishers hope they will be seen in a favourable light [Hammer, 2006]. The Marine Institute hoped an alternative approach may uncover fishers' covert knowledge of discards, allowing them to repopulate their current data for these with more accurate assessments.

⁷⁶ See glossary: nephrops.

Thirdly, the Galway and Aran Islands fishery has historically been seen as one of Ireland's most socio-economically and culturally important [O Donnchadha, *et al.*, 2000]. The value of Irish fisheries have however declined and the fishers in this region were seen to be at particular risk of socio-economic marginalisation [Morrissey, *et al.*, 2011]. The local fisheries were already exploited at close to MSY in most cases [MI, 2010], meaning there was little apparent opportunity for economic growth by expansion. Also, few alternative livelihoods were available in this fairly remote and non-industrial region [O Donnchadha, *et al.*, 2000]. The Marine Institute had so far not been able to offer suggestions to arrest the economic decline of the fishery [MI, 2010, pp. 300-03]. With an added socio-economic dimension, we could investigate whether Irish fishers had the same socio-ecological knowledge discovered in previous fishers' knowledge studies.

Finally, discussion in chapter 2 [revisited in chapter 5] shows that recognising knowledge at different temporal and spatial scales may be crucial to the integration project for fishers' knowledge. Both could be analysed in this case study. As it was an active commercial fishery there was potentially real-time fishers' knowledge. At the same time, the fishery had been identified to possess an extensive history [O Donnchadha, *et al.*, 2000; Mac Laughlin, 2010], allowing ample scope to research knowledge of the past. The fishery's workers also operated at diverse geographic scales. Some fishers operated inshore, with others travelling offshore. Industrial trawler skippers traversed large ranges, while potters always focussed on the same small bays and stretches of coastline. Further proof of this diversity is evident through a brief analysis of the profiles of boats registered within County Galway on the national fleet database [DAFF, 2008]. Every potential variation in scale that could change the form or shape of fishers' knowledge was present in the region, confirming its status as an ideal case study.

The specific area selected for the case study ranged west from Galway City to the Carna Peninsula [see figure 3.1]. This included the Aran Islands. All fishers who lived or operated in this area were considered for inclusion in the study. Efforts were made to include fishers on the south shore of Galway Bay also, but few were found to be fishing this piece of coastline.

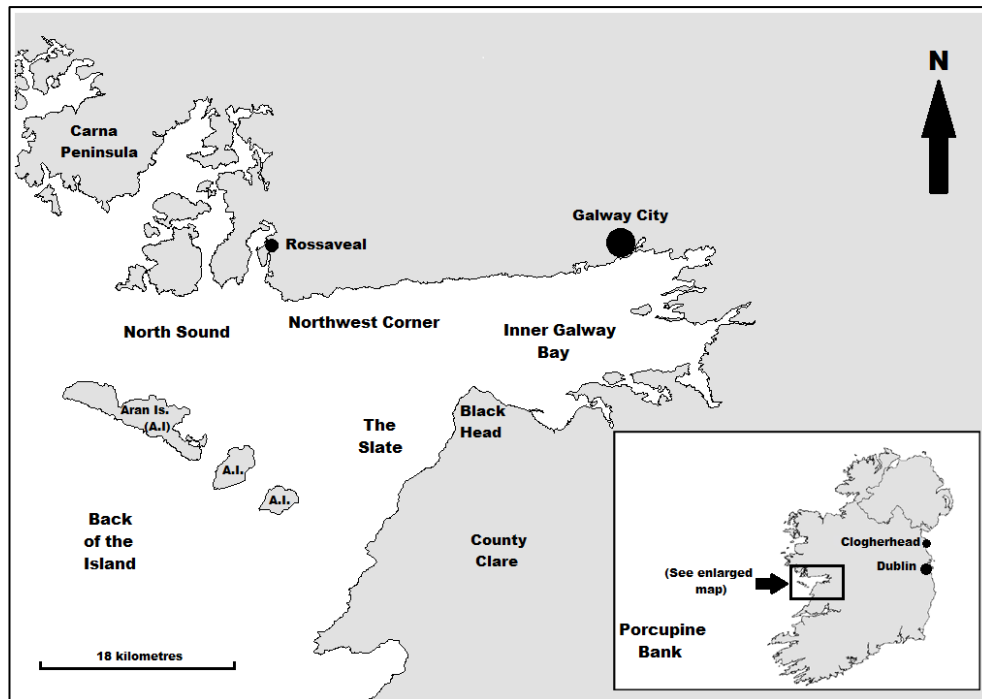


Figure 3.1. The study area and fishing grounds⁷⁷.

The official registry showed there to be approximately two hundred inshore boats of under 12 metres, sixteen coastal boats of 12 to 20 metres and sixteen offshore boats of over 20 metres actively fishing in the region [DAFF, 2008]. Inshore vessels could land their catch at any location, because the species they caught were not regulated by the CFP. However, coastal and offshore vessels primarily utilised Rossaveal⁷⁸ because it was the only local port where quota species could be landed. The fishing gears used by the smaller boats included various pots, jiggers⁷⁹, trammel nets and trawls. The industrial fleet almost exclusively used either demersal otter⁸⁰ or pelagic trawls. The region's fishery was a multi-species one and in recent decades those predominantly landed into Rossaveal have included nephrops, pelagic fish and several demersal species [MI, 2009, pp. 12-14]. Potting vessels landed lobster, shrimp, nephrops and crab species. They used other gears to target fish and scallops [Fahy, *et al.*, 2008].

⁷⁷ Fishing grounds and important locations for the fishery are marked. The fishing ground names (North Sound, Northwest Corner, Inner Galway Bay, Back of the Island, the Slate, Porcupine Bank) are as given by interviewees, rather than ICES. The ground locations are a best approximation, as fishers do not assign specific boundaries to each.

⁷⁸ Irish name: Ros an Mhíl.

⁷⁹ See glossary: jigger.

⁸⁰ See glossary: otter trawl.

The primary fishing grounds used by those operating in the region are labelled on figure 3.1. The Slyne Head ground is labelled on figure 3.3. Also active on the Galway and Aran grounds were non-local Irish boats⁸¹ and foreign visitors hailing from France, Spain and the UK (including Scotland) [MI, 2010].

3.2. Methods: towards a uniform fishers' knowledge research

The research framework for the *Irish Fishers' Knowledge Project* provided scope to develop new methodologies to collect fishers' knowledge as part of this thesis [Flynn, 2008]. The absence of a long history of fishers' knowledge research in Ireland meant that there was little scope for building on previous work in the state, but a wider review of fishers' knowledge research globally showed that there was no need to start afresh when it came to developing a methodology for researching the knowledge of Irish fishers. Successful techniques had been developed in a number of countries, including in developed ones with industrial fisheries. These provided an excellent foundation for conducting similar research in Ireland. The methods used in this thesis have taken the most impressive elements of other studies and refined them in an effort to create a best-practice technique for researching fishers' knowledge. The goal of the academics working on the project was to adopt a research method that was not just applicable to the case of the fishery in Galway Bay and the Aran Islands, but one that could be used in all Irish fisheries, regardless of scale or situation. If an approach from an entirely different country worked for this case study, then it surely stood a greater chance of working in any fishery.

This thesis should additionally be seen as part of the wider integration project for fishers' knowledge research discussed in earlier and following chapters. To veer wildly away from work already done on how to research fishers' knowledge would be to ignore the momentum of the last few decades, where academics have slowly arrived at a consensus. Whilst the

⁸¹ In particular, there is a long history of specialist vessels targeting nephrops visiting from the port of Clogherhead on the Irish east coast. Due to their considerable experience fishing in the Galway and Aran area, skippers of these boats were considered to potentially have the volume of local knowledge required to take part in this research.

radicals and reformists identified in chapter 2 may have different ideas on how fishers' knowledge should be integrated into fisheries science and management, they agreed closely on how to actually collect the information in the first place. Numerous examples from the developed and developing worlds showed in-depth interviews and direct dialogue between fishers and researchers to be effective instruments for getting fishers to contribute information that was both qualitative and quantitative, as well as ecological and socio-economic. Our hope was to discover the same from fishers during the course of this project. With no major shortcomings evident in these methodologies, little reason existed to deviate extensively from them. A new methodology would also find it harder to compete against the established interview-based methodology for the attention of the fisheries scientists and managers who could potentially empower it. If the established techniques could be replicated and also produce valuable results, then we could reference their proven track-records in any attempt to convince Marine Institute scientists of the merits of integrating fishers' knowledge research into their long-term strategy for fisheries science and management.

Also considered, was the practicality of carrying out research that relied on the continual and extended exposure to fishers, which the more ethnographic techniques like participant observation (typical of the radical scholars described in chapter 2) would require. They may produce results comparable to the shorter interview techniques of applied social scientists (predominantly the reformists identified in chapter 2); however, the longer timescale was not practical for this project where the fieldwork had to be completed during a relatively short period. Also, ethnographic research, (such as that documented by Johannes [1981]), is perhaps more suited to subsistence and artisanal fisheries where fishers are easy to locate, usually returning to their home communities each day after short periods at sea. The Irish commercial fishery did not share the same profile. Fishers worked long, erratic hours and often spent extended time offshore. The constant contact needed with the subject for ethnographic research would only have been attained if the researchers were embedded on a single boat. As the study's goal was to assess a large sample of the Galway and Aran Islands fleet this type of research would not have been possible.

There was also awareness that, for fishers' knowledge to be permanently integrated into mainstream Irish fisheries science on completion of this research, employees of the Marine Institute could be required to conduct the methodology themselves. They would not be able to schedule long periods of fieldwork within individual fisheries at many geographical locations. Their primary fisheries survey for a key fishery species (nephrops) was limited to a single month per year [Lordan and Doyle, 2010]. With their workload already stretched [Anon. MI scientist, 2011a] it was unlikely that they would have time to make the commitment necessary for extensive participant observation.

Another favourable reason for using the methods of applied social scientists was their demonstrated ability to produce quantitative results alongside qualitative ones [see Neis, *et al.*, 1999b; Catlin, 2008; Daw, 2008]. In their work there was often a chance to conduct structured quantitative questioning at the same time as recording open narrative. Quantitative interventions appeared rarely in participant observation research. Criticisms of fishers' knowledge research include its lack of ability to produce the statistical outputs that fisheries scientists desire. The view was taken that if we could not produce these as part of our outputs, then it would be harder for the Marine Institute scientists to engage with the results, because they would be alien to their day-to-day lifeworlds.

Semi-structured interviews with fishers were therefore chosen as the method for collecting fishers' knowledge. The most developed, tested and published methodology of this kind was deemed to be that used in Newfoundland by the group of researchers who had focussed on fishers' perceptions of the northern cod collapse [see Neis, *et al.*, 1999b; Murray, *et al.*, 2008a]. As it had been conducted in an industrial fishery, it was considered that it would transfer well to the similarly commercial fisheries of Ireland's west coast. Barbara Neis and Grant Murray (two of the main researchers in this region) were contacted in order to discover the exact structure of their interviews [Neis and Murray, 2009a]. The information they provided heavily influenced guide sheets that were created for the interviews in this study [see Appendix A].

A pilot study was conducted in the format of an informal discussion with a small group of fishers. The purpose of this was, like in the Newfoundland research [see Neis, *et al.*, 1999b], to first ascertain the viability of the proposed study (*i.e.* did it seem like the fishers had knowledge?). It also gave us a chance to refine interview techniques and familiarise ourselves with topics that may arise during the main interview programme.

Participants were usually interviewed individually⁸², as previous research had shown that fishers are less politicised and not open to influence by their peers in this environment. The risk of receiving dishonest responses or respondents withholding information is reduced [Neis, *et al.*, 1999a]. Additionally, the pilot study had demonstrated that some fishers were more vocal than others in a group scenario, preventing others from contributing as much knowledge as they perhaps could. In contrast, the interview team itself almost always consisted of an interdisciplinary team of two⁸³.

It is important to note in the context of this thesis that the research team primarily consisted of myself and my supervisor. We both contributed during the interview process. Firstly, this was for practical reasons. I could not drive and the supervisor transported me to the widely spread interview locations. Secondly, there was an ethnographic reason. I am not local (being of English nationality) and it was seen as desirable for my supervisor (being Irish) to help make connections with the Irish fishers, especially as many spoke Irish as their first language. Thirdly, professional considerations were a motivating factor for the arrangement. The Marine Institute wanted the broader project's leader (*i.e.* my supervisor) to help

⁸² Only during the pilot study and one interview did the interviews not consist of a single fisher.

⁸³ Following the pilot study it was ascertained that interviews conducted by an individual were not easy to conduct efficiently. It was found that whilst a researcher with more biological expertise administered sections of the interview to do with ecology, then the other with social science expertise could perform administrative duties (and vice versa). This meant that interviews could be fluid, because one individual was totally focussed on engaging with the interviewee, whilst retaining order. The interviewer not currently conversing with the subject could act as an administrator who kept track of topics covered on the interview guide sheets to ensure every topic of interest had been covered. They could also take scribbled notes (in case the electronic recording failed) and assist fishers with adding markings on the maps provided to them during the interview. Some of these strategies were cited as successful by Neis, *et al.* [1999b], and proved equally so in this study.

conduct and deliver the research, making his presence necessary. Despite my supervisor's presence at most interviews however, the research was designed by me. I contributed significantly in the asking and framing of questions; clear divisions of labour evolved. My supervisor asked mainly questions on each fisher's social history in the fishery, whilst I asked about gear, engine size, vessel tonnage and boat history. I also helped fishers to complete map work. Being of an interdisciplinary background, but also being the only team member with prior knowledge of fisheries science, I also took charge of biological and ecological questioning. My supervisor, an expert in political science, asked questions on fisheries politics whilst I interjected with queries of a socio-economic nature. The questionnaires were designed, written and produced by myself. I personally transcribed and edited the interviews, before then taking the lead role in their analysis.

Each interview typically lasted between one and three hours. They were recorded on an Olympus VN-3100OPC digital voice recorder and afterwards transcribed using Olympus Digital Wave Player. Microsoft Word and Microsoft Excel were employed to analyse the interviews and process the results.

Replicating the methods of Murray, *et al.* [2006] we used career interviews. Interviewees were first asked about their fishing profiles (*e.g.* characteristics of boats skippered, fishing crew compositions, how they had learnt to fish). Not only did this set the foundation for further questions, but it also helped to de-politicise interviews from the outset. Fishers are understandably often suspicious or wary of researchers from (or funded by) the government institutions who regulate them. To put a fisher at ease, it has been advised that it is better to start with these less threatening topics than ones to do with management regulations, which may be controversial [Marchand and Ardron, 2004].

In the second stage of each interview respondents were asked ecological questions (*e.g.* catch trends, location of fisheries, sites of spawning aggregations). This was done species-by-species and from decade-to-decade. A poster with local marine species was placed on the table in front of fishers to help trigger their memories of encounters with species that

may not be part of their daily operations, but that could still be of relevance to the study⁸⁴.

Where the interview methodology in this study perhaps deviated slightly from past studies was to also include the innovation of a third stage towards each interview's end. The purpose of this section was to elicit political and socio-economic knowledge. This inclusion was partially decided upon because other research had started to successfully uncover findings in these areas [see Murray, *et al.*, 2006], but it was mainly because of our own disciplinary backgrounds. Based on our first-hand knowledge, and also upon documented knowledge of the political obstacles to fisheries in Ireland (legislated by the often criticised CFP⁸⁵), we suspected that fishers may have extensive knowledge of the effects of management on their fishing operations. This was likely to be the section of the interview to raise topics that interviewees were most opinionated about, so situating it at the end of the interview meant that it could be discussed when we already had the interviewee's trust. It was hoped that with this trust built, fishers would be more open to talking about any controversial practices within Irish fishing.

The structure of each interview still varied despite the guide sheets and the three stage approach. Fishers frequently deviated from the topic under discussion, and they were permitted to do so. Ultimately they were the interview guides; not the researchers. Fishers' knowledge researchers have been criticised in the past for taking preconceived ideas of what fishers could know into interviews [Holm, 2003]. Imposing of their own perspective of what a fisher's worldview might be has perhaps led to them constricting the scope of interviews and any resulting outputs. By making the fishers the *de facto* guides it was hoped this would be avoided. The guide sheets were used only to stimulate fishers' memories; not to shape their responses.

⁸⁴ This technique was taken from work in Melanesia, where similar posters and species identification guidebooks were used as visual aids for interview work with artisanal fishers [Hamilton, *et al.*, 2005].

⁸⁵ Some of these criticisms have been documented in earlier chapters of this thesis. An excellent summary of them is compiled by Daw and Gray [2005].

We also followed the advice of Neis, *et al.* [1999a] by avoiding the imposition of the scientific terminology common to population ecology (e.g. CPUE, MSY, Latin fish names). Instead we encouraged fishers to use the everyday language of their lifeworlds. As with the Canadian methodology [Neis, *et al.*, 1999b], we attempted to record and understand this local terminology (e.g. taxonomic descriptions, names for fishing grounds) during the project's pilot study.

Another precaution taken to make sure interviews represented fishers' lifeworlds was to allow the participants to choose where interviews took place. This had been identified as best practice by other fishers' knowledge researchers [Marchand and Ardron, 2004; des Clers, *et al.*, 2008; Edwards, *et al.*, 2009]. Locations such as university meeting rooms were avoided. Sites chosen included fishers' boats, their houses, restaurants, hotels, pubs, the headquarters of a fishing cooperative, and a fishing industry trade show.

The decision to include mapping exercises as a key component of interviews was also influenced by previous studies. Contemporary projects had formalised the mapping techniques introduced by Neis, *et al.* [1999b] and Murray, *et al.* [2008a] to map northern cod distributions and migrations described by Newfoundland fishers. Projects in the UK [des Clers, *et al.*, 2008; Edwards, *et al.*, 2009] and California, USA [McClintock, *et al.*, 2009; Gleason, *et al.*, 2010] had been able to map increasingly complex geospatial characteristics of fishers' knowledge. These included; location and intensity of fishing effort, fish spawning grounds, the suitability of areas for MPA designation. Fishers in this study were encouraged to mark whatever spatial knowledge they had directly onto A3 photocopies of the Admiralty charts⁸⁶ covering the study region. Maps were placed on the table in front of them for the duration of the interview. We were able to record information for multiple species and fishery characteristics by using

⁸⁶ See glossary: Admiralty charts. The following numbered charts were used: 1125, 3339, and 1984.

a different colour pen for each⁸⁷. The individual outputs were pooled to produce composite maps of the fishers' knowledge.

The final methodological consideration, and the most important, was to select ethical procedures to adhere to during the study. Two social scientists have highlighted the dangers of not complying with these when researching fishers' knowledge. One warns that the scope of a project can be constricted. The other shows how uncontrolled dissemination of findings can introduce new tensions to fisheries science. Firstly, Jones [2009] highlights a case study in the UK where fishers were happy to map their fishing activities, but refused to contribute ecological knowledge (e.g. of spawning ground locations). This was because the fishers were wary of fisheries managers using their own knowledge against them to close fisheries which they might identify as ecologically sensitive.

Secondly, Maurstad [2002] explains how granting freedom of access to the results of her Norwegian case study could have angered the fishers she had sampled. Published maps of their knowledge of fish stock locations could be used by outside fishers (unfamiliar with the waters of the research locality) to start competing with the indigenous fishers for the resource. If our project's findings resulted only in inspiring more top-down legislation, or in introducing conflict to the Galway and Aran region, we would alienate the participants. If the fishers themselves had turned against fishers' knowledge research, a scenario discussed further in section 5.5, it could irreparably damage the prospect of an integration project for their knowledge. Therefore, we adopted a code for ethical conduct.

First, we granted total anonymity to all fishers interviewed⁸⁸. Ensuring this meant that any knowledge recorded could not be used against a fisher at a

⁸⁷ This is one of many excellent tips provided by Marchand and Ardron [2004] in their *Gathering Spatial Knowledge from Local Experts: A Handbook for Interviewing Fishermen*. Anybody seeking to do research on fishers' knowledge that involves interviews would benefit from reading this guide, which also gives advice on how to source respondents, conduct interviews and process data.

⁸⁸ During the course of this research it was suggested to us by academic colleagues that our respondents may not actually desire the anonymity we had granted them. They may have wanted a personal hearing. Certainly some interviewees stated they were happy to be quoted publicly. We had not considered this eventuality and it does not seem to have been an issue considered in other

later date, either by their own colleagues or by management institutions (e.g. to prosecute them for any potentially illegal activity). Following guidelines laid down by Marchand and Ardron [2004], each fisher was given a code (e.g. F7 for the seventh fisher interviewed). During interview transcription any identifiers (e.g. boat names) were removed or censored⁸⁹.

Second, interviewees were allowed to go off-record. This entailed turning off the digital voice recorder whilst they relayed information that they did not want to appear in the project's outputs (e.g. the location of fishing grounds that only they knew of, potentially sensitive comments about individuals and institutions). Although this meant that potentially useful knowledge could not be reported verbatim it did permit us to carefully reproduce the knowledge in generalised outputs. For instance, we could say that there were fishing grounds known only to a few fishers, but we would not identify them on a map.

Finally, it was decided that feedback sessions⁹⁰ would be conducted. These had been usefully employed in research in both Canada [Murray, *et al.*, 2008a] and the UK [des Clers, *et al.*, 2008]. For assessing the accuracy of our data the meetings were highly productive. The sampled fishers were able to comment upon and correct our findings, including the composite maps drawn from their knowledge. It was also a chance for the fishers to moderate or embargo any of the findings that they thought could damage their interests⁹¹. We asked the Galway and Aran fishers whether they would

published fishers' knowledge research. It is an issue that deserves attention in future research.

⁸⁹ Quotes from these transcripts do appear in this thesis and other outputs of the *Irish Fishers' Knowledge Project*. Permission was sought from the fishers involved in the study (during the feedback meetings) to use these. The participating fishers uniformly agreed, with the condition that the personal identity of the individual giving the quote should not be revealed.

⁹⁰ To date (7th June 2011) three feedback meetings have been held and cumulatively 32% of respondents have been able to attend these. It is intended that further meetings will be held to share and validate the results with a higher proportion of those interviewed. The third of the three feedback sessions conducted was the first given in a semi-public (mostly fishers) forum. Hosted during the *Irish Skipper Expo* at the Galway Bay Hotel, Galway, it opened up the feedback to groups of fishers that had not been part of the sample. Opening up feedback to wider groups of fishers and also asking them to comment on and moderate the results has been seen as a good way of gauging whether a study's findings are representative and accurate [Murray, *et al.*, 2008a].

⁹¹ Maurstad [2002] had embargoed the publication of some fishing grounds in her outputs so that fishers from neighbouring communities and countries could not see

object to the publication of any of the research findings. This gave them a chance to rethink anything they may have regretted saying in their interviews. Additionally, it allowed them to put forward a case for moderating anything their colleagues had said which might compromise their own operations⁹². Whilst we did not want to have to omit anything we thought to be of interest, our priority was to make sure that the fishing community was happy with the research and would not come to resent it. In hindsight there was no need to worry about the fishers' motives for taking part in the study. During feedback, not a single fisher asked for any of the data to be withheld.

The sample

Sampling design is a developing process in fishers' knowledge research. It has been criticised for sometimes assuming that the fishers who are more experienced and/or who share the researchers' ecological perspectives of a fishery are judged to be those who are most knowledgeable [Holm, 2003]. In this research the approach taken was to try and capture the historical experiences of the retired and eldest active fishers, particularly those held in high regard by their peers. However, it was also decided to investigate whether less experienced fishers also had useful knowledge.

Therefore, snowballing techniques employed by Neis, *et al.* [1999b] and Murray, *et al.* [2006] were used to identify highly experienced fishers recommended by their peers, but also utilised was a more systematic approach. Using the *Irish Fleet Register* [DAFF, 2008] we identified all of the offshore and coastal boats in the local fleet and then directly targeted interviews with their skippers. With relatively few boats of this size in the commercial fishery this systematic approach was very manageable. However, the snowballing technique was the only method used to find retired and inactive skippers⁹³. As outsiders to the local fishery and

them. She had only released complete maps confidentially to scientists, managers, and her sample.

⁹² To be clear, this was only an opportunity for fishers to identify anything they wanted omitted. Contribution of new knowledge at this stage would not have been included if it appeared to be an attempt to falsify findings so that they appeared more favourable to the interests of the fishing industry.

⁹³ Only fishers who had skippered boats were targeted. This is a potential limitation, as the knowledge of crew members may be just as relevant and may

because we originated from the academic sector, which often has a negative profile in fishing circles, we sourced a gatekeeper who could introduce us to fishers. Peter Tyndall, the local representative of Bord Iascaigh Mhara (BIM)⁹⁴, was known to be respected by local fishers and he performed this role for us. Having been informed of the nature of the research, and having found its goals agreeable, he agreed to assist us. Peter made initial telephone calls on our behalf, explaining the project to fishers who he believed may otherwise have opted out of the research. His recommendations, as well as word-of-mouth endorsements from fishers who had already been interviewed, ensured that we were able to interview most of the fishers whom we targeted. Another BIM employee, Seamus Breathnach, played a similar and equally important role in helping us find inshore potters to interview.

Where the sampling technique was more targeted was in its deliberate focus towards boats that targeted nephrops as the main species in their catch. Initially, this was because the scientists at the Marine Institute who had commissioned the research were interested in finding out more about the fishery for this species. It was a stock where they evaluated a considerable amount of uncertainty in its assessment [MI, 2009]. On further reflection this direction of enquiry was later deemed to have wider methodological legitimacy. Much of the fishers' knowledge research so far had exemplified cases of inshore fisheries where scientific assessments were rare and regulations few (e.g. the developing world and artisanal fleets reviewed in section 2.2). The nephrops fishery was the region's most commercial fishery and it provided an opportunity to see whether fishers' knowledge was of the same nature in highly commercial offshore fisheries. Even so, efforts were also made to contact boats in the inshore fleet, particularly those that shared fishing grounds with the offshore fleet or that potted for nephrops. These fishers acted as a reference group with which to

also be different to that of their skippers. However, the timeframe of the project did not allow for such an expansion. Additionally, many of the crew members currently in the Galway and Aran region were temporary migrant workers from countries including Egypt and the Philippines. They would have less historic knowledge of the region. The assumption was made that as most of the skippers had started off as crew members, then the knowledge of those currently crewing was not likely to add significantly to what skippers had. This assumption was also based on work that shows deckhands learn most of what they know from skippers anyway [Pálsson, 1995; 1998a].

⁹⁴ See glossary: BIM.

compare the skippers of larger boats. They could also contribute secondary knowledge of the operations of larger boats and impart any experiences they had of where these vessels had effected their own operations.

Table 3.2. Demographics and selected information for interviewees.

Age (years)		Time in fishery (years)		Age started fishing (years)	
20-39	37.5%	<5	0.0%	<20	96.9%
40-59	46.9%	<10	3.1%	20-39	3.1%
60+	15.6%	<15	18.8%		
		<20	12.5%		
		>20	65.6%		
Fleet Sector		Employment status		Taken leave from fishing career	
Offshore	53.1%	Full time	68.8%	Yes	12.5%
Coastal	25.0%	Part time	12.5%	No	87.5%
Inshore	21.9%	Retired	18.8%		
Family history		Fishing education (learned from)		Areas fished (total reach)	
Grandparents fish(ed)	28.1%	Family	37.5%	Just Irish west coast	21.9%
Parents fish(ed)	56.3%	Skipper of Galway and Aran boat	34.4%	Around Ireland	53.1%
Children fish (ed)	15.6%	Away from locality	28.1%	International	25.0%

The total number of interviews conducted was thirty-two, exactly the same as the number of offshore and coastal trawlers active in the Galway fleet. This does not however represent a 100% sample: six of those interviewed had retired from the industrial fishery, two were simply visitors to the area's fishery, and seven were from the inshore fishery. Nonetheless, this represents a significant proportion of the fleet. Table 3.2 shows that the sample also represents a diverse cross-section of fishing interests, which hopefully led to capture of a diverse fishers' knowledge.

3.3. Contributing (or not) to stock assessment

But how can this help us? [Anon. Marine Institute scientist to researchers on the *Irish Fishers' Knowledge Project*]

This response to a preliminary presentation of the results for the *Irish Fishers' Knowledge Project* was not what I had hoped for. Having completed the interviews and some analysis of them, there had been a sense of excitement. I believed that we had made novel biological discoveries that could be cited directly in Marine Institute fisheries assessments. However, rather than being shocked or impressed by this supposedly new data, the Marine Institute scientists showed little positive reaction. In fact, Marine Institute scientists did not see how many of the results could help them at all.

The main problem the Marine Institute scientists had with the findings seemed to be with their inability to contribute to the collection of data for annual stock assessments. Of “vital importance” to the institution’s work was the production of advice, based on these assessments, which was then used to calculate the TAC for fisheries in Irish and European waters [MI, 2008]. The agency performed the major assessment role for most of the fisheries covered in this case study, which mainly consists of those in ICES management zones VIIb, VIIc, VIIj and VIIk, as well as the functional units (FUs) 16 and 17 [see map in Appendix B]⁹⁵. One of their reasons for their commissioning this research was that they had already become unsure of the accuracy of the fisheries dependent data which informed their stock assessments for these areas; the landings data collected in vessel log books and at Irish ports⁹⁶. They had perhaps hoped that our project could produce precise findings which they could confidently input into their stock assessment models, but their feedback suggested that they were now even more sceptical over the accuracy of fishers’ biological knowledge.

It is important to note that investment in fishers’ knowledge research was not the Marine Institute’s only strategy for eliminating uncertainty in their assessments. They were also trying to produce new, more accurate datasets that required zero contact with fishers. One such approach was to monitor fish populations using underwater television (UWTV) surveys. The Galway and Aran nephrops fishery is one place in which these have been deployed. Since 1988, the stocks of this species present in FU17 had primarily been assessed through analysis of commercial catch data provided by fishers. Scientists had come to judge this as unreliable, initially because they thought catches may have been over or underreported by fishers, and latterly also because whilst disputing scientific assessments

⁹⁵ The zones designated by ICES are the broad areas they designate for fisheries assessment and management. A stock assessment and management plan is generally formulated for each species in each zone. Functional Units are created when the zone scale of management is believed to be too broad, and not suitable for managing a stock. This is the case for sedentary species like nephrops where there may be little interaction between populations of nephrops, even if they dwelt in the same ICES zone. Designated quotas for the whole zone could theoretically lead to one population receiving all the permitted fishing effort, whilst others went untouched. The heavily targeted population would likely be overfished.

⁹⁶ A previous report had shown that the levels of discards reported by fishers did not match those recorded by onboard observers [Lordan, *et al.*, 2011].

fishers were deliberately withholding catch and discard data [ICES, 2009, p. 139]⁹⁷. They responded to the perceived unreliability by introducing the UWTV surveys in 2002. The results of these have since achieved the status of being the primary indicator for assessing the health of the nephrops stock. Catch data recorded by fishers in their log books has become only a secondary indicator. Despite initial complications with the precision of UWTV surveys its practitioners at the Marine Institute and in other scientific institutions believe it to have become the most accurate way to survey nephrops stocks, and their confidence in the methodology continues to increase [Bell, *et al.*, 2006; ICES, 2007; 2009; Lordan and Doyle, 2009; 2010]. For fishers' knowledge to be integrated into scientific assessments it needs to show that it can produce better results than UWTV surveys or act to compliment them.

This is the same challenge for all the findings in this chapter. The precedent set by the statistical modelling in the Irish *Stock Book*⁹⁸, means that any replacements or compliments would likely need to consist of robust quantitative information in order to be acceptable to the Marine Institute's scientists. They would have to be demonstrably more precise and reliable than their own calculations for figures such as CPUE, for which they also admit uncertainty [MI, 2010, pp. 59-60, p.303]. In the remainder of this section four major findings are detailed which show how fishers' knowledge could meet the challenges of stock assessment, start to address scientific uncertainty, and inform the research programmes of fisheries scientists.

Although this study took a multiple species approach and considered the entire geographical area covered by the sample during their fishing operations, the example used to illustrate the results is most often the nephrops fishery of FU17. This is because it was by far the most discussed in interviews. Of the total sample (N=32), twenty-seven of the fishers were currently, or had previously, targeted nephrops on this ground. The best

⁹⁷ The fishers thought that the scientific figures for discards were greatly overestimated and were worried that management regulations to help reduce discards would be unnecessarily introduced, perhaps impeding their commercial fishing opportunities [Lordan, *et al.*, 2011].

⁹⁸ See glossary: Stock Book.

way to assess the full potential of fishers' knowledge is to see how it measures up where its owners have most experience.

Finding 1: the micro resolution of fishers' spatial knowledge

Even though they believe UWTV surveys to be the best technique for surveying nephrops populations, ICES scientists, including representatives from the Marine Institute, still have some reservations with the methodology [ICES, 2009, pp. 22-34]. These include difficulties in identifying the ecosystems in which nephrops are located and in particular, the boundaries of their distribution. Previously they worried that stocks were being underestimated because populations of nephrops lay outside the survey area.

Figure 3.2 shows how the Marine Institute's UWTV surveys of FU17 have developed since 2002 to encompass an increased area. Scientists believe they have greatly improved their ability to identify the locations and boundaries of nephrops populations. They attribute this partially to their detailed analysis of VMS data, which is combined with log book data to identify fishing effort for nephrops [ICES, 2009, pp. 24, 146; Gerritsen and Lordan, 2011]. Additionally, they have begun to conduct habitat mapping, allowing them to identify areas with benthic characteristics ideal for nephrops colonisation⁹⁹ [ICES, 2009, pp. 24, 152-53]. My personal communications with a Marine Institute scientist also revealed that the agency had consulted with a group of fishers when they first started the UWTV surveys [Anon. MI scientist, 2011a]. The purpose of the consultation was to ask fishers which locations in the Galway and Aran region were host to nephrops fisheries. However, when the maps in figure 3.2 are compared with the map produced from our interview mapping exercise in figure 3.3 it becomes immediately clear that the Marine Institute's attempts to assess FU17's total nephrops stock have not been entirely successful.

⁹⁹ Both depth and sediment type are variables which can influence nephrops abundance. The nephrops populations of FU17 were all found between 80 and 110 metres and the species was more abundant on muddy ground [Lordan, *et al.*, 2007, p. 10].

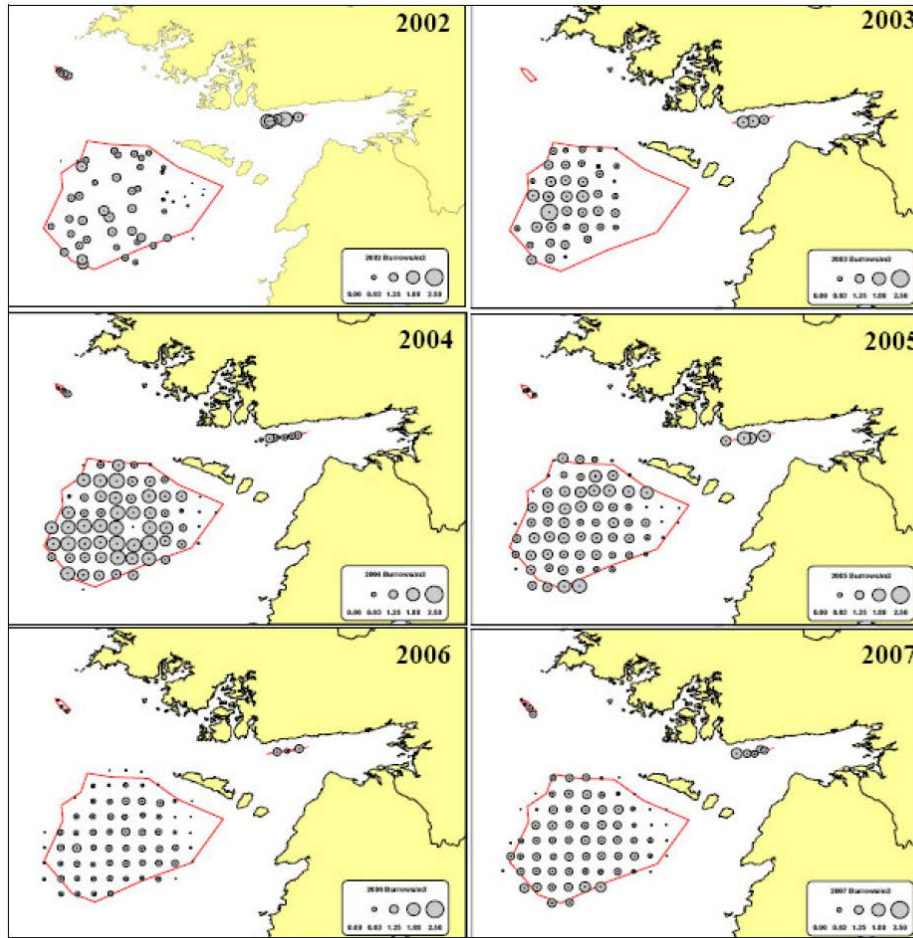


Figure 3.2. The development of the Marine Institute's UWTV surveys¹⁰⁰ [Source: taken directly from MI, 2007, p. 320 with permission of the publisher].

¹⁰⁰ The grey dots represent sampling sites where nephrops populations were found. The greater the dot size, the higher the nephrops abundance at that location. The red lines represent the boundaries of the grounds according to Marine Institute scientists [Lordan, *et al.*, 2007, p. 22].

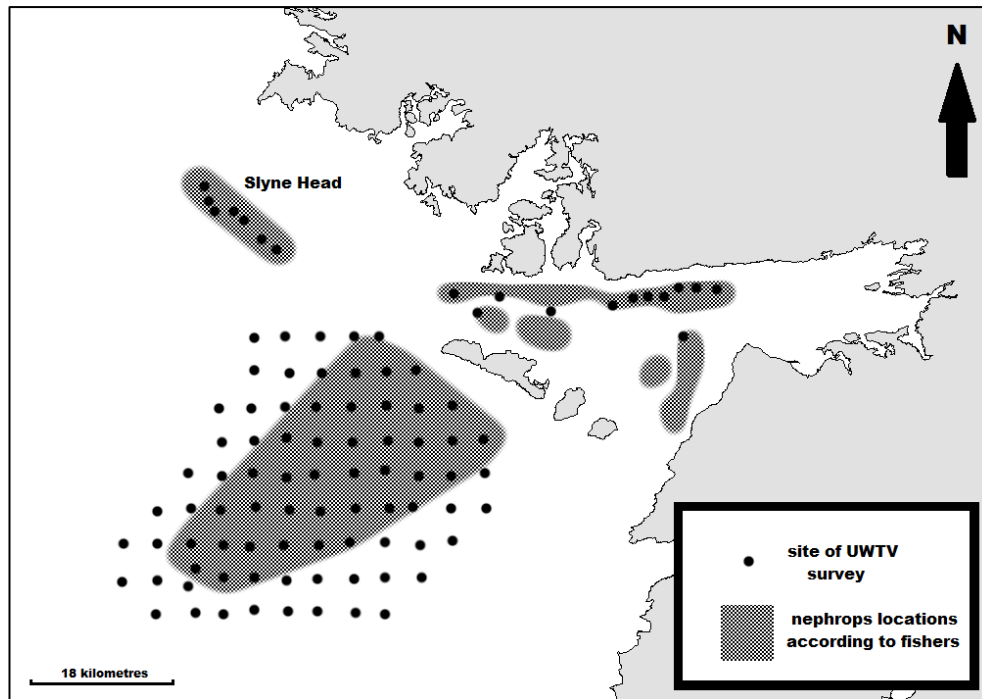


Figure 3.3. Locations for the Marine Institute's 2011 UWTV surveys in FU17, overlaid with fishers' knowledge of their targeted effort for nephrops [Source: sample stations provided by Marine Institute. Fishing effort data is original to this research].

Population ecologists are aware that nephrops fisheries are often constituted of several sub-grounds, or “stocklets” [Briggs, 1995]. Indeed, the UWTV survey results in figure 3.2 show that these have been acknowledged since the start of the Marine Institute's self-monitoring of FU17. In addition to the main ground at the Back of the Island, they have always included stocklets located at Slyne Head and on the Northwest Corner. Until 2007 however, there is no evidence that scientists recognised the existence of stocklets in the vicinity of the Slate and the North Sound. Maps of the UWTV survey coverage for 2008 to 2010 have not been published in such an accessible format as those up until 2007, but a review of the yearly assessment reports shows that until 2009 the picture remained the same [Lordan and Doyle, 2009; 2010]. The first UWTV survey of the North Sound then occurs in 2010, but only for a single sampling station [Lordan and Doyle, 2010]. Not until 2011, as the survey stations marked on figure 3.3 illustrate, did the UWTV surveys begin to come close to surveying the entire North Sound as drawn by fishers. It is also in this year that the first sampling on the Slate is conducted, but again only for a single station. At this stage the Marine Institute surveys still fail to assess the following stocklets which fishers said they actively fished: the majority of

the Slate, a small stocklet to the immediate west of the Slate, and stocklets to the south of the North Sound. This current lack of coverage can be seen in figure 3.3.

The reasons for shortfalls in the Marine Institute's knowledge of fishing effort became clear during the interviews. The fishing operations of two of the sample were not included in the assessment of fishing effort which informed the choice of UWTV sampling stations. Both owned coastal vessels that were primarily fishing in the vicinity of the Slate, the North Sound and the Northwest Corner (*i.e.* in the areas where the 'unknown' stocklets were). Their shorter vessels were not required by law to fit a VMS system and therefore their effort was not being tracked by satellite. The landings profile of one (fisher 14) identifies the stocklets of the North Sound and those just to the south of that ground, as being far from inconsequential to stock assessment. He put his average catch for these ecosystems at twelve 'boxes per tow'¹⁰¹ and he was towing twice a day. This was a similar figure to that which many interviewees described taking with larger boats on the Back of the Island ground. Until these 'unknown' stocklets become part of the UWTV survey, the stock assessment for FU17 will be an underestimation.

The initial consultations in 2002 must either have not included the fishers without VMS or must have failed to capture some of their knowledge. When collecting spatial data, there is clearly an advantage in an interview methodology which lets you talk individually to almost all of the individuals working in a certain fishery. During interviews with fishers, it was possible to discover a lower spatial resolution of fishing effort and catch activity than has previously been captured. The VMS maps indicate clearly fishing activity at macro and meso scales, but they do not always capture this micro scale. If the Marine Institute had been able to use fishers' knowledge at this smaller scale then they could have assessed the FU17 nephrops stock accurately in 2002, instead of gradually accumulating the knowledge

¹⁰¹ The Galway and Aran fishers generally measured their landings in 'boxes'. These are literally the boxes that fish are put in before being sold at auction. The boxes that all of the interviewees were using were uniform in size. A tow in the FU17 nephrops fishery was described by fishers as approximately a 4 hour linear trawl.

using their own methods, which still left them with an incomplete assessment in 2011. Feedback from scientists at the Marine Institute regarding this finding was positive. They have agreed to look at the map of fishing effort in figure 3.3 to see whether they need to reassess the spatial deployment of their UWTV surveys [Anon. MI scientist, 2011a].

The scaled up significance of this finding is that it demonstrates how effective fishers' knowledge can be when it is rendered spatially. In section 4.1 this finding is built upon. There, it is shown that fishers' knowledge can be used to map the distributions of multiple species, as well as the locations of important ecological sites at macro, meso, and micro spatial scales. It is also shown that fishers can map these features historically, from when they first started fishing until the present day. The particular significance of this is discussed in that section. Coupled with the findings in this section however, the broader discovery is one that could be important to the integration of fishers' knowledge in fisheries science. Detailed maps of fishing effort and stock distribution would be hard natural science outputs, similar to those in reports produced by scientists. Matching their standards, whilst introducing novel scales of information which could help solve scientific uncertainty, would give them little reason to reject fishers' knowledge.

As the *Irish Fishers' Knowledge Project* was only a scoping exercise to discover methods for collecting and analysing fishers' knowledge, mapping was only one part of a suite of methods we experimented with. Our goal was to see if mapping worked, not to find how it worked best. Nevertheless, the potential of the technique is clear and future fishers' knowledge work should strive to develop ways to visualise fishers' knowledge so that it matches as closely as possible the standard of scientific outputs. One way this could be achieved is through embracing geographical information systems (GIS) and perhaps getting fishers to describe spatial data using the units of their GPS, which many of them already have on their boats. Projects in the USA, Canada, and the UK are already mapping fishers' knowledge using one or the other (or both) and the outputs are being actively integrated by national fisheries science agencies, non-governmental organisations (NGOs) and management institutions [Macnab,

2002; Scholz, *et al.*, 2004; Aswani and Lauer, 2006; des Clers, *et al.*, 2008]. This momentum should be sustained and the potential for using the techniques in Irish fisheries science should be explored.

Finding 2: the potential to solve biological puzzles

Underpinning the stock assessments of population ecologists are a number of biological assumptions. For example, to calculate the stock levels of nephrops in FU17, a value for the stock's natural mortality must be inputted into a statistical model. Marine Institute scientists use a standardised figure derived from research of other nephrops populations [ICES, 2009, p. 140]. Members of the fisheries science community have formulated and tested hypotheses in order to identify causes of natural mortality and the extent to which each impacts nephrops populations [see review in Bell, *et al.*, 2006, p. 429]. The standardised value of what is believed to be the true degree of natural mortality has been agreed by scientists working across the geographic range of the species.

During our interviews we found that fishers were just as likely to form hypotheses from their own knowledge of the fishery, which they would then effectively test by experimenting with their fishing practices. They did not need to calculate the size of fish stocks, but essential to them was the ability to maximise the efficiency of their fishing trips. During their careers, they had accumulated knowledge that informed them of the best times, locations, and conditions in which to find their desired catch.

One example of this was that a majority of interviewees reported that starfish populations had increased dramatically in abundance during the 1990s on some of the fishing grounds for nephrops in FU17 [see figure 3.4 for locations where interviewees mapped this event]. Some, like fisher 17, hypothesised that the starfish had outcompeted the nephrops stocklets on the Northwest Corner and North Sound, causing CPUE to drop as a result of there being a reduced population [see table 3.3]:

Fisher 17 (F17): '93, '94, '95,' 96 you wouldn't see one of the [starfish]. [...] Once it's full of starfish, you won't get the prawns¹⁰² there.

¹⁰² Name given to nephrops by fishers. Outside the scientific community the species is known in Ireland as 'Dublin Bay prawn'. Fishers shorten this to 'prawn'.

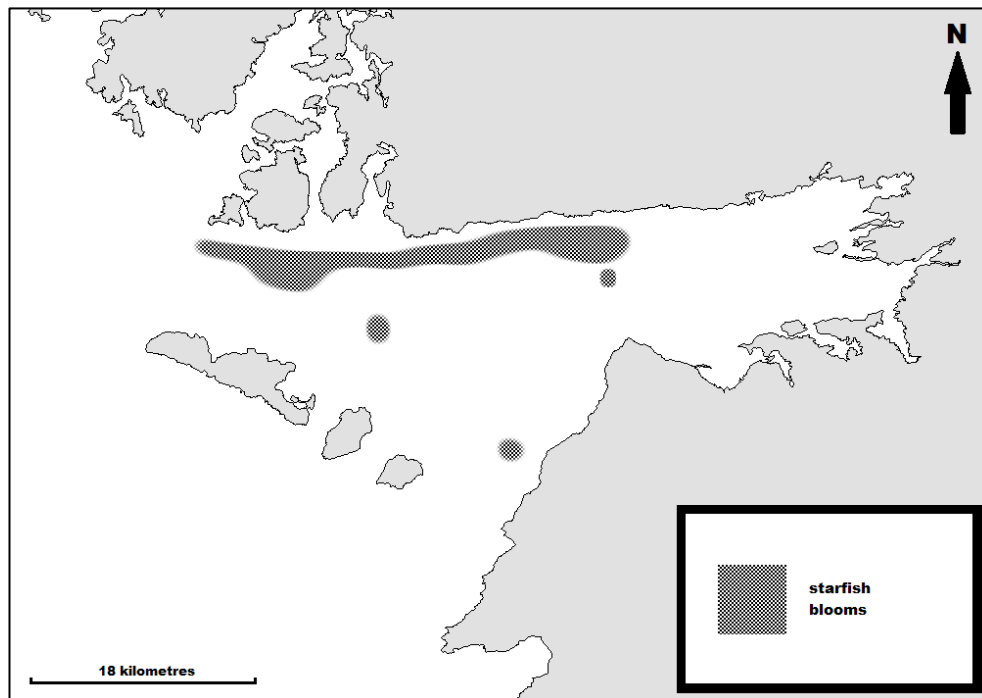


Figure 3.4. Locations of 1990s starfish blooms identified by interviewees.

Whilst they cited competition with starfish as a downward driver of nephrops populations, some also noted a recent event which they believed had caused starfish populations to recede and nephrops ones to rebound. Firstly, fishing effort had increased on the Northwest Corner and North Sound grounds as a select few fishers began to operate on them circa 2000. It then increased again in 2008, because fuel prices had risen and vessel skippers could not afford the diesel necessary to travel further than these inshore fisheries. In this period, because of their belief that starfish out-compete nephrops, they kept any starfish they caught on the deck of the boat until they were deceased. Resultantly, they attributed a perceived rise in the nephrops population for these stocklets in the 2000s to the hypothesised lack of competition. Fisher 4 summarises this:

F4: My theory always was, as I said about a prawn ground, the more it's fished the better it gets. This place was left and when we went back here we were getting months and months of mud balls and starfish and everything. The more boats that came on it the cleaner the ground got and the more prawns we started catching in it. It was much easier then.

The idea of inter-species competition for habitat is not noted in the *Stock Book*, where the management recommendations for FU 17 nephrops assume that a decrease in effort will not lead to a decrease in abundance.

However, recent scientific research potentially confirms fishers' knowledge on the subject [Vergnon and Blanchard, 2006; Hinz, *et al.*, 2009; Ramirez-Llodra, *et al.*, 2010]¹⁰³, finding that the species can benefit from fishing pressure. If the fishers' hypotheses were indeed proven, that starfish are a significant downward driver on nephrops population, there would be a case for scientists factoring such competition into the stock assessment.

Table 3.3. Hypotheses suggested by fishers or constructed from their knowledge.

Characteristic of nephrops in FU17	Example of fishers' knowledge	Hypothesis (in bold)
Competition for habitat	68% of fishers (N=19) believed starfish populations had increased substantially on the Northwest Corner and North Shore fishing grounds since they started fishing.	Starfish can out-compete nephrops, leading to drop in population of the latter.
	Nephrops have become easier to catch after heavier fishing of the Northwest Corner and North Sound stocklets, during which starfish were removed (see fisher 4 quote in this sub-section for Finding 2).	With starfish removed, nephrops populations increase in absence of competition for habitat.
Natural mortality	Cod used to be abundant in the Galway and Aran region, but 70% of fishers (N=23) identified its commercial extinction between the 1960s and 1990s.	Previous scientific studies show approximately 80% of cod to have <i>three</i> nephrops in their gut [Thomas, 1965]. Natural mortality of stocklets where cod previously existed may have dropped.
	Fishers 24 and 8 amongst those to report increased bycatch (therefore populations) of spotted dogfish on the Back of the Island fishing ground.	Previous scientific studies show approximately 50% of dogfish have <i>one</i> nephrops in their gut [Thomas, 1965]. Natural mortality of nephrops may have increased on the Back of the Island ground.
	Fisher 13 reported regularly finding nephrops in the guts of rays he was landing. Catches of 1 to 17 boxes of ray per tow were reported by fishers for FU17's sub-grounds of the North Sound, Northwest Corner and the Slate.	Previous scientific studies show approximately 50% of ray have <i>three</i> nephrops in their gut [Thomas, 1965]. Natural mortality may be higher for stocklets where ray are present.

¹⁰³ The research outlines that nephrops motility and ability to burrow deeply gives them a competitive advantage over species that like the same muddy substrate. They are more able than starfish to avoid capture in demersal trawls. Therefore, whilst starfish are amongst the species to usually dominate in low or moderately fished ecosystems, the opportunistic nephrops can become the most abundant species in heavily fished ecosystems.

On other occasions, fishers' knowledge was found to be more tacit and they did not show an ability to form hypotheses from their biological knowledge. However, referencing my own interdisciplinary experience, I was able to construct hypotheses from it [see table 3.3].

For instance, during interviews, none of the skippers noted the potential significance of two of their observations for the natural mortality of the nephrops stock. Firstly, fishers gutted the fish they landed and would often find nephrops in the stomachs of those caught in FU17. Secondly, fishers had knowledge of how the abundance of nephrops predators such as cod, spotted dogfish and ray had changed, spatially and temporally. The biggest change in abundance was perhaps the staggered extinction of cod, described by fisher 16:

F16: When we bought the [boat] in '95, my father had the [other boat], we went pair trawling in '96, '97 and we got over a 100 boxes, 150 boxes and I'd say there were 40 boxes of cod in it. And I remember at St Patrick's Day, another time, we were fishing, I was fishing on the [boat], and [another boat], there was three of us fishing that weekend, no other boats out, we had 200 boxes of [whitefish] and 60 were cod. That was in '96. That was single trawl.
[...]

Interviewer (IV): when is the last time you saw a cod?

F16: That time. You might get one [single fish] every couple of weeks [now].
[...]

F16: [...] we used to get [...] maybe 100 boxes of cod, this would be when my father was fishing back in the sixties and seventies.

IV: And can you put a year on when the cod disappeared from [the Northwest Corner ground]?

F16: I'd say late sixties. I'd say up until then there was.

IV: But you're saying for the Back of the Island, up until the mid-nineties and late-nineties there was cod?

F16: There was, because I caught them.

Across the sample of interviewed fishers, the commercial extinction of cod was the most frequently identified ecological event within the region. Having disappeared from the grounds inside of the Aran Islands in the 1960s, the species was gone from the Back of the Island ground in the early 1990s [see figure 3.5 for locations where interviewees mapped these past populations].

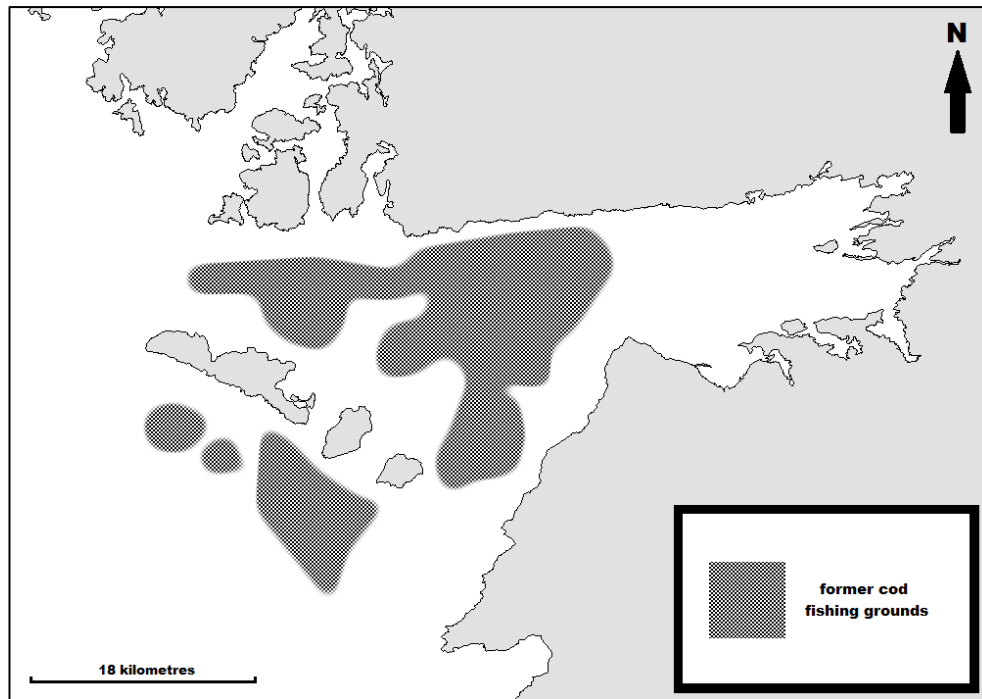


Figure 3.5. Locations of former cod populations identified by interviewees.

Informed by Thomas' [1965] study of nephrops predation in a Scottish fishery and an updated review in Bell [2006], it was possible to hypothesise that the natural mortality of nephrops could be different for the micro-populations within the different stocklets of FU17, and that it would have changed historically. The figure for natural mortality used by the Marine Institute is uniform for the whole of FU17 and is not reassessed each year, but if the hypotheses in table 3.3 were proven, it would lead to the conclusion that for stock assessment to be accurate, calculations would have to be made separately for each stocklet and the abundance of predators within each would have to be continually monitored.

The type of hypotheses formulated here are the kind that Daw [2008] and Soto [2006] say can be used to compliment scientific enquiry, as testing them would help reduce uncertainty and increase precision. Despite this belief, during our feedback sessions with the Marine Institute scientists we did not find them to be greatly interested in this potential. Certainly, some of the hypotheses were already part of their scientific knowledge¹⁰⁴, and testing of them is therefore unnecessary. However, the theories of ray

¹⁰⁴ *E.g.* Predation by spotted dogfish is already accounted for in the official figure for natural mortality [ICES, 2009, p. 140].

predation and starfish competition are not ones they have either known about or acknowledged in previous publications. They did not specify precisely why they were not convinced about the value of hypothesis generation, but the general feeling of scientists seemed to be that even if the hypotheses here were proven the alterations they would have to make to their formulae would not change the output figures by a significant magnitude. Additionally, they revealed that testing of the hypotheses would require a great deal of extra research and they imparted that their research schedule was already too demanding [Anon. MI scientist, 2011a].

In not investigating the fishers' hypotheses the Marine Institute are missing an opportunity to solve the uncertainty that they know is present in their surveys. For instance, their scientists state that for their assessments of the natural mortality of nephrops in FU17 that the accuracy of their assumption is "unknown" [ICES, 2009, p. 140]. As a solution they even suggest using stomach contents data to solve this uncertainty! Here, the state agency is also missing a chance to conduct collaborative research with fishers, and the negative implications of this are discussed further in section 3.4. What is perhaps less obvious, is that the Marine Institute are additionally failing to take the opportunity to find what fishers do not know. They are not taking note of where fishers cannot formulate hypotheses.

For example, the monitoring of the sex ratios of nephrops stocks is important, because a change in the ratio (where there is an increase in males) is evidence of a potential collapse [Briggs, 1995]. Scientific monitoring of the Porcupine Bank population in FU16 showed that the population of sexually mature males had crashed and that future recruitment was no longer guaranteed [MI, 2010, pp. 292-99]. This was an occurrence that had largely gone unnoticed by those we interviewed until they had been informed by scientists. As the following anecdotes of fishers 6 and 15 reveal, some had only learnt the difference between the female nephrops and the male ones in recent times, because of an operational need. Spanish buyers, who bought most of the nephrops landed in

Rossaveal, were rejecting catches of female nephrops that had black/green heads¹⁰⁵.

F6: Years ago we never paid any heat to females. We didn't even know what females were, but since the Spanish market opened up, that's when we found out about the females, when the black stuff comes up, we call them females and they don't look as nice on the plate. As a matter of fact they're perfect to eat; they just don't look so good.

F15: Well, you see, we didn't know, years ago, we probably would have noticed the females coming on the ground. I did notice the females, the past few years coming on the ground a lot sooner. 2 months sooner. Years ago we'd go out on the Porcupine and you wouldn't see the females coming on the ground to June you know? You'd knock 2 months out of the place before. Not even the berries, the green head like. You'll start to see the berries now.

If the fishers have little knowledge on an issue, as seems true of their knowledge of sex ratios, it is perhaps a chance for scientists to identify areas where they should not be attempting collaborative research.

Finding 3: confirming and confounding science

One area where the Marine Institute specified that our project could assist them was through helping them to address weaknesses they recognised in the official landings data for FU17 nephrops. They believed much of their data for fishing effort and landings before 2008 to be of "potentially poor quality" [ICES, 2009, p. 139], leading them to conclude that the important measure of CPUE for the fishery may also be unreliable¹⁰⁶. The scientists were also insecure over the accuracy of the landings data for showing the size distributions of the nephrops population¹⁰⁷. The hope was that the *Irish Fishers' Knowledge Project* could record new and robust datasets for CPUE and size distribution, especially for the period prior to the commencement of the UWTV surveys in 2002. Initial results indicated that this may well be possible.

¹⁰⁵ The heads on female nephrops go black/green when they start to produce spawn.

¹⁰⁶ CPUE was calculated by dividing the nephrops fleet's total number of hours spent at sea (*i.e.* the effort) with their total landings (kilograms). The value is important as a high CPUE indicates the stock to be in good health, whereas a decreasing CPUE would show the stock to be becoming depleted.

¹⁰⁷ Any change in the size distributions found in a nephrops stock may indicate a change in the overall health of the stock.

Uniform across the sample, was the ability of every skipper to precisely detail the specifications of every vessel they had worked on during their career. During interviews, they gave immediate responses to any questions they were asked about length and tonnage of their boats, the size of the respective crews, dates of construction, engine power, and the exact nature of the fishing gear deployed (e.g. number of and mesh size of trawl nets). A typical exchange was fisher 7's listing and description of each engine he had used since entering the fishery in the mid-1980s:

Interviewer (IV): What's the engine you have?

F7: 700 Cummins¹⁰⁸.

IV: And on the last boat?

F7: I had an 850 Caterpillar on the last boat.

IV: And the one before?

F7: 425 Cummins.

IV: And the [one before]¹⁰⁹ was?

F7: 25 metre, 850 Cat[erpillar].

IV: The [one before]?

F7: 425 Cummins.

IV: How big was [she]?

F7: 60 foot, she was smaller than the [current boat].

IV: And they've all been wooden?

F7: All been wooden, yeah.

IV: And [your first boat]?

F7: Timber.

IV: Horsepower?

F7: 250.

IV: Orion?

F7: It was an Alpha 550.

IV: [Your second boat]?

F7: She was 1500.

IV: [Finally, the third boat]?

F7: That was 400.

A review of the digital recording showed that he did not hesitate once in this section of the interview. His answers flowed freely.

Less fluently, but still capably, fishers were able to describe both their current and historic landings and the size distributions of nephrops within these. We asked them to describe 'good', 'average' and 'poor' landings across their career. The following extracts from interviews with fishers 20

¹⁰⁸ The numbers in this piece of dialogue are the horsepower of each engine. Cummins and Caterpillar are the names of manufacturers.

¹⁰⁹ The texts in [parentheses] are substitutions for what was actually said during an interview. The changes are not introduced here to alter the meaning of a quote. They simply replace vessel names and other personal identifiers in order to ensure the anonymity promised to interviewees [see section 3.2]. In some previous and later quotes parentheses are also used to make sentences easier to understand for readers of this thesis.

and 21 are both recollections of catches made on the Back of the Island ground before the Marine Institute had recorded any landings by Irish vessels. Each was able to describe a good day's (or half day's) fishing and then to break that catch down into the various sizes of nephrops it consisted of.

F20: Ah yeah, you probably would in bulk, not in prawns, no. About 50 boxes¹¹⁰ we'd be saying. [...] when we say 50, that would be tails¹¹¹ in 40. There was a lot of picking of medium¹¹². Maybe thirty¹¹³, thirty-five to the kilo.

IV: This was in the '80s? And you'd get jumbos¹¹⁴?

F20: You would, you'd get 2 or 3 boxes.

IV: No more than 2 or 3.

F20: No, no, no.

IV: And the rest would be would be tails?

F20: Yeah, it would.

IV: So how many tails would you have?

F20: I suppose towing with a smaller boat, 15 stone. I think a stone is roughly a box?

IV: Is that tails?

F20: Yeah. It was tails. 15, 25 would be a good tow.

IV: What would have been a good tow out there in say, you started '75, '76, maybe '77?

F21: Well if you shot early in the morning, maybe 5 or 6 o'clock, tow for five or six hours. You'd definitely get three or four lifts.

IV: And how many boxes?

F21: Well you'd be talking at least 50, 60, 70 boxes, but we used to tail the small ones and pick the big ones?

IV: How many boxes of jumbos, of thirty-fives?

F21: Well thirty-fives, on the landing for maybe two days, you'd have at least 180, 190, maybe 200 boxes.

IV: So 300 boxes?

F21: Yes. Of prawns, whole prawns, and maybe some tails as well.

The units used by fishers to describe their landings [see footnotes in this section] are not always those used by scientists (e.g. 'boxes' instead of kilograms), but they are all quantifiable and therefore perfectly adequate as

¹¹⁰ Where fisher 14 is talking about 'boxes', he is referring to boxes of both whole nephrops and of tails [see next footnote]. During interviews we would clarify with the respondent which they were referring to. However, fishers also talked about weights of nephrops in the unit of 'stones'. For reference, fishers said a box of tailed nephrops would fill roughly three boxes before tailing. They also said that a box of tailed nephrops weighed roughly a stone.

¹¹¹ Some nephrops are landed in the form they are caught, because there is a market for larger whole nephrops. Smaller nephrops mostly have a market as a processed product, which involves a vessel's crew removing their heads in an activity called 'tailing'.

¹¹² The nephrops which were not the largest, but did not require tailing before sale were called 'mediums' by the fishers.

¹¹³ Scientists grade nephrops by measuring a section of their exoskeleton (their carapace) in millimetres. Fishers instead grade them by how many individuals collectively weigh a kilogram. A thirty, or a thirty-five is what they would term a 'medium' grade (*i.e.* between thirty and thirty-five to the kilogram).

¹¹⁴ The largest grades of nephrops were called 'jumbos' by the fishers.

a measure or specimen size, or for insertion into the formulae that calculate CPUE. However, when considering our results, Marine Institute scientists immediately identified fishers' quantitative descriptions of their landings as something that they could not use in their stock assessments. The three reasons they cited were a lack of precision, limited frequency, and subjectivity.

For example, time spent at sea was defined by fishers in units of 'tows', 'hauls' and 'trips'. Fishers in the FU17 nephrops fishery typically described a 'tow' as a four hour trawling event consisting of one or two hauls, and a 'trip' as comprising of two 'tows', but scientists deemed these to be too vague. Their technical method of VMS analysis allowed them to analyse the speed of trawlers, from which they could determine fishing effort to the nearest hour [Gerritsen and Lordan, 2011]. Another problem with fishers reporting of statistical data was the way they reported numerical values. As can be seen in the previous quotes, their catches were often only reported to the accuracy level of the nearest ten boxes, whereas the scientific assessments always use absolute values. Likewise, the scientific measurements of nephrops size were made to the nearest millimetre [Anon. MI scientist, 2010; MI, 2010, p. 59], but fishers could only define them as 'fives', 'tens', 'twenty-fives', 'thirties' and 'thirty-fives' (*i.e.* to the nearest five nephrops to the kilogram). The only data fields for which fishers' precision matched that of scientists were those of vessel specifications (*e.g.* engine power), but there was no institutional demand for this data because the existing scientific records in this area were already rated as "good" [ICES, 2009, p. 139].

Frequency was another characteristic of data provision where scientists could outperform fishers' knowledge. Skippers struggled to remember specific years or even decades for remembered hauls and trips. Often, their historical recollections were of non-specific, representative trips. Indeed, it would be unfair to have expected them to remember every single fishing excursion they had taken part in during their careers. However, the Marine Institute produce measurements of nephrops size on a monthly basis [Anon. MI scientist, 2010; MI, 2010, p. 59] and VMS monitoring analyses every fishing trip.

Ultimately, the main barrier when it came to integration of fishers' quantitative knowledge may have been the Marine Institute's pre-existing perceptions. When shown some of the direct quotes from fishers (including those shown earlier in this section), one of the fisheries scientists noted that whilst many of the results were "interesting" to them, the institution would not be keen to use this element of fishers' knowledge in their reports because of its "subjectivity" [Anon. MI scientist, 2011a]. One reason behind their worry that fishers' knowledge may be subjective was their previous experience in other parts of Ireland. We found that of the nephrops fishers in our sample who had fished on the Back of the Island ground for more than a decade (N=16), twelve (75%) said that the size of prawns had decreased on average over the period they had fished the area. The Marine Institute scientists said that this was a similar finding to what they had heard anecdotally for the FU15 nephrops fishery in the Irish Sea. Having analysed the FU15 claim using historical biological data, they had found that nephrops size distributions had not changed significantly after the application of fishing effort, despite what fishers had said [Lordan, 2010]. They noted our findings may be host to the same error. In particular they were worried that fishers' memories would be biased towards their best day's fishing when comparing past landings to those of the present. Average and poor days would be forgotten.

In summary, the Marine Institute seemed to be looking for something highly precise and robust, like the logbooks utilised in the research of Dobby, *et al.* [2008]. Perhaps they would have been satisfied if we had been able to solicit secret diaries of fishing trips that fishers had kept alongside their official logbooks, or if fishers had been able to contribute detailed plots of fishing trips stored in their electronic GPS. The former would have relied on fishers' real time observations, rather than their possibly subjective memories, and would be free from bias (*i.e.* why would fishers misreport landings to themselves?). The latter could be analysed to identify the exact period of time of fishing and therefore calculate effort effectively. However, this was not something we felt able to produce using the interview methodology we had chosen. Some fishers did tell us they had diaries and GPS logs, but these were the minority and if we had been able to solicit them they would not have represented the sample faithfully. Also,

attempting to solicit interviewees' written catch records may have been seen by fishers as an effort to confirm whether what they were telling us verbally was true or not. Given the nature of historic disputes over discards in the fishery [Lordan, *et al.*, 2011] it may have eroded their trust in our project and even triggered their withdrawal from it. To avoid that unwanted scenario we did not push fishers for such data.

Admittedly, our methodology could have been adapted to collect better quality quantitative data, but a deliberate decision was taken not to. Initially, the goal for our qualitative findings was to match the high standard achieved by Neis, *et al.* [1999b], but it proved hard to measure effort as accurately as they had. The Canadian research had analysed a static gillnet fishery, so time spent at sea was not a variable. This was not the case in the FU17 mobile trawl fishery for nephrops. As previously noted in this section, fishers are perhaps most categorical when describing gear and equipment (*i.e.* like gillnet length), but are not so precise when remembering time spent at sea. We knew that the introduction of inexact data may compromise our results. Furthermore, Neis, *et al.* [1999b] had talked to fishers who had mostly targeted the same species. Many of the Galway and Aran fishers had switched to nephrops fishing as a primary source of income (from a whitefish fishery) as recently as the late-1990s. Before this, nephrops fishing had been a secondary activity for most. Many did not have the experience to have accumulated good historical knowledge of landings for the species. It was obvious at an early stage that we would not be able to collect the quantity or quality of statistical information that our research remit perhaps demanded, and therefore we focussed on discovering elements of fishers' knowledge that might be seen as more desirable by those who could integrate fishers' knowledge.

A further reason for not collecting robust quantitative data was methodological. When the research team pressed fishers for specific quantitative responses, it was perceived that the atmosphere within the interviews changed. As outlined in section 3.2, the interviews were designed to be led by the fishers and guided by those conducting them. Attempts to elicit quantitative data from the fishers often seemed to interrupt the fluidity of interviews. As researchers we were starting to

introduce our own preconceptions of what fishers might know, rather than letting them relate their own experiences. Therefore, we decided early on in the research that sustained periods of quantitative questioning would only be used where it did not faze interviewees. We hoped that this approach would allow us to gain insights into all dimensions of fishers' knowledge, especially the rich anecdotal ones described in chapter 2.

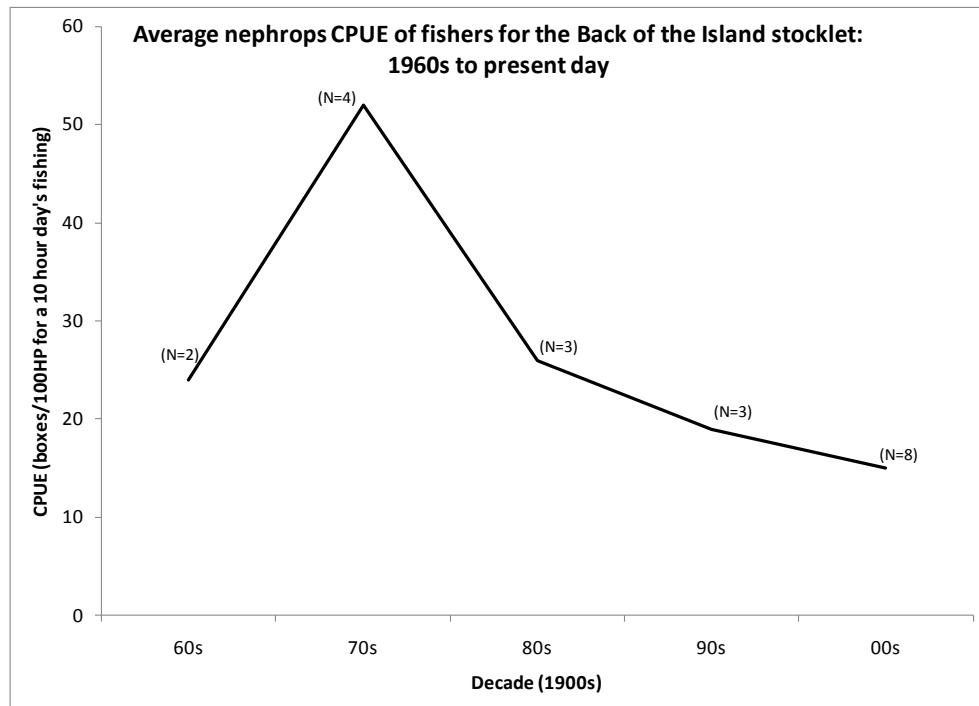


Figure 3.6. Fishers' estimates of CPUE for nephrops on the Back of the Island ground.

The criticisms and shortcomings listed here may provide reason to believe that fishers' descriptions of their fishing trips cannot be used to identify quantitative trends in the character of a fish stock. This is not the case. Although our data did not meet the standards needed for inclusion in scientific publications, we were able to identify a trend in the change of CPUE on the Back of the Island ground by plotting each skipper's remembered catch for a day's fishing in each decade (as a 'best' or 'good

day's' fishing) against the engine power¹¹⁵ of the vessel they owned at the time. This is illustrated in figure 3.6¹¹⁶.

The trend from the 1990s until 2005 broadly confirms the hard data assessments of fishery landings in the *Stock Book*, both illustrating a fairly stable CPUE [MI, 2010, p. 304]. From 2005 until 2009 (the year most interviews were conducted) the trend in figure 3.6 agrees with the UWTV surveys, which show a fairly stable, if slightly decreasing abundance of nephrops [MI, 2010, p. 301]. There is however a disagreement between the trend described by fishers and that in the official landings data from 2005 [MI, 2010, p. 304]. This is a conflict that the Marine Institute also notes between their landings data and UWTV data. This dispute cannot be ignored just so that I can say, "fishers and scientists agreed, therefore fishers' knowledge is valid!" However, fishers' knowledge may be able to explain the confusion between the two sets of scientific data.

The reason for what is almost a doubling in CPUE for FU17 is concluded to be uncertain in the *Stock Book* [MI, 2010, p. 303]. An explanation may lie in some of the qualitative narrative of interviewees. In 2008 some said that they had started to reduce fishing effort on the Back of the Island ground, instead concentrating on the Northwest Corner stocklet. A rise in petrol prices had attracted even the larger offshore and coastal boats onto this inshore ground, nearer to the fishers' home port of Rossaveal. Fishing in shallower water and having to travel a shorter distance to the fishing ground they were consuming less fuel. Tows on this ground could potentially be more productive in terms of CPUE than those on the Back of the Island. The doubling of FU17's CPUE in the official data is therefore not necessarily because nephrops populations have increased, but because the data is representative of the fishing of an entirely different nephrops

¹¹⁵ Engine power was seen as an acceptable surrogate for effort. Larger engines are needed to access more productive deepwater grounds offshore, to trawl at higher speeds, and to drag larger or multiple nets. All of these events would be seen by scientists as an upgrade in effort.

¹¹⁶ The low number of data entries on the graph is disappointing. The number for the 1960s is just two, because few fishers had targeted nephrops on the ground in that era. Many of the fishers who had fished the ground historically were unfortunately deceased and this limited the sample. However, figures given to us for catch were not erratic from fisher to fisher. The landings they reported were within a narrow range for each decade and there were no numbers contributed that could be considered serious outliers.

population. The same increase would not be seen in the UWTV data, as the specific location of catch is not a variable in that survey. It would also not be seen in the trend drawn in figure 3.6 from fishers' contributions, because they were specific descriptions of the Back of the Island ground and do not include the Northwest Corner stocklet.

The ability to produce results at lower spatial scales may go further towards explaining the anomaly in the *Stock Book* conclusions. The CPUE of fisher 14 for nephrops on the Northwest Corner is shown in figure 3.7. He had located his fishing operation within this smaller ecosystem for his whole career and knew the ground better than anybody we interviewed. He believed the stocklet to be at its most productive level for two decades, due in his opinion to the removal of starfish by the heavier fishing effort [see finding 2 in this section]. With their larger nets, the offshore boats coming onto the ground could have been landing many more boxes per unit of effort than fisher 14. The unexplained increase in the official landings data could realistically be attributed to the increasing productivity and targeting of this stocklet. This theory is simply a hypothesis based on fishers' knowledge, but it again shows how such knowledge could be used as a starting point for scientific enquiry. Investigation of this hypothesis could help the Marine Institute to better understand their own data.

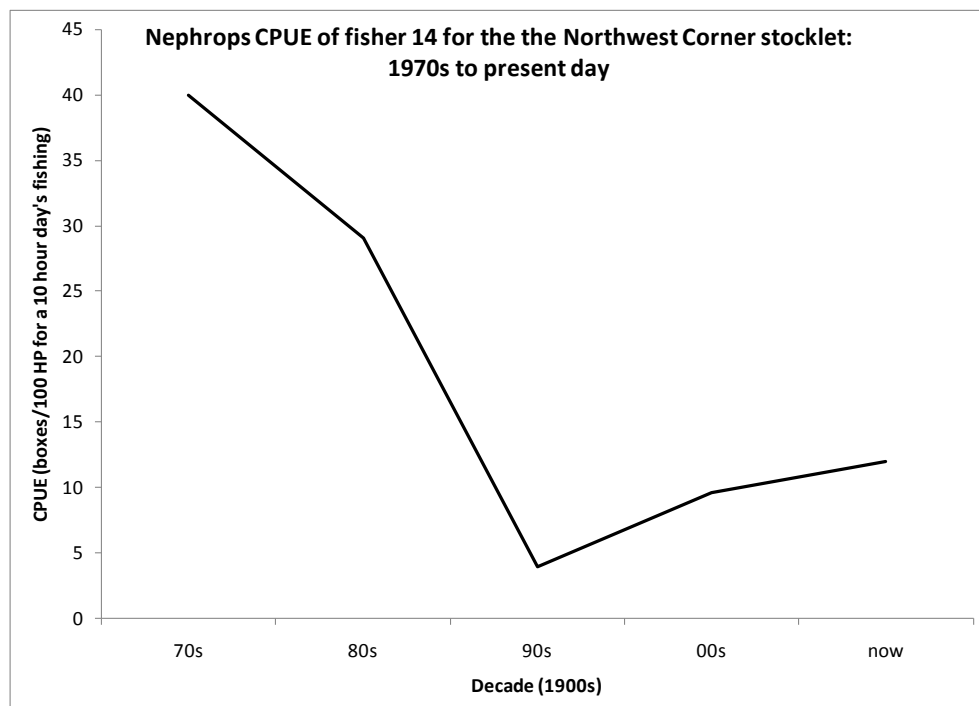


Figure 3.7. Fisher 14's estimates of CPUE for nephrops on the Northwest Corner ground.

There are also findings made in this case study that could confound current scientific thinking. Institutional records of CPUE and catch size distributions for nephrops in FU17 date only to 1995 [ICES, 2009, p. 139; MI, 2010, p. 304; ICES, 2011c, p. 781]. Scientific reviews do not suggest that any dramatic changes to the stock's character have occurred [ICES, 2009]. Contrastingly, figures 3.6 and 3.7 show that fishers describe a large decline in the stock's catchability between the 1970s and 1990s on both the Back of the Island¹¹⁷ and Northwest Corner grounds. If the stock were depleted, it may well change the context of the assessments and management recommendations made by the Marine Institute and ICES. The unwillingness of scientists to integrate data that they see as imprecise and subjective is perhaps preventing them from understanding the true biology of nephrops populations.

Not only are scientists limiting their historical understanding of a fishery, but they are also missing the opportunity to conduct science and management at smaller spatial scales. Fisher 14's narrative of change in CPUE on the Northwest Corner ground is another example of fishers having useful knowledge at the micro-scale. His perception of a recent increase in CPUE is different to his colleagues' (and scientists') perceptions of a slight decrease on the Back of the Island ground, yet they are treated as a single ground by the epistemic community. If they have different population dynamics, then there is an argument for assessing and managing each stocklet individually.

The relegation of fishers' knowledge to a status below scientific knowledge, because of its subjectivity, is the root cause of the epistemic community not considering these wider temporal and spatial scales. I believe they should reconsider their criticism of the quality of fishers' quantitative contributions, based partially on the hypocrisy of their stance. Since their inauguration in 2002, the UWTV surveys for FU17 have produced assessments that vary

¹¹⁷ There was also a reported increase in the catchability on the Back of the Island ground from the 1960s to the 1970s, but with so few data points it is hard to be confident without anecdotal information. The fishers then were fairly inexperienced at nephrops fishing and their anecdotal descriptions of the fishery were quite vague. Although the information in figure 3.7 is based on the activity of only a single fisher it is possible to have more confidence in the data, as he was experienced in the fishery by this time and backed up his assessments with in-depth anecdotes.

so widely that no discernible trend can be identified [MI, 2010, p. 301]. This could be because nephrops populations vary considerably year-on-year due to erratic recruitment, but it could also be attributed to the subjectivity and error margins that Marine Institute and ICES scientists themselves acknowledge in their own UWTV survey assessments [ICES, 2009; Lordan and Doyle, 2010, pp. 22-34].

Looking beyond the findings we produced for FU17 nephrops, we found fishers could also describe trends of the historical and spatial abundance for species such as whiting, anglerfish and hake. However, it was in the same general ranges of volume and timescale with which they had described nephrops landings. For this reason, the Marine Institute again saw their knowledge as being too erratic and subjective for inclusion in official assessments. The only occasion when scientists gave primarily positive feedback about values fishers had given for their CPUE, was when we reported our findings for species that were targeted with pots.

Inshore stocks of shellfish and crustaceans were little assessed by the Marine Institute, because their mandate was only to monitor the commercial species regulated under the CFP [MI, 2010, p. 5]. However, like their colleagues in Europe they recommended that inshore species (e.g. lobster) should be assessed and managed more diligently going forward, due to the increasingly industrial¹¹⁸ nature of inshore fisheries [EC, 2010c, p. 4; MI, 2010, p. 25]. Their potential for doing this has been limited by their sparse knowledge of inshore species. The first scientific stock take of inshore species in Ireland only occurred in 2010, and little of the data published in that report predates the 2000s [MI and BIM, 2010]. There is a pressing need to source information which will allow Irish scientists to measure the abundance of inshore species historically. The following quote is one example of how the fishers we interviewed may well be able to satisfy this:

IV: What's a good day's lobster fishing now?

F31: Jeez, a good day now for 200 pots, a good day now would be 50 lobsters.

IV: But ten years ago that would have been?

¹¹⁸ The Irish lobster fishery in 2004 consisted of 1400 boats whose landings totalled 13 million Euros [Tully, *et al.*, 2006a].

F31: Oh god, you wouldn't have 200 pots out anyway. You'd get 50 lobsters out of half of the gear ten years ago, easy. You'd get 60 lobsters at times.

IV: So you'd get 60 out of 100 pots ten years ago?

F31: Yes, easily. And they were more expensive by comparison.

IV: And twenty years ago?

F31: You'd get 50 lobsters easily, a box of lobsters easily.

IV: So maybe out of 60 pots?

F31: You wouldn't even have 60 pots, maybe 50 pots.

The inshore fishers we talked to seemed able to recall their catches with greater ease than most trawler skippers. This can probably be attributed to the stability of the inshore fishery. Whilst offshore and coastal fishers have tended to change target species frequently, the potters interviewed said that lobsters had always been their most important catch (*i.e.* since at least the 1950s, the decade in which the oldest potter we talked to had started fishing). Their knowledge of the species was likely more developed as a result.

The ranges of effort and landings inshore potters described were still not precise; the number of pots operated and of lobsters landed each day were given to the nearest ten and attributed only to the decade in which they were owned. However, it was easier to estimate historical CPUE because there were fewer variables to consider than when calculating the same figure for trawlers. Like for the gillnetters Neis, *et al.* [1999b] studied in Newfoundland, the predominant variables needed to calculate CPUE are simple to describe. 'Absolute pot number' and the 'frequency with which gear is hauled' are easier to describe than the 'time period of a trawler's tow'.

Personal communication between myself and a Marine Institute scientist confirmed that scientists would consider integrating the CPUE data of potters into their outputs, primarily because of these fishers' tendency to focus on a single species throughout their career [Anon. MI scientist, 2011b]. They agreed that this made it less subjective¹¹⁹. Unfortunately,

¹¹⁹ Indeed, BIM have already partnered with fishers to monitor lobster stocks [Tully, *et al.*, 2006a, p. ii]. If their experience of integrating fishers' knowledge was positive then it could persuade their scientific colleagues at the Marine Institute to follow suit. There is evidence this may already be occurring. In a paper co-authored by BIM and Marine Institute scientists, they reference use of fishers' "tacit knowledge" in assessing inshore stocks as an example of successful coordination between the fishing industry and fisheries scientists [Lordan, *et al.*, 2011, p. 5].

because my interviews mainly targeted trawler skippers, not enough inshore fishers' knowledge was collected to produce statistical outputs of trends in CPUE for species like lobster. However, my suspicion is that it would be entirely possible with further research.

Finding 4: the limits of fishers' knowledge and some hidden strengths

Another stated aim of the *Irish Fishers' Knowledge Project* was to unveil covert knowledge of discarding within Irish fisheries [Flynn, 2008]. There was hope amongst Marine Institute scientists that our research could elicit detailed information about the levels of bycatch and discarding in the Galway and Aran fishery, which they had found hard to elicit in the past.

A scientific report published following research in 2003 and 2004 had shown that the discards reported by fishers did not match those recorded by onboard observers [Lordan, *et al.*, 2011]. There are certainly acknowledged benefits to under-reporting both discards and bycatch [see Kelleher, 2005]. Each can count towards making up the TAC for certain species. Firstly, specimens below regulation size or of small size can respectively have either zero or little market value. Fishers can obviously benefit financially from not reporting these landings, thereby allowing them to catch more fish of a higher value. This is called high-grading. Secondly, bycatch of a non-target species can count towards the permitted TAC for that species. If that is exceeded, managers may act to reduce the TAC or permitted fishing effort for the species which the fisher had actually been targeting, in order to protect the non-target from overfishing. Such an eventuality would represent a lost earning opportunity. Irish fishers believed that the finding of their misreporting was largely inaccurate and that they were being accused falsely of harbouring some of the (above) motives for misreporting. They also blamed the report for what they perceived to be stricter fisheries legislation introduced after its publication. In response they ceased cooperation with the Marine Institute's scientific programmes from 2006 to 2007, including for the monitoring of nephrops landings for FU17 [ICES, 2009; Lordan, *et al.*, 2011, p. 139].

The possibility of misreporting and the related non-cooperation meant that the Marine Institute saw their records for discards and bycatch for the FU17

nephrops fishery as unreliable [ICES, 2009, p. 139; MI, 2010]. Research in similar nephrops fisheries has found discarding to be more prevalent than in most other types of fishery, often exceeding 40% of the total landings. The discards are usually diverse, but often the main commercial species returned to the sea is whiting [Catchpole, *et al.*, 2005]. Discards of the target species itself are generally low, sometimes below 5%, as there are markets for all size grades. Previous assessments for the FU17 nephrops fishery have also identified whiting to be a major non-target species landed [MI, 2010, p. 242], but the volume of this catch is not well quantified and discarding of fish species has not been noted as a major issue [ICES, 2009, p. 139]. Instead, opposite to the findings of Catchpole, *et al.* [2005], discarding of the nephrops themselves has been seen as a considerable problem, with scientific surveys finding them to number between 25% and 34% [ICES, 2009, p. 144]. The predominant bycatch species in the region are listed as megrim, hake and anglerfish. The Marine Institute thought our softer methodology would be able to get fishers to reveal information which they had previously concealed from researchers, because of the poor relationship between the two groups. Ideally, we would be able to create robust datasets from fishers' knowledge that confirmed their high estimates for nephrops discards in the fishery, as well as reduced uncertainty about demersal and pelagic fish discards and bycatch.

It became apparent early in the interviewing period that we would not be able to construct the hard science datasets that we were expected to produce. Firstly, scientists again found any quantitative values given by fishers to be imprecise and subjective (for the same reasons as previously stated). Secondly, any assumption that using a softer methodology would encourage or trick fishers into revealing all the information which they perhaps had motive to withhold was misguided.

Obvious contradictions over the level of discards in the responses of fishers (despite working in the same fishery and with similar gears) implied that some may have been reluctant to reveal the true extent of the practice. Of the fishers actively targeting nephrops in FU17 who offered an opinion (N=16), 69% did not believe discarding to be a problem, whilst the remainder stated that it was. For those who were willing to discuss

discarding in detail (N=12), 67% identified juvenile whiting as the major discard, but others said there was little landing of undersize fish. It was harder still to get fishers to estimate figures for discards of nephrops. Not one of the sample identified discarding of the species as being a regular occurrence.

Clearly then, there are limits in the abilities of fishers' knowledge research to discover the knowledge it seeks to make overt. However, it should not be written off as a way to research discarding in fisheries. We found that the methodology had safeguards that allowed it to uncover knowledge that ultimately may be more useful than a hard dataset.

The inconsistent responses of fisher 17 show how the softer approach of open-ended interviews can eventually elicit information about discards. Near the beginning of the interview he answered a direct question as to whether there were discards with the short reply, "not much". A review of the recording shows his answer was assertive and without hesitation; as if it was a reflex response to outsiders like us when it came to talking about this sensitive topic. However, prompted by an almost identical question later on in the interview (after we had built a rapport with him) he responded in a noticeably more relaxed voice:

F17: You'll always have a percentage.

IV: If you had 15 boxes of prawn and 2 boxes of whitefish, how many boxes of discards would you have? Do you know what I mean? 7 or 8?

F17: With the old rig you might have [...]. 3 boxes or 4 boxes maybe. But then with twin-rigging¹²⁰ it would multiply.

IV: Would it be worse on the Porcupine [Bank ground] than it is here [on the Back of the Island]?

F17: The only discard we have on the Porcupine is them [...] blue whiting.

IV: There was a whiting issue was there?

F17: If you had a lot of whiting you weren't gonna get much prawn.

IV: Would you take up the nets?

F17: Well no, you'd do your five hour tow. Whiting are a bit like mackerel, they get out through the mesh you see. Let's say now they go in your cod end, you'd get 3 boxes of blue whiting out on the deck and we had [absolutely no] prawns.

If this had been an entirely quantitative study, using a closed response questionnaire, then the only information garnered would have been that to the first question (*i.e.* that discards were negligible). By not constraining

¹²⁰ See glossary: twin-rig

fishers with top-down questioning, the bottom-up style interviews actually provided a forum in which fishers felt comfortable enough to contribute knowledge which they had previously withheld (*i.e.* of considerable discards of whiting and blue whiting). Other interviewees were also willing to talk about discards and bycatch under the same circumstances, and it was possible to collate their anecdotes to construct a historical narrative of both practices on the Back of the Island ground and within the other stocklets of FU17.

Although some might have initially said there was no discard problem, of those who talked in detail about the nature of discards (N=12), 75% admitted to having at least 2 boxes per day. Their narratives began well before the start of scientific recording in 1995 [ICES, 2009, pp. 137-54]. It turned out that the ground had not originally been primarily targeted for nephrops, but instead for whitefish and prime species. A number of elder interviewees lamented their actions on this ground before the 1980s:

F26: In the early days it would be 80% to 90% [discards], all whitefish.

IV: That's because you didn't have the quota?

F26: Just because we couldn't sell them at that time and it didn't matter what size mesh you used, and you were targeting species you could sell.

IV: So that's when you were fishing in the Bay?

F26: In the Bay and at the Back of the Islands. The coastal fisheries. [...] fishermen ourselves, we wiped out the coastal fisheries. [...] small fish. Haddocks, cods, whittings, sole, everything, because the mesh size, we didn't have any restriction on mesh size. We were using 80 millimetre. It was deadly. We should have been using up to 120, 130 millimetre for whitefish, but we were targeting black sole which was the only one that we could sell and make money from.

IV: When would that have stopped?

F26: It stopped around 1990.

IV: What was the catalyst?

F26: Because the fish were wiped out.

F19: [...] for example, and I'm being conservative here, tows of a 100 to 150 boxes, whitefish, and you wouldn't pick 10 boxes of mature fish out of that. In that 10 boxes you would have monk that size because there was no legal minimum size for monk, so you were getting in that 10 boxes, definitely, and a conservative estimate now, definitely less than 10% of your catch was saleable.

IV: A lot of juvenile whiting?

F19: An awful lot of juvenile whiting, juvenile hake, juvenile haddock, juvenile flats, juvenile everything.

IV: So this area is a nursery for fish?

F19: It was, not now, it's gone.

Clearly discards had been a major issue at this point in history with both fishers 26 and 19 identifying a discard of approximately 90% of the entire catch. A lack of regulations to control mesh size and the minimum landing

size of species meant that discards of juvenile whitefish had been prolific, which could have been very damaging to the sustainability of their stocks.

By the late 1980s and early 1990s the ground had become primarily an area for fishing nephrops, as it is today. During this period, the narrative shows that discarding of small nephrops was commonplace, but that the discard of bycatch of whitefish had fallen to lower levels:

F21: Well in the first net [in the 1980s], I'll never forget, [...] it was only 44 millimetre [mesh], but the bulk of prawns we used to get was crazy. We didn't know at that time. We just picked the best out of them and let the rest go, but later we were getting a bigger mesh and getting the right stuff.

IV: What sort of percentage would you be letting go?

F21: Well definitely in the early years you'd be putting more than half of them out, scuppering them.

F26: [...] some reason when you're on prawns it's nearly all prawns, [...]. It depends on the gear you're using, but that time we were using low nets, you're towing slow, you're towing at 2.2 knots, so the amount of whitefish, maybe you might catch, there's very little bycatch from prawn fishing. [...] in all my time, would be roughly around 20%.

In addition to describing the nature of discards and bycatch, attention to the narratives of fishers can also tell observers why they occur (or do not occur). The following anecdotes, describing fishing practice from the 2000s to the present, demonstrate this:

F14: At the Back of the Island in April you would be throwing [a] lot of small ones [nephrops] over, because that's what I was saying about the bulk. You notice your tails like. You keep the tails, [Grades] 90 to 100 usually. Some boats go as far as 130. [...] we used to never go over 100 if we could, because it's more work like and there's a difference in the price like. [...] Now, our scrapers¹²¹ like has 110 mill[imetres] in the top and 90 in the bottom, so we had way over the limit of 80 mill. [...] if you had the 90 here, you'd have the small prawns lost and that's where it comes to lose them because they're alive. If it goes back in the cod end, it's [dead] anyway, because the small prawn is too weak like. [...] When you discard nephrops they won't live.¹²² That's why I'm saying to you, there's too much concentration being done on the cod-end¹²³ instead of on the nets. The height off the bottom like. In other words, the mouth of the net like. Say like you have a net there and you want to go catching whiting; you have a big opening like this. Now, if you want to catch prawns, you only want to get what's low. You don't want to be catching the fish, you want the low net. So this is the main thing like, scientists like, can't understand it. If you are prawn fishing, you don't want to be catching fish, because the biggest problem is, that's the problem with the day night like, if I shoot out there at 6 o'clock and

¹²¹ See glossary: scraper.

¹²² This opinion coincides with the estimates of Marine Institute scientists, who estimate survival rates of discarded nephrops to be 10% in FU17 [ICES, 2009, p. 140].

¹²³ See glossary: cod-end.

I get a box or 2 boxes of small whiting, or small fish, if that goes into there and lifts the cod end, I'm not going to catch prawns.

Fisher 14 drew on his socio-economic experiences to describe why landing small nephrops and whiting (which need to be discarded) is a hindrance to fishers. It leads to wasting of net capacity on fish that cannot be sold. Therefore, he experimented with net design and his fishing patterns, in the process accumulating operational knowledge which allowed him to tailor his fishing style so that he caught almost exclusively nephrops of a marketable size. He reduced his discard to close to nil. By avoidance of nocturnal fishing, a period where he said juvenile whiting were abundant, he shows that he was also drawing on biological knowledge to make decisions.

The drop in discarding in the last decade was noted by other interviewees, and the perceived lack of recognition of this by the Marine Institute was cited as a reason for the previously mentioned lack of cooperation by fishers with scientists. We also found that a number of skippers were actively seeking to land non-target species with their nephrops catch, not considering it to be a negative practice despite scientists seemingly trying to discourage it [Davie and Lordan, 2009; EC, 2010a]¹²⁴. They saw relatively small landings (e.g. as little as 2 boxes) of megrim, anglerfish and ray in particular as a crucial supplement to their income, which was suffering because of depressed market prices for nephrops. Like with that of fisher 14 in the previous paragraph, this narrative is an example of fishers developing a strategy to reduce unnecessary discards and bycatch.

The premise for inclusion of discards and bycatch data in fisheries science publications is the desire to assess its impact, before then mitigating it through management. The narratives about the FU17 nephrops fishery illustrate that fishers have learnt from their negative experiences of discarding and are now acting to minimise unwanted catch. Gear refinement (like that undertaken by fisher 14) shares the methods of scientific work done in Ireland to find ways to reduce discards [e.g. Briggs,

¹²⁴ Irish and European fisheries managers and scientists would prefer fishers to use a larger meshed net when catching all fish (c. 120mm). The dual purpose nets used to simultaneously catch nephrops and other species (TR2 gears) are typically around 80mm and the worry is that the bycatch in these gears will not always be of saleable size grades, meaning it may instead have to be discarded.

2010]. The Galway and Aran fishers are effectively working unprompted towards the goals of fisheries scientists and managers. Instead of ignoring fishers' narratives because they are not quantitative and cannot be used in stock assessment, why not bypass the science and integrate them instead as part of management? The concept of fishers' strategies and their significance is explored further in section 4.3.

3.4. Fishers' biological knowledge: noisy... qualitative... useful!

The overall perceptions of the Marine Institute towards the results in this chapter were that fishers' knowledge was too noisy to be integrated into their yearly datasets, and that their narrative was too qualitative and subjective to be part of stock assessment. Irish scientists have set the bar very high for inclusion in the *Stock Book* and ICES recommendations. It seems that only methodically collected, highly precise data can be utilised. Scientists assessing fish stocks on Ireland's west coast have come to trust more the hi-tech research methods where they are the only human actors (e.g. UWTV surveys, VMS monitoring). If this continues to be the case, fishers' knowledge will never be integrated into fisheries science, because evident through findings 1 to 4 is that it will never be this kind of data-heavy information source. Anecdote and narrative are words that describe it better.

Beyond this obstacle to the integration of fishers' knowledge, further feedback on these results highlighted a potentially more damaging barrier. Senior representatives of the Irish fisheries unions gave a similar judgement to that of the scientists. In the preliminary meetings of the *Irish Fishers' Knowledge Project*, the industry representatives had been outwardly optimistic that the study would discover knowledge that could become part of the information underpinning fisheries science and management. However, towards the end of the research it was unclear whether they backed its continuation, because they too were unsure of the value of narratives. Like the scientists, they were mostly interested in hearing whether quantitative data could be collected and plugged into stock assessments. In particular, it appeared they were most intrigued in finding out whether the research echoed their given opinions; that the nephrops

population of FU17 was stable, and that discards were relatively low. The two institutions that are most interested in stock assessment in Ireland and elsewhere [see chapter 5] are the scientific ones and the fisheries unions. With both disparaging of this element of the research, it is hard to see how biological research is an area in which Ireland's epistemic community will fully empower fishers' knowledge.

Fishers' knowledge researchers should not let the case for including fishers' knowledge in stock assessment rest here with this disappointing assessment. The standards set by scientists, for what is acceptable biological information, are arguably too exacting and may even be flawed. Hauge [2011] highlights the significant levels of doubt ICES scientists (including representatives from the Marine Institute) admit in their own methods. She criticises the hyper-precision of the stock assessment models, and the TACs based on them, for not representing the many uncertainties that make them far from accurate. The UWTV surveys discussed in this chapter would be an example of such a method. Fisheries managers have allowed population ecology to become the dominant science despite its weaknesses. The excuse that justified this action according to Hauge [2011] was that scientists believed they could quantify any uncertainties. It should therefore be asked why fishers' knowledge research is not acceptable to some actors just because some of its outputs are uncertain? If its weaknesses can be identified and mitigated then surely it too is a valid science, one which reformist fishers' knowledge researchers like McGoodwin and Neis [2000] would say deserves symmetrical treatment to population ecology.

Fisheries managers in Europe are supposedly looking to broaden the base of knowledge with which they formulate policy [Hauge, 2011] and so they will have to abandon technical standards that only scientists can achieve. The Marine Institute have already proposed using alternative indicators of fish stock health where they cannot physically produce the data needed to make an accurate stock assessment [Kelly and Codling, 2006]. Perhaps as Johannes [1998] suggests they can perform "data-less" management, using fishers' knowledge as an indicator where they have little of their own

knowledge (e.g. at the micro-scale of the stocklet which is not currently recognised by ICES).

There would be an added bonus (not yet analysed in this chapter) of including fishers in scientific research. A study by Marine Institute employees concluded that the main benefit of their working with fishers during discard surveys was that both parties will come to agree with the science [Hoare, *et al.*, 2011]. This may be true, but I would suggest more valuable is Daw's [2008] conclusion that the practice of participatory research, where fishers' knowledge is translated into valued scientific outputs, breeds an environment where fisheries management is more effective. Fishers build a mutual respect with scientists when they feel part of the assessment and management process. Under these circumstances they are highly likely to comply with management regulations and share in the goal of achieving sustainability within fisheries.

The lack of integration of fishers' knowledge in the Galway and Aran case is definitely holding back the development of a mutual understanding between local fishers and Marine Institute scientists. The potential does exist though for relations to improve in the future. Only one of our sample wanted to take the radical approach of replacing management based on science, with one totally orchestrated by fishers themselves. The remainder wanted reform, where scientists listened to what they had to say before taking any management decisions. Although some commended individuals at the Marine Institute for disseminating scientific results to them during meetings in Rossaveal, most complained that the relationship was one-way. A number of interviewees had approached the Marine Institute in the past with observations about fish stocks, but felt that they had not been listened to. Fisher 21 sums up this frustration:

F21: Of course science is good like, but I think what you're doing here now, I think you should listen more to people who've fished for years and years and years. I think that is [where] the science should come in. We tell you and you take it from there, you know what I mean?

Recent developments in other countries with industrial fisheries hint that attitudes may be changing in the epistemic community, possibly keeping the door open to the integration of fishers' knowledge in population ecology.

Scientists at CEFAS, the UK's national fisheries agency, used interdisciplinary open-ended interviews with fishers to make quantitative and qualitative assessments of discards in a regional nephrops fishery [Catchpole, *et al.*, 2005]. Managers then used their work to construct a national policy framework for future fisheries management. Additionally, the Canadian model of participatory governance has allowed fishers not just to comment on scientific results, but also to reference their own knowledge whilst assisting state agencies (*e.g.* the DFO) with the planning of stock assessment programmes, and even with the design of at-sea experimental techniques [Stanley and Rice, 2003]. Finally, anecdotal and micro-spatial fishers' knowledge has been used by managers in Australia, working in conjunction with the fishing industry and a diverse range of stakeholder groups, to assess and manage fish stocks that are deemed to be "data-poor" [Smith, *et al.*, 2009].

Notwithstanding their mixed reaction to some of the findings detailed here, the Marine Institute's willingness to commission the *Irish Fishers' Knowledge Project* is also a step towards integration. The problem for fishers' knowledge and its recognition in Ireland is that scientists may be confusing it with more extractive research techniques that focus on the sourcing of hard data. Some of the Marine Institute's most recent publications, and those of its scientific partners at BIM, demonstrate that they are beginning to endorse fisheries dependent data [described in section 2.4] as an information source [Davie and Lordan, 2011; Hoare, *et al.*, 2011; Lordan, *et al.*, 2011]. It is not an integration representative of the one envisioned by reformist fishers' knowledge researchers.

However, there is also reason to believe that Irish scientists may be finding value in what reformists would actually describe as fishers' knowledge. Their documentation of positive engagement with inshore fishers (to assess inshore stocks) is evidence that they see some validity in the techniques used to collect it [Lordan, *et al.*, 2011]. Additionally, a small number of scientists who specialise in the research of fishing gear have come to develop close relationships with fishers because of the on-the-ground nature of their work. They realised that Irish fishers had knowledge to offer which was not being recorded. Using interdisciplinary techniques that

allowed qualitative responses, they recorded knowledge that included information about changes to fishing effort and the nature of discarding. The scientists involved in this research, plan both to carry out further research using the same methods, and to find better ways to integrate their results into stock assessments [Rihan, *et al.*, 2011].

Finally, Irish scientists' indications of a willingness to investigate further a limited selection of our results is promising. If they integrated the CPUE history of potters and perhaps extended their UWTV surveys to incorporate small nephrops stocklets that they were previously unaware of, they would be engaging in science at new scales. The former would require them to look back further than they have before and the latter would necessitate assessment at a micro-scale below anything defined by ICES. These are scales where fishers' knowledge has proven to be strongest, and if the national fisheries institutions permanently committed to conducting science at such scales, it could be the catalyst for creating further opportunities for fishers to inform scientists. The success of the integration project for fishers' biological knowledge would be far more likely.

3.5. Summary: chapter 3

In this chapter, the thesis' case study located on the west coast of Ireland has been introduced, as have been the mainly qualitative methods used in the research. Laid out was the rationale for undertaking a real-world case study. This was stated as being to build on the conclusions of the first two chapters and to provide support to a broader discussion in chapter 5, so that it could be ascertained whether the theorised integration of a reformist fishers' knowledge was indeed possible in reality, or whether a radical one was more likely, or neither.

It was found that Irish scientists did not see fishers' knowledge as an information source that could help them greatly with their scientific stock assessments. They perceived it to be overly subjective and to lack the degree of accuracy necessary for their quantitative assessments. However, they did acknowledge that some of the fishers' knowledge could be useful

where they lacked data (e.g. CPUE of shellfish, spatial distribution of nephrops stocklets).

With regards to overall likelihood of the potential integration of fishers' knowledge into fisheries management, it was concluded that any contributions it could make to population ecology would not be of the magnitude that would make it an essential information pillar for fisheries scientists. Therefore, a reformist approach would likely not be possible if this was the only path of integration available. At the same time, it was admitted that the quantitative results produced in this research were not of the quality produced by scientists, which casts doubt on any claim radicals have that fishers' knowledge could be used in isolation to effectively assess fish stocks.

4. What is the best use for fishers' knowledge? Evidence from the case study demonstrating its potential to support evolving fisheries management thinking and practice

To end the data analysis for the Galway Bay and Aran Islands case study with the discussion in chapter 3 would be to leave at least half of the findings on the cutting room floor. Ignored, would be some of the major strengths of fishers' knowledge, potentially the most compelling reasons for its integration into Irish fisheries science and management. Chapter 2, drawing on qualitative data, detailed how fishers' knowledge provided socio-cultural insights and showed how these may complement the traditional focus on natural science quantitative data. This may not make it essential viewing for those whose job it is to collate the quantitative assessments of fish populations in the *Stock Book*, but it is possible that other empowered actors may see it as of value in a reformed management paradigm. In this chapter, I consider whether findings from a fishers' knowledge study could be integrated into a new information base for policy-makers, management institutions, and even the previously unreceptive fisheries scientists. The findings of this chapter are presented so that they can then support a broader debate on the integration of fishers' knowledge in chapter 5.

Section 4.1 details an institutional philosophy shift that shows how Irish scientists and managers may have come to outwardly favour EBFM over single-species stock assessment. Theorised later, in section 5.6, is that the best chance for integration of fishers' knowledge into mainstream fisheries management may be to ally it directly to this emergent science. Here, it is investigated whether in a practical setting fishers' knowledge can perform a role in an ecosystem approach. The issue of how and if institutions would integrate it is also addressed.

Recent directives outlining the future path of Irish fisheries research and management have suggested that more socio-economic information is desirable. Section 4.2 outlines the nature of fishers' oft overlooked

knowledge in these areas, and scans the institutional landscape to see where it may be valued.

In section 4.3 one of the landmark findings of this study is advanced. A case is made for the discovery of fishers' strategies being the most useful findings from fishers' knowledge research. A case is made that a fisher's strategy is knowledge in its own right, and is usually of a tacit nature which has made it difficult to discover or collate.

The penultimate section before the chapter summary, 4.4, conveys a message to scientists and managers in Ireland (and beyond). It is that they should look at fishers as sources for management and conservation ideas, rather than necessarily assume fishers are by default hostile or incapable of suggesting, refining and even agreeing to detailed environmental measures themselves. Using their knowledge, fishers have the capacity to develop their own innovative ideas for fisheries management.

Finally, section 4.5 brings together the results of the fieldwork that has been the subject of chapters 3 and 4. The significant potential of fishers' knowledge to change the landscape of Irish fisheries science and management for the better is advanced here, albeit with two qualifications. Firstly, that the relevant epistemic community continues to fail to integrate fishers' knowledge (despite promising commitments to it) because they do not fully understand it or how it could be used. Secondly, rigidity on part of the institutional landscape that makes up Irish fisheries management is preventing the paradigm broadening needed to allow the integration of fishers' knowledge in its pure form. Potential reforms of both epistemic communities and Irish and European fisheries institutions are outlined. Only with these will Irish fishers and their knowledge have some chance of being listened to.

4.1. Fishers' ecological knowledge as a partner for EBFM

The results in chapter 3 show that the Marine Institute scientists have hesitated to integrate fishers' knowledge in their own outputs. Unacknowledged in the *Stock Book* however, is the perilous position of population ecology itself in Irish fisheries science and management.

Chapter 1 described a crisis within fisheries science where the best work of population ecologists is no longer good enough to protect or fully assess fish stocks. Ireland has not been removed from this crisis. Various institutions, bodies and interest groups have expressed uncertainty in the fish population data produced by the Irish state agencies and ICES. Often they have commented on how this shortcoming impedes the effective management of Irish fisheries. Fishing industry groups in particular have seen such uncertainty as unacceptable [Degnbol, *et al.*, 2008, pp. 60-93; NWWRAC, 2010b]. Equally, the continued existence of data-poor fisheries has also concerned environmentalist and NGO stakeholders [Degnbol, *et al.*, 2008, pp. 60-93; Birdlife International, *et al.*, 2010], as well as politicians and senior civil servants [Cawley, *et al.*, 2006, pp. 62-70; DAFF, 2010, pp. 7-12]. Most significantly, the Marine Institute itself has disclosed openly the scenarios in which its research is below the standard needed for good management of fisheries. For example, they admit in the last *Stock Book* to having some level of uncertainty in 49% of the assessments made for the most important commercial fish populations [MI, 2010, p. 18]¹²⁵.

The Irish response to a collapse of confidence in the population ecology paradigm has been similar to the general response documented in chapter 1. Efforts have been made to improve stock assessment through introduction of UWTV surveys (e.g. for nephrops stocks in FU17) and VMS analysis of fishing effort [Lordan and Doyle, 2010; Gerritsen and Lordan,

¹²⁵ The most high profile fishery where the Marine Institute has been unable to confirm an accurate stock assessment (because of uncertainty in their data) is the cod fishery of ICES zones VIIe-k [MI, 2010, pp. 18, 218-26]. Assessment uncertainties are also common in the case study area, focussed mainly on VIIb. For example, scientists state that figures are "not known precisely" for fishing mortality of haddock, horse mackerel and plaice. Labelled as more "uncertain" are the fishing mortality, stock spawning biomass and recruitment for both herring and plaice [MI, 2010, p. 18].

2011]. From outside the field of biology have come suggestions of switching to market-orientated management [e.g. Breen and Hynes, 2010]. Yet, the response that may offer the greatest opportunity for integration of fishers' knowledge is a paradigm shift towards EBFM. An institutional analysis in chapter 5 shows that increasingly the ecosystem is being chosen as the spatial unit for management and case studies in chapter 2 have shown that fishers' knowledge is highly developed at this scale. If this strength is recognised by advocates of EBFM, it could become a favoured source of information in a refreshed paradigm.

A recent policy memorandum signed by the Irish minister overseeing the fisheries portfolio shows implementation of EBFM to be a priority [DAFF, 2011]. It is a position echoed in civil service reports published by the Department of Agriculture, Fisheries and Food (DAFF) and the ministry overseeing environmental affairs [DAFF, 2010, pp. 10-11; Crowe, *et al.*, 2011]. Evident is the state's willingness to adhere to, and contribute to, international governance efforts to support EBFM structurally. Collectively they cite the EU Habitats directive¹²⁶, the OSPAR convention¹²⁷ and proposed reforms to the CFP, which all have protection of both marine biodiversity as a core goal.

Additional pressure to switch to a multi-species system of management has come from outside government. The same transnational directives referenced by state bodies have also been utilised by the country's green movement in advocacy and lobbying for a switch to EBFM [IWDG, 2006; FIE, 2011]. Equally, regional representatives of the fishing industry have demonstrated their intention to comply with the demands of ecosystem management [NWWRAC, 2009, p. 14].

Ultimately, biological scientists themselves have proposed an ecosystem approach as an alternative to single-species stock assessment. As with the

¹²⁶ Also known as Council Directive 92/43/EEC. An EU directive designed to protect both species and habitats of European importance. Parts of the Inner Galway Bay, North Sound, Back of the Island and the Slate fishing grounds have some degree of protection under this legislation [EU, 2011].

¹²⁷ An agreement between fifteen national governments to protect the natural environment of the northeast Atlantic using the ecosystem approach.

other Irish institutions, they have been involved in influencing, and in turn been influenced by, international bodies. The intergovernmental scientists of ICES credit both UN and EU statutes in guidelines that put EBFM at the forefront of scientific advice in Europe [ICES, 2011a]. Initially, such policy has often been recommended to the international governments by nation state scientists, including those from the Marine Institute working within bodies like the European Commission's Scientific, Technical and Economic Committee on Fisheries (STECF) [EC, 2010d]. The support of Irish scientists for the views of their colleagues at ICES and those of European policy makers is apparent in the frequent references to the processes of these outside actors in their own publications [MI, 2010, p. 4; MI and BIM, 2010, pp. 5, 209-11]. The Marine Institute has even taken the lead role in a transnational project to produce a baseline for marine ecosystem health in northwest Europe [Nolan, *et al.*, 2011].

The point here is that EBFM is being disseminated from within the traditional network of natural science experts. The Marine Institute has signalled its future commitment to the consensus:

[...] within fisheries management the approach has changed from consideration of a single species, e.g. cod stocks in the Irish Sea, to the so-called 'ecosystems approach' where the interaction between multiple species and habitats is considered. [...] The key to this approach is the ability to turn disparate data sources into the information and knowledge required to support effective management decisions. It requires data from a wide spectrum of disciplines, themes and organisations to be packaged, structured and made accessible to support integrated analysis. [MI, 2006, p. 145]

Problematic however, could be the actual switch from single-species assessment to multi-species advice. Previous focus on the former by the Marine Institute may have compromised its ability to perform the latter. Pikitch, *et al.* [2004] state that successful implementation of the ecosystem approach relies on more than just assessment of commercial fish stocks. Also necessary is knowledge of non-target species and their habitats. The institutional records for these in Ireland are not extensive. For instance, although the most recent *Stock Book* does consider the idea of EBFM,

ecosystem advice was limited to 3 of 140 pages dealing with west coast fisheries [MI, 2010, pp. 209-352]¹²⁸.

A more comprehensive effort to use the ecosystem approach seems to be a regional report assessing Europe's northwest waters [Nolan, *et al.*, 2011]. However, whilst this report would be an excellent introduction for policy-makers and managers at the European Commission and within Ireland, its assessments deal mostly with large ecoregions. Assessment of localities below the scale of an ICES zone is rare. Scant coverage is given to ecosystem change at smaller scales (*e.g.* for Galway Bay or the Slate fishing ground) despite previous attempts to show just how important management at these scales is [Hughes, *et al.*, 2005]. In summary, if existing EBFM science was to be judged by the standards Marine Institute biologists judged fishers' knowledge by in chapter 3, then it would almost certainly be seen as lacking the precision and rigor historically deemed imperative by the epistemic community.

It is impossible to condense the whole narrative of thirty-two fishers for six decades, and for each local ecosystem, into the following subsections. However, the extracts used can begin to demonstrate how fishers' knowledge could support EBFM.

4.1.1. Monitoring and managing biodiversity

An overview, comparing institutional records against fishers' knowledge, immediately begins to show how fishers may be able to fill some of the gaps in scientific knowledge. Table 4.1 is a timeline of when Irish agencies began to collect data for fish stocks in the Galway and Aran region. In only two cases (spurdog and porbeagle shark) did this pre-date fishers'

¹²⁸ The magnitude of the task of switching to an ecosystem approach for those at ICES and the Irish science institutions is obvious in their own summaries, which are as "disparate" as the previous quote suggests. The *Stock Book* review includes only cursory descriptions of the physical state of habitats, abundance of non-fisheries fauna, and inter-species behaviour [MI, 2010, pp. 209-11]. The ICES report it references is more complete, but barely [ICES, 2008, pp. 50-67]. Little of the collated data it lists covers the Irish west coast. When it does, it is spatially ambiguous and temporally sporadic. Mostly, it mentions one-off academic studies to give a rough baseline of ecosystem state and biodiversity in the region [*e.g.* Rees, *et al.*, 1999; Heath, 2005]. Absent are the continuous monitoring programmes that have been favoured in population ecology assessments.

knowledge. Our sample was able to describe continuously, at least qualitatively, changes in the populations for all of the species in table 4.2 from the 1950s or early 1960s. Inclusion of fishers' historical knowledge into multi-species assessments would represent a great temporal extension in records for many stocks (e.g. anglerfish, whiting, plaice).

Table 4.1. Decades in which Irish state agencies (and European partners within ICES) started collecting statistical data for each monitored species in ICES zones VIIb and FU17. [sources: Lyons, 2004; Tully, *et al.*, 2006a; Tully, *et al.*, 2006b; Kelly, *et al.*, 2008; Ingram, *et al.*, 2009; MI, 2010; MI and BIM, 2010; Ryan, *et al.*, 2010]¹²⁹.

1900s	spurdog
1910s	
1920s	porbeagle shark
1930s	
1940s	
1950s	albacore tuna
1960s	mackerel
1970s	elasmobranchs (skate), pollack, sprat, herring, nephrops, saithe, basking shark, grey seal, harbour seal
1980s	haddock, anglerfish, megrim, horse mackerel, blue whiting, bluefin tuna
1990s	cod, whiting, plaice, sole, sardines, lobsters, brown crab, cetaceans (whales, dolphins, porpoises)
2000s	boarfish, shrimp
2010s	scallops, oysters

Furthermore, many datasets listed in table 4.1 are accurate at best to the scale of the entire Irish west coast¹³⁰. Effective EBFM requires knowledge of ecosystems of all sizes, not just those of large ecoregions [Pikitch, *et al.*, 2004]. Before the modern advent of VMS it had clearly proven hard for scientists to be certain of fishing distribution below the scale of an ICES zone [MI, 2010; Gerritsen and Lordan, 2011], limiting spatially their historic appreciation of species distribution. By talking to fishers through maps during interviews, we were able to assess all the biodiversity changes described at the micro-scale (e.g. those of the cod extinctions in figure 3.5).

¹²⁹ This table is based on an extensive literature review of reports published by the Marine Institute, BIM and the National Parks and Wildlife Service. If a species is not mentioned in the table, it is because no data for that species could be found in known published records.

¹³⁰ For example, ICES stock assessments for plaice are for the whole of zones VIIb and c. Those for saithe encompass the whole of sub-area VII, which includes waters on the Irish west and east coast, off the English south coast, and the French northwest coast [MI, 2010, pp. 271-74, 319-20].

Table 4.2. Changes in abundance of species (according to fishers) since the 1950s in ICES zones VIIb and FU17. Evidence for change is displayed as either a quantitative consensus between fishers, as a quote from an individual, or as a summarised narrative from one or more fishers¹³¹.

Abundance change	Species	Example (evidence from fishers' knowledge)
INCREASE	seals	100% of interviewees who talked about these (N=17) identified an increase in abundance.
	tuna	Fisher 7 targeted a number of tuna species and said that warming waters were bringing them closer to Irish waters, including the west coast.
	spotted dogfish	F29: I think the population of dogs has gone up. [...] They're the only thing that's going back alive. You can have a 6 hour tow and have a full bag of dogs and every one of them will go back alive [...].
	starfish	68% of interviewees who talked about these (N=19) identified an increase in abundance, especially on the Northwest Corner ground.
	amphipod	F28: Now he was the greatest scourge we had for the latter years and he was over at the Black Rock here. [...] It started in the mid-'70s. It started first, they were back on the west side of the bank here and then the next place we notice them was in here at the Black Rock. [...] They moved, they started to move over here. I know what happened, some of them came on the pots.
	jellyfish (certain species)	F24: They'd be in the summer say in July and August and they'd disappear. We'd have to leave the ground anyways. What I noticed over the last say 5 years is we're getting jellyfish in the winter now.
	shrimp	Fisher 2 fished solely lobster up until 1975 as there were no shrimp. He got shrimp pots between 1978 and 1979 when other fishers started to catch them.
	dolphins	F8: There's a lot of dolphins around [recently]. Right outside the island. There'd be hundreds.
	spider crab	F31: '70s, '80s, there were no spider crab, but now you can set nets [...]. When the nets come up they are full of them. It's an awful plague spider crab. But I started fishing it 6 or 7 years ago.
LITTLE CHANGE/ UNCERTAIN	ling	Fisher 7 said ling had always been present in the deeper waters of ICES zone VIIb, although not in the inner bay.
	john dory	The only fisher to talk about this species, (fisher 27), said they had always been scarce, but present.
	witch	Fisher 15 said that these had never been a focus of the fishery, but had always been present in similar numbers.
	ray	Fisher 12 described how catches of blonde and thornback ray had decreased gradually over time on the best fished grounds, but how currently he was getting his best ever ray landings on some smaller, lesser fished grounds.
	poor cod	Fisher 2, as well as a number of fishers based on the Aran Islands recounted how this species had always been present in kelp, near to shore.
	mackerel	No fishers identified collapses in the mackerel stocks and this comment was typical of current landings. F5: Last year it was full of mackerel. Last year there was boats there that couldn't get there nets down to the prawns.
	megrin	F6: [...]back in 1989 there was lots of fisheries for meg on the west coast here, we were getting 50 or 60 boxes of meg a day, now that's stopped. Why has it stopped? I don't know. But there's more megs now there this year.
	nephrops	Figure 3.6 shows CPUE for FU17 to have been fairly stable, although there may have been a larger population before the 1980s.
	horse mackerel	The two fishers who talked of this species (8 and 15), did not seem concerned that its population may be changing.
	jellyfish (certain species)	Inconclusive. 64% of interviewees who talked about these (N=11) identified no change in abundance, but the other 36% identified an increase.

Table 4.2. (continued on next page)

¹³¹ A number of locations are quoted in the evidence provided by fishers. They are all of micro fishing grounds in the study region. Those not mentioned so far in this thesis, or labelled in figure 3.1 are: Black Rock, Oranmore (both within the Inner Galway Bay ground), Inverin Bank (within Northwest Corner ground).

DECREASE	orca	Fisher 8 remembered seeing these regularly in the past, but had not seen one for many years. He believed them to have migrated to Norway.
	whiting	Many fishers reported increasing catches of whiting in the last 5 years, but said landings had originally collapsed after the 1970s. F14: They'd come in and they'd have 30 boxes of whiting, [...]. That's gone like.
	cod	70% of interviewees who talked about disappearance of species (N=23) identified cod as commercially extinct.
	bream	F28: And the bream then he went away. He dropped off completely in '74 or '75, inside and outside the island.
	halibut	F8: They reckon in the Gregory Sound, you used to get halibut, you wouldn't even fit them into the boat, they were that big. IV: You wouldn't get any halibut now? F8: Two since I've been fishing out there.
	turbot	F8: The stocks have gone down and big time. Turbot, black sole, [...]
	brill	F9: That's gone down, down, down, down. I remember when I was young and going to the sound there and you'd have towed 10 or 20 boxes [of turbot and brill]. Now if you get 2 baskets you're doing very well.
	anglerfish	F20: There's a decline in monk alright on the [Back of the Island] prawn ground. [... a] box or 2 [per tow]. But they seem to come back in odd years. [...] '98. [...] Half a box, maybe 1 [now].
	sprat	F28: The year, 1986 I think, '88 is when [sprat] left it. The Bay was flooded with them. They'd be there for the whole season. All you had to do was go tow up beside the river and you took the lot away, then came the big ones. '50s, '60s, '80s [they] were in and they were actually beaching over in Oranmore. We used to fish from Oranmore out to Black Rock.
	skate	A number of fishers remembered catching skate commercially as recently as the 1980s (e.g. fishers 26 and 28), but none had caught them regularly since then.
	hake	Fisher 11 recalled an industrial hake fishery on the Back of the Island ground in the 1960s, exploited by a visiting French fleet. Fishers 7 and 21 were amongst those to also remember the near terminal decline of this fishery in the 1970s and 1980s.
	white pollock	Fisher 22 told of a previously better fishery for the species, which had slowly declined, but was still fished in some parts of Galway Bay and nearshore on the Aran Islands.
	black pollock	Fisher 23 netted so much of this species, [100 boxes] once in 1979, the weight caused his boat to turn in the water. He had not managed a commercial landing since.
	brown crab	F20: There used to be a good bit of [brown] crab in them days [1980s] too. [...] a box or 2. And now they've completely gone out. They've gone away.
	crayfish	F18: We stopped fishing for crays, because crays were virtually disappeared off the ground, '93, '94.
	lobster	Fisher 2 described how lobster had disappeared from inshore areas which he fished as soon as bottom trawlers started fishing the same ground.
	herring	Fisher 19, in a detailed narrative, revealed that herring catches could still be good, but were lower than some historical levels.
	gurnard	F28: [...] the only place you'll get gurnard is on the bank here, the Inverin Bank, on the patches. IV: Did they drop off? F28: They did. They didn't drop off as much as the rest of the stuff. They're still there.
	wrasse	Fisher 32 had always used these as bait, catching them in trammel nets. He recounted that they had been harder and harder to catch as time had passed.
	haddock	F10: There has been a decrease on this coast definitely, whiting and prime fish and stuff like that, [...] turbot and haddock too.
	salmon	F28: A couple of years before the licence was taken away they were getting slack. They weren't getting slack, they were gone slack.
	sandeel	F8: That's one thing you don't see a lot of now is sandeel [...]
	plaice	F14: They'd come in and they'd have [...] 10 boxes of plaice. That's gone like.
	spurdog	F27: We used to do half an hour on spurs and then get bored and move on. Now there is a situation where it is hard to find them.
	black sole	IV: I mean in the '80s how many boxes of sole would you have got? F12: You'd be lucky if you got 2 boxes. IV: And now? F12: Less than that again.
	plankton	F19: There doesn't appear to be as much feed in it, and by feed I mean on the sounder dirt in the water, on the West Coast as there is other. Whether it be plankton or small fry or otherwise and for a lot of those years, the last year or 2 there does seem to be a bit more again you know [...]
queen scallop	F13: We used to work queenies now as well for 2 years. They've disappeared for good. [...] That was in the '70s. From then on they never came back again.	
scallop	Scallops have almost disappeared in some inlets in Galway Bay - F18: [...] there was a fantastic fishery in scallops in the '50s and the big frost in 1962 I think decimated the stock. [...] Then it was fished to extinction nearly the late '70s [...]	

Where fishers' knowledge can perhaps add most to existing science however, is in recounting fishers' interactions with less commercial and non-fisheries species. Galway and Aran skippers had knowledge of populations of at least fifteen species, both commercial and non-target (e.g. wrasse, starfish, amphipods, gurnards) for which there was little or no apparent scientific data.

When broken down, it was found that there were three broad categories of biodiversity change recognised by fishers: extinctions, gradual increases/decreases, and introductions.

Already described in section 3.3 was fishers' knowledge of the staggered *extinction* of cod on first the North Sound and Northwest Corner grounds (1960s), and later at the Back of the Island ground (1990s). The *Stock Book* records for cod in the region only begin in 1995 and therefore only capture the tail end of this commercial cod fishery on the larger sub-ground [MI, 2010, p. 227]. The following extracts describe further losses in local biodiversity noted by fishers, but not in scientific records; of micro-stocklets of nephrops in a number of small inlets, and of near the whole population of inshore crayfish:

F26: Do you see that there [*gesturing at map*], Ballykill Bay, Clew Bay, that's Killary here, up in here. We used to tow up and down there for prawns.

IV: So they'd be as big as the [Porcupine Bank ground] prawns?

F26: Bigger than the Porcupine ones I'd say, from the beginning. Jumbo prawns. But they were wiped out. There was too much fleet in there. There'd be about ten boats, Achill boats and Cleggan boats that time.¹³²

F32: You used to be able to catch crayfish in pots. I did when I was younger, but tangle nets wiped them out. Up until the mid-1970s, 3 to 4 lbs. or 1 kilo was the average size, and you could get a crayfish up to 8 lbs. in the 1950s. After a couple of years of tangle netting, the size and number decreased rapidly. They have come back a bit now, but there are still not many. I know people don't get many in pots that are suitable for crayfish.¹³³

The fact that extinctions can go unnoticed¹³⁴ by science raises the question as to whether scientific advice is at too large a scale for EBFM. ICES and

¹³² Ballykill Bay, Clew Bay, Killary, Achill, and Cleggan are fishing areas and small harbours to the near northwest of the case study region.

¹³³ The digital recorder was not functioning during parts of fisher 32's interview. This quote is given as recorded in handwritten notes of the interview.

¹³⁴ The timeframe for the collapse described by fisher 26 was between 1978 to 1981, years where scientific stock assessments were being made for nephrops in

the Marine Institute agree for instance, that FU17 is the appropriate geographical scale for stock advice and management [MI, 2010, p. 300], and their data shows they believe fishing effort for nephrops in this unit to be near levels that are sustainable (*i.e.* within their MSY) [MI, 2010, pp. 300-03]. However, successful EBFM should recognise, halt and reverse ecosystem degradation [Pikitch, *et al.*, 2004]. Fishers' knowledge of the disappearance of nephrops from some smaller ecosystems shows that this procedure has not always been followed in FU17. Hauge's [2011] worry is therefore confirmed; that if "independent geographical units" within an area defined by scientists as a single "stock" are not known to managers, then irreversible changes can be inflicted on an ecosystem by an activity such as overfishing. With further stocklets of nephrops potentially still unknown to scientists, as found in section 3.3, a lack of management could result in further micro-extinctions.

Fishers were also able to recognise *gradual* changes in biodiversity and *introductions*, including for species not targeted by the local fishery. Gradual increases tended to be collectively noted (*e.g.* seals across the case study region, starfish on the Northwest Corner ground; [see table 4.2]), but sometimes only individual anecdotes contained the evidence of a change. In the case of jellyfish, it was hard to tell using statistical analysis of interview transcripts whether their populations were increasing regionally [see table 4.2]. However, fisher 24's perception suggests that there was strong evidence that they were becoming more abundant:

F24: They'd be in the summer, say in July and August, and they'd disappear. We'd have to leave the ground anyways. What I noticed over the last say 5 years is we're getting jellyfish in the winter now [...]. You'd only be towing for 10 minutes and then your net would fill up with them. All the way along. [...] out all the way to 20 miles.

Such qualitative discoveries may not be verifiable to the statistical degrees of significance common to scientific enquiry, yet they could be important indicators of nascent biodiversity shifts within ecosystems.

A stated aim of the Marine Institute, shared by other European fisheries institutions, is to develop new suites of ecosystem indicators to measure

FU17 [MI, 2010, pp. 61-62]. Yet, the extinction he describes is not documented in the *Stock Book*. The crayfish extinction was missed because official landings were not even being taken for the species.

impacts of fishery pressure, climate change, and marine pollution [MI, 2006; EC, 2010d]. Changes in biodiversity are proven responses to these stressors. In Australia, stakeholder knowledge has already been used to successfully map shifts in biodiversity and habitat range for certain species in response to warming waters [Johnson, *et al.*, 2011]. Fishers' knowledge of when and where extinctions, introductions and gradual changes in biodiversity transpire in Irish waters could become an official indicator of ecosystem health for the state institutions implementing EBFM.

Jellyfish for instance are one species for which there is certainly need in the scientific community for more information on their abundance within Ireland¹³⁵. Their presence in greater numbers than expected is an indicator of climatic warming and also for biodiversity loss of higher trophic level species [Lynam, *et al.*, 2011]. An EU funded scientific research programme has been able to quantitatively assess some populations of jellyfish in Irish waters, but the scope of the project has been limited temporally and spatially¹³⁶.

To complement their scientific surveys, the jellyfish researchers have employed a less scientific approach, encouraging members of the public to utilise the internet to report any jellyfish sightings [EcoJel, 2011a]. Use of a tool of this nature shows a willingness of scientists and partner agencies to integrate data that is no less subjective than fishers' knowledge into ecosystem science. Most of the reported sightings until now have been nearshore and on beaches. If fishers' sightings were also included, the number of sightings could be dramatically increased. Coverage would be expanded to approximately 200 miles offshore and to all Irish and European waters visited by fishers. There seems to be no argument against the integration of fishers' knowledge in this scenario and it would be surprising if researchers did not seek to source it more actively.

¹³⁵ Coastal managers also need to know where jellyfish are present, because they have negative effects on wild fisheries, aquaculture, and recreational use of the marine environment [Bastian, *et al.*, 2011; EcoJel, 2011b; Lynam, *et al.*, 2011].

¹³⁶ Historically, only one set of scientific records date as far back as 1994, with most monitoring starting in or post 2009. Also, the data collected has usually only assessed jellyfish populations for limited periods of the year and with limited coverage of Irish waters, and then only using dispersed systematic sampling rather than continuous observation (e.g. May to June, April to September) [Bastian, *et al.*, 2011; Lynam, *et al.*, 2011; Bastian, *et al.*, in press]¹³⁶.

The civil service National Parks and Wildlife Service (NPWS) and environmental NGOs who assess mega-fauna could also be attracted to this model of knowledge harvesting. Programmes to monitor seal and cetacean populations have similarly restricted coverage, historically and spatially [IWDG, 2006; Ingram, *et al.*, 2009; Ryan, *et al.*, 2010; Cronin, 2011], and they are also already using the same online approach to address urgent data needs [IWDG, 2011].

The constant presence of fishers on the water and the vast area they collectively cover means that they will always achieve greater temporal and spatial dispersion than can be achieved on a research vessel or from a shore-based observation. Those attempting to integrate fishers' knowledge must highlight this advantage to EBFM practitioners.

4.1.2. Identifying areas of ecological importance

Another key goal for ecosystem-based management is the conservation of ecosystems or habitats that host endangered species or essential ecosystem services. Policy-makers using the ecosystem approach have typically attempted to designate MPAs to enforce protection [Roberts, 1997; Roberts, *et al.*, 2001; Pikitch, *et al.*, 2004].

Analysis of the anecdotes and narratives within our interviews revealed that in some ecosystems, species with important roles were precariously close to potential extinction. This was particularly true for elasmobranch and flatfish stocklets. Fisher 20's description of brill and turbot catches near the Slate ground was one of several that described how resident fish populations for certain species could be noticeably depleted by a single fishing event.

IV: Would anywhere else be good for brill or turbot?

F20: Down the Clare coast. Come out from Liscannor there. Just off the rocks. If you're the first boat [of the season], you'll knock a landing out of that all the time.

His implication is that a second vessel at the same location and in the same year would not achieve the same CPUE for these prime fish species. In healthy, abundant stocks it would likely not be possible to notice such an instant drop-off. The oldest interviewees revealed that this was a change

from the past, when brill and turbot were plentiful [see table 4.2]. The scale of stock assessment employed by ICES is again at too great a levels to identify this sensitivity within local stocklets [Vandamme, *et al.*, 2009], and therefore no specific management measures have been taken to pre-emptively prevent any potential extinction¹³⁷.

Previously, fishers' knowledge research has also shown fishers to be skilled at identifying spawning grounds and fish nurseries, vital as early life habitats for most species [e.g. Johannes, 1981; Maurstad, 1997, pp. 174-75; Neis, *et al.*, 1999b]. This case study was no different. Former and current spawning grounds and nurseries were marked on maps by interviewees [see figures 4.1 and 4.2]. Interviewees even went as far as to say which areas could be designated as MPAs. The significance of this is discussed in section 4.4.

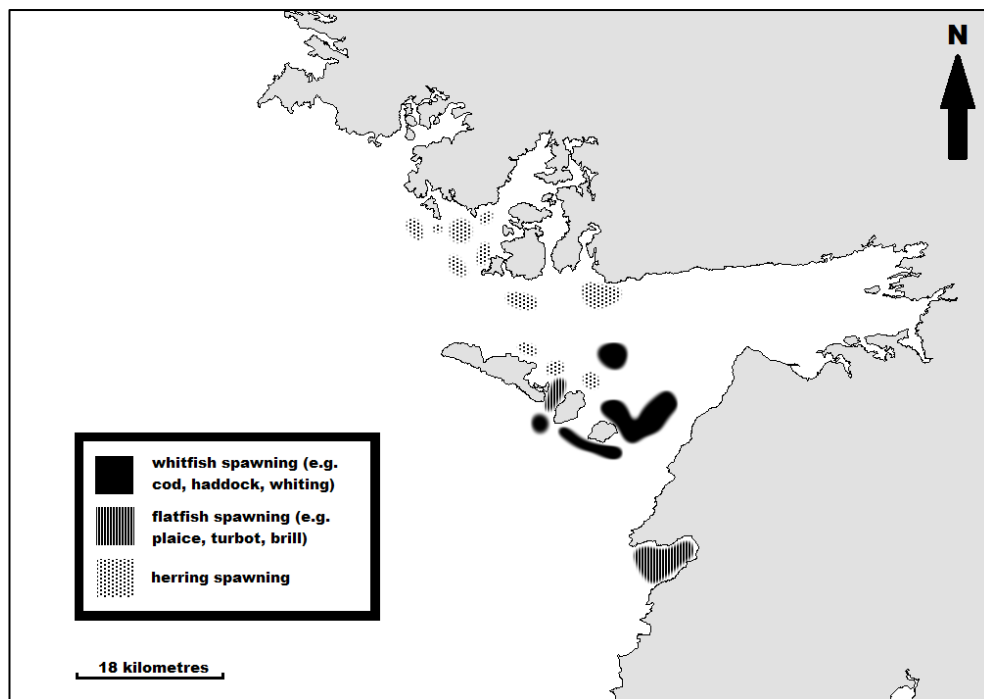


Figure 4.1. Current and former spawning grounds of various fish species in the Galway and Aran region.

¹³⁷ The results of a local extinction of both on the Slate ground cannot be definitively foretold, but one possibility would be increases in abundance on lower trophic level species due to a collapse in the food web (e.g. amphipods, which are prey species of brill and turbot [Besyst, *et al.*, 1999]). Amphipods are already a growing nuisance to inshore fishers [see quote in table 4.2, because they eat valuable catches and bait from pots. Further blooms of the species might introduce new conservation problems for managers, as potters could increase their fishing effort to unsustainable levels to make up for the financial losses incurred from having their catches destroyed and having to buy more bait [Anon. BIM employee, 2011].

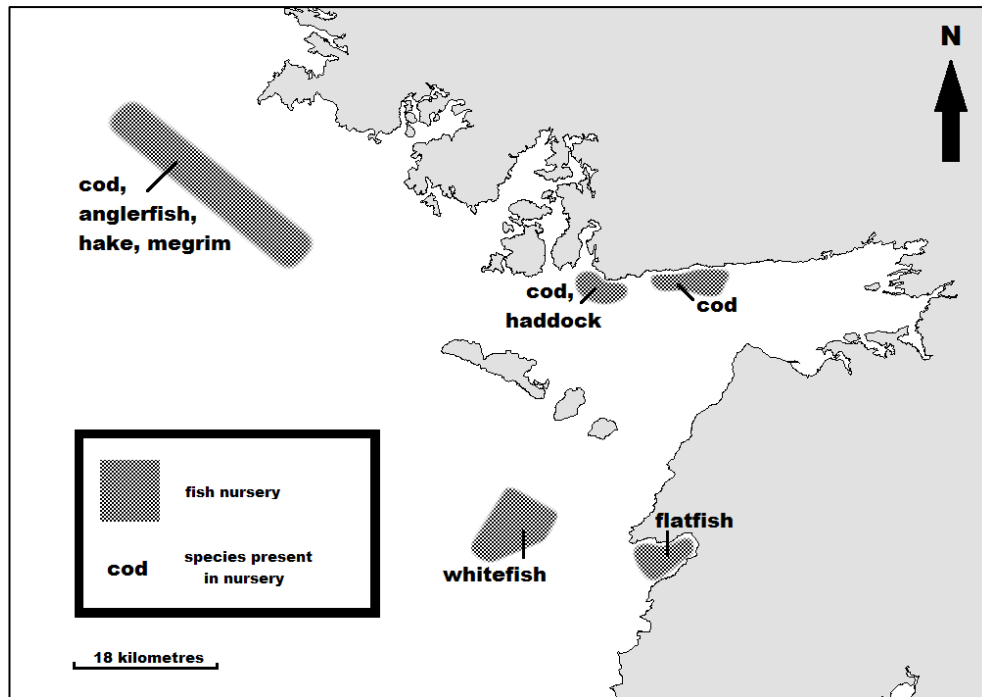


Figure 4.2. Current and former nurseries for various fish species in the Galway and Aran region.

When combined with fishers' narratives and scientific surveys, maps can become powerful tools on which to base EBFM. The following anecdote identifies the species spawning, the location and timing of the spawning event, the benthic substrate on which it occurs, and an ecosystem service it enables.

IV: Do you see herring at all round here anymore?

F7: [...] very little now. [...] October, November, nothing like it used to be. I can remember this area [...], tangle netting with my father for crayfish, and you'd get rocks, and they'd be covered in spawn from herring. That area there. And that was the spawn that the haddock, the cod, the whiting were feeding on.

One of the most interesting sites identified by fishers in this study is that at the mouth of Rossaveal harbour on the Northwest Corner ground, which they described as a current herring spawning ground and a former nursery for juvenile cod. Scientific studies show that this is also the site of a maerl¹³⁸ bed, a habitat identified as important as an aggregation site for fish spawn, and a refuge for juvenile fish [Maggs, 1983; De Grave, *et al.*, 2000, p. 18]. Anecdotal evidence from one inshore fisher pointed to the fact that juvenile cod may have returned to the Northwest Corner in the past two or

¹³⁸ See glossary: maerl

three years, having not been seen since the regional cod collapse documented in section 3.3. A potter, he was using a trammel net to catch bait in the area, but amongst the baitfish he was getting small cod. If this is the case, managers should be looking to manage this small maerl dominated ecosystem carefully, because it could potentially be the catalyst for sustaining biodiversity (*i.e.* of herring) and even restoring it (*i.e.* by reintroducing cod).

At the very least, all the ecologically significant areas identified by fishers should be audited by Irish scientists who are still in the process of identifying such sites in order to meet national goals and satisfy European directives [MI, 2006, pp. 53, 163; NPWS, 2008b, pp. 1-12; 2008a, pp. 296-418]. If fishers' knowledge is not integrated soon, potential areas of ecological importance could be gone before they are even known to the epistemic community.

4.1.3. An ecological narrative of a shifting baseline

Fishers' ecological knowledge has been presented thus far in this chapter as an information source that could compliment fisheries science and management in specific areas where it is weak. There is also merit in weaving together individual anecdotes to create a longitudinal natural history of the Galway and Aran fishery. We found that it was possible to create a continuous narrative from the 1950s, when the eldest fishers in our sample started fishing, until the present day.

The forged narrative of fishers appears to partly outline a classic case of "fishing-down-the-food-web"¹³⁹. The story is of the offshore fleet's switch from predominant targeting of whitefish (*e.g.* cod, whiting, haddock, hake), to an almost total reliance on nephrops. With the exception of one individual in the research sample, no fishers currently trawled the Inner Galway Bay ground for fish species. However, the eldest fishers remembered an industrial whitefish fishery on that ground in the 1940s and

¹³⁹ Pauly *et al.* [1998] summarise such an event as a sequential decline. The predatory fish at the highest trophic level are removed first by overfishing, and replaced by fish at lower levels (*e.g.* pelagic species). Eventually, all that is left is invertebrate species at the lowest trophic level.

1950s and the later whitefish fishery on the outer grounds of Galway Bay. These sections of interview show how fishing has changed in the region, with fisher 4 describing the present day:

F13: We used to fish for whitefish in the North Sound years before that, and even Galway Bay. One of the best bays in Ireland for whiting. The Scots boats used to come in from Scotland [...], and I just barely remember them. There used to be whitefish. And my father and all the Aran trawlers. It used to be great just for whiting.

F17: There was big spring fishing '93, '94, '95, '96. [...] There was spring fishing '97 and then '98. '98 it kind of switched off. [...] It just dropped, they didn't come in you see¹⁴⁰.

F4: If we can't fish prawns there will be no industry. The fish is from the start of February to the end of March. That's it. You might get a couple of shots, a couple of trips out, two or three trips, or you might get a bit of prime fish¹⁴¹, but not what I'm talking about. This is where the prawn side is the bread and butter of our industry.

Several of the fishers agreed with the fishing-down-the-food-web theory, blaming overfishing as a contributing factor to regional biodiversity change:

F19: Now, there used to be good whiting fishing in Galway, but we have been killing the immature and juvenile fish for so long, over so many years, and I'm talking about '92 and a number of years before that, and possibly in other places, but that area was a big area for them. How could they survive?

F26: They've gone as well because of our overfishing. We overfished that. Plaice, everything, sole, skate, ray, everything, the whole lot have gone, because you're killing the, how do you call it? The local fish, what's the word for it? The local population which were the ones that weren't migrating. Cod, haddock and black pollock. Indigenous, that's the word. We killed them ourselves.

It is staggering that the Irish scientific literature barely mentions a collapse in multi-species fish stocks that is big enough to represent a phase shift¹⁴² for several of the region's ecosystems. This example is a further indictment of what Pauly [1995] recognises as the inability of the techniques of population ecology to always recognise a shifting baseline. The problem with relying on the scientific baselines for the Irish west coast [ICES, 2008, pp. 50-67; MI, 2010, pp. 209-11], is that the collection of data underpinning

¹⁴⁰ Interviewees identified the whitefish fishery to be mostly seasonal, with migratory species entering outer Galway Bay (and historically Inner Galway Bay) between February and March.

¹⁴¹ See glossary: prime fish.

¹⁴² Described in Caribbean ecosystems by Hughes [1994], a phase shift is a potential permanent change to a habitat. The ecological degradation may be so extreme that it is impossible to reverse by management. In this case, it is unknown whether whitefish could return in commercial numbers to grounds now dominated by starfish and nephrops.

them postdates what appear to be the greatest changes in the area. If the methods of this study had involved only interviewing active fishers, then the shifting baseline may also have not been recognised. The youngest interviewee, who had started fishing in 2001, said:

F4: There is no cod. I've never seen cod.

This statement is consistent with low landings of cod registered in the *Stock Book* records [MI, 2010, p. 227], but contrasts with the collapse documented by some of his colleagues. The failure to integrate fishers' knowledge because of its non-technical nature has, as Pauly [1995] says, lead to the "true ecological cost" of fisheries not being recognised. A lack of any plan to try and restore west coast cod stocks is attestation of this [MI, 2010, pp. 19-25]. The impression is that Irish and ICES scientists believe the environment to be in relatively good health, when in reality it is degraded.

4.1.4. On what terms could fishers' knowledge be integrated into EBFM?

Previous research warns we should be careful when claiming that fishers' knowledge can identify shifting baselines [Daw, 2010; Lordan, 2010], because memories (especially qualitative ones) are not always reliable when describing trends. However, it is fair to say that biodiversity changes such as extinctions and introductions are more definitive than trends and are not the constructs of fanciful fishers. Therefore, the shifting baseline identified here could conceivably break down the barriers which the epistemic community have previously raised to integration of fishers' knowledge into scientific knowledge.

The inability of the epistemic community to trust fishers has been hard to overcome. This is evident in the European Commission's message to institutions called Regional Advisory Councils (RACs), set up by it to provide a forum for the fishing industry to give advice on fisheries management. This message is that their advice must be backed up by hard (natural science/quantitative) data [MI, 2010, p. 13]. It is a message echoed in the Marine Institute's feedback for this study, that many of the findings are subjective. These objections to integration may well be justified if the results here solely indicated that the fishery was sustainable and

ecosystems were healthy. The fact that the Galway and Aran fishers have described degrees of ecological degradation that are more severe than those documented in the *Stock Book*, and that they willingly cite overfishing as a cause, should begin to dispel opinions that they are liable to mislead those in control of quotas in order to serve their own commercial interests. Scientists and managers could begin to integrate data which they trusted.

Another motive for the epistemic community integrating it would be the potential to eliminate their fractious clashes with industry representatives. Disputes over the validity of the quantitative evidence of stock collapses often results in managers struggling to bring in the conservation measures that they desire [Daw and Gray, 2005]. For instance, members of the North West Waters RAC (NWWRAC), whose advice covers Irish waters, are still unwilling to accept quota cuts for stocks that are assessed to be diminished because of the scientific uncertainty in the data [NWWRAC, 2011a, p. 2]. If policy makers could instead establish the reduction in stock sooner through referencing fishers' knowledge (a source of information that fishers cannot readily dispute) its integration would be in their interest. It would permit them to accelerate enforcement of legislation that restricts fishing effort.

Other institutional barriers may also fall because of the Galway and Aran fishers' identification of biodiversity loss. Some eco-centric NGOs and individuals within the green movement have been critical of fishers and their institutions, blaming industrial fishing for marine degradation. They have preferred to work directly with the epistemic community, rather than negotiate sustainable fishing strategies within RACs, in order to pursue their goals of restoring ecosystems to pristine states [see section 5.5]. However, typically lacking their own data, they have tended to work with scientific baselines to identify what constitutes pristine. FIE, for instance, referenced the Marine Institute's *Stock Book* [FIE, 2011]. To remain true to their goals of restoring ecosystems to historical states they will have to consider the more biodiverse baseline suggested by fishers.

Whilst noting obstacles to fishers' knowledge that may be removed due to the identification of the shifted baseline, it would be naive to omit the possibility that a negative ecological finding could trigger new objections.

Managers could use the results against the interviewees and the wider fishing industry, referencing their ecological narrative as justification for further curtailment of their quotas and fishing effort. Further discussion in section 5.5 shows that this is a scenario that they and fishers' knowledge researchers are aware of. A recent communiqué of the industry dominated NWWRAC to the European Commission's Directorate-General for Maritime Affairs and Fisheries (DG MARE) discloses that the motivation for their critique of scientific data is the hope that it will prevent unnecessary reductions in TAC [NWWRAC, 2011c]. Union officials have proposed using industry information to reduce the uncertainty [NWWRAC, 2011a, p. 3], but this stance might change if it were used by managers as evidence that shares of quota needed reducing, therefore perhaps detrimentally impacting the incomes of their members.

Nullifying the concerns of fisheries representatives should be the attitude of the individuals on the ground who took part in this research. With one exception, all the fishers in the sample identified local fisheries in which they thought excessive fishing effort was a problem. Asked to identify threats that could compromise the future of the Galway and Aran fisheries, 34% (N=32) included overfishing. In line with the ethical considerations outlined for this study in section 3.2, during feedback sessions participants were told of the potential repercussions of their identification of a shifting baseline. None objected to the further dissemination of the finding. Sceptics might dispute the compliance of fishers, arguing that fishers in the sample who have retired no longer need to defend commercial interests. Quickly dispelling this should be the awareness that the declines listed in table 4.2 often represent the whole sample. Equally, testimonies of overfishing came from those who had decades left in the fishery, such as fisher 10 (aged 20 to 39 years):

F10: [...] there has been a decrease on this coast, definitely whiting and prime fish and stuff like that, but the whiting and stuff, I'm convinced it's changing patterns, they're swimming elsewhere, but the brill and turbot and stuff like that, it's overfishing really, on the smaller grounds.

The response of the Galway and Aran fishers is not unique. Fishers' knowledge researchers in Mexico also found their sample to be comfortable with the implications of their revealing a shifting baseline [Sáenz-Arroyo, et

al., 2005]. If their colleagues and members are comfortable with this development, then it gives union representatives less cause for concern. They could build on the integration, arguing that if fishers' knowledge of shifting baselines is acceptable to fisheries science, then all of their knowledge should be equally admissible.

Where integration of fishers' knowledge could alienate the Galway and Aran skippers is if their knowledge is *only* used when they perceive biodiversity change to be caused by overfishing. The NWWRAC has criticised scientists and managers for their continued use of MSY within EBFM, because apart from natural mortality it ignores causes of mortality that are not down to fishing effort [Gray, *et al.*, 2008; NWWRAC, 2010a, p. 3]. Here, analysis of the interviews identifies that these concerns were shared by our sample. Respondents hypothesised that pollution from fish farms, warming waters, and increased predation by a growing seal population were also to blame for biodiversity loss in ecosystems where they believed fishing effort to have been sustainable:

F12: Well we are always getting plaice and sole here. We are always getting prime [fish] here, off Inisheer, but years ago there was a fish farm here and to me that has destroyed that place. The fish farm's not there now, but it's left its legacy.

F24: The Bay couldn't be overfished, but the boats wasn't in it to overfish it and the few boats that were in it were underpowered, say 150 horsepower. With a small net you're not going to clean the sea with 150 horsepower and these small nets. But it's the climate [...]. When we started getting whiting out here, about 30 miles off, and we'd never seen whiting out there before. They weren't going in [to Galway Bay].

F14: We had to give [black pollock] up because of the seals. I was out there one day and I landed 12 boxes, but we had another 14 on deck damaged in pieces. He was under the boat like and as the net came up he'd just pull the skin off them. It was the same as the salmon.

During interviews and feedback fishers expressed their frustration at being wrongly blamed for damaging the environment. They wanted their ecological knowledge to be taken seriously, no matter what its nature. Particular animosity had arisen over a moratorium brought in by Irish fisheries managers to ban commercial salmon fishing. For those who had fished salmon (N=17), 82% identified seals as the real threat to the stock. The following quote by interviewee 18 is representative of fishers'

frustrations with the process of trying to engage with local scientists over such issues:

F18: I think scientists at times, let me see, arrogance is too strong now, that's too strong a word, aloof. I know they have their job to do, but I'll give you a case in point, it was scientists from the Marine Institute that got rid of salmon fishing. And that was one of the most dastardly acts ever done to [...] fishermen, [...]. Fishermen tried [...] to engage [...] with the Marine Institute on the salmon case, but they said there is so much that you can take [*i.e.* blaming it on fishing effort]. Now [a Marine Institute employee] decides after years of fishermen telling him [...], I heard him on the radio one day, "Oh the seals are a problem." But when the fishermen had to be got rid of the seals weren't a problem. There are counters on the river now, but when the fishermen were fishing there was no counters working and this is fact.

Scientists have been mistaken elsewhere in citing overfishing as the main cause of salmon declines [Holmes, 1994]. Moore [2003] highlights that uncertainty was likewise present in the Irish scientific community, especially regarding the feeding habits of seals. Potentially this could have been an ideal opportunity to integrate fishers' knowledge of a non-fisheries effect on biodiversity. Our research did not focus on seals enough to pass judgement on whether Galway and Aran fishers could have complemented the agency assessments and institutional management of the species [Cronin, 2011]. However, Moore's [2003] quantitative and narrative report on Scottish fishers' extensive knowledge of seals, appears to justify grievances at lack of at least acknowledgement for their discourse. Fisheries scientists should at least engage with fishers' colloquial narratives, if only to disprove them.

The Galway and Aran fishers previously withdrew their cooperation with Marine Institute scientists because they did not agree with how their contributed statistical data was being used in single-species stock assessment [ICES, 2009, p. 139]. If they believe their knowledge were also being ignored in EBFM, or worse still, if the only finding integrated by the epistemic community from this research is a headline style finding of say, "Fishers Agree That They Are Destroying Ecosystems!", then any integration project would likely be dead. The most important actors in fishers' knowledge research, the fishers themselves, would almost certainly be unwilling to contribute knowledge again if it were only used by top-down management regimes for their own convenience. With scientists debating amongst themselves to what degree their lack of understanding of ecosystems has caused them to be uncertain of whether baselines have

shifted [e.g. Brander, 2005; Pinnegar and Engelhard, 2008; Vogel, 2010], it seems reasonable that fishers should be able to integrate their narratives where it can help to explain uncertainty.

4.2. Fishers' socio-economic and operational knowledge: shifting the paradigm towards an area where it performs poorly, but is most needed!

As part of its shift towards EBFM, alongside its call to integrate “disparate” data sources from a “spectrum of disciplines” [MI, 2006, p. 145], the Marine Institute has suggested that in the future it will place greater emphasis on socio-economic information as part of fisheries science [MI, 2006, pp. 152-56]. The ecosystem approach was born in a more interdisciplinary forum than that of population ecology. Advocates include social scientists and they have widened EBFM to include socio-political, economic, and cultural drivers of biodiversity and habitat change [Imperial, 1999]. New or existing data is needed to assess each driver. Significantly, this multidisciplinary vision views humans as part of the ecosystem [Imperial, 1999] and therefore changes in social and economic wellbeing also require measurement.

The same agency has also stipulated that new knowledge “is required to support effective management decisions” [MI, 2006, p. 145]. As Pikitch, *et al.* [2004] reason, effective management cannot be achieved without satisfying fishers' social and economic goals. If restrictions designed to rehabilitate ecosystems mean that fishing becomes socio-economically unsustainable, then skippers may be forced to either ignore fishery regulations or withdraw from the fishery against their will. Preservation of culturally important fishing communities is a key part of Ireland's marine development strategy [MI, 2006, pp. 152-56]. For EBFM to be successful it will be necessary to identify how fishers wish to operate strategically in the future.

As with the mandates for research of ecological indicators [see section 4.1], institutional support for the inclusion of socio-economic information is diverse. It is a position backed by scientists, managers, and bureaucrats within the epistemic community, and at international (e.g. STECF, the EU's

Council of Ministers [see following quote]) and national levels [DAFF, 2010, p. 12].

One of the main and explicit objectives of the ecosystem based approach to fisheries management, as defined under Council Regulation (2371/2002), is to optimise economic activity while seeking to minimize the impact on the relevant ecosystem (*i.e.* damages on habitats or reduction in stock abundance, etc.). [...] The scale taken into account is crucial and should be relevant for management purposes. Currently, biological and economic data are available at different scales. STECF suggests that the principle scale of analysis should be the ecosystem and data should be (dis)aggregated accordingly. [...] STECF considers it to be an urgent and prior task to setup the organizational structure for addressing future ecosystem analyses. [EC, 2010d, p. 13]

Similarly, support is found beyond the epistemic community. Unions representing industrial fishers are obviously eager to make the socio-economic situations of their members part of fisheries management [FIF, 2009]. Perhaps more surprising is that environmental NGOs have made the same request. Despite these institutions ordinarily prioritising environmental sustainability ahead of socio-economic sustainability a number have come to realise that success of the former is often only possible if the latter is achieved. In particular, they have blamed the most industrial fishing practices for causing ecological damage which stops other fishers (using less destructive techniques) from making a living. Therefore, they have begun to lobby for the inclusion within EBFM of socio-economic and cultural criteria so that fisheries which cause harm in these areas can be restricted [Leslie, 2005; Ocean2012, 2011].

Whether Irish agencies are close to being able to meet this demand for socio-economic data is questionable. Certainly, detailed financial information is systematically collected for each fish sale in the Galway and Aran region [SFPA, 2009, pp. 8-14, 35-36] and recent meta-studies have addressed the economic and cultural value of Irish fisheries at national and large regional scales [Bullock, *et al.*, 2008, pp. 70-93; Morrissey, *et al.*, 2011]. Doubtful however, is the ability of these studies to provide information for a comprehensive socio-economic analysis at the smaller scale of the ecosystem, as requested by STECF. As socio-economic data is supposed to be part of EBFM, it would be expected to appear in annual fishery assessments (*e.g.* in the *Stock Book*). It is conspicuous by its almost total absence. For example, with regards to the FU17 nephrops

population, only ten lines of prose briefly describe the changing profile of the vessels targeting the stock. A single statement makes the general observation that the fishery is in a “poor economic condition” [MI, 2010, p. 303].

Our findings showed that fishers may be able expand upon the existing agency knowledge whilst addressing some of the shortcomings identified in this section. During interviews we found that a considerable portion of skippers’ knowledge was socioeconomic and cultural. The reason for this became quickly apparent as the sample provided a narrative for this dimension of their fishery. Although fishers had concerns about what was happening at sea, with some worried about the ecological sustainability of some grounds and fish stocklets [see section 4.1], their greatest concerns were on land. When asked to list threats to the future of the fishery, 38% of the sample (N=32) listed poor management and inappropriate legislation, and an even greater proportion of 66%¹⁴³ cited the economic state of the fishery. Fisher 24 was one of these:

F24: [...] there will be very little boats here in a year’s time. Every kilo of fish that we land we need to get at least a Euro extra to survive. The money we are making at the moment, and I’m not any different to any other skipper, we’re at least three or four thousand back on gross every week. [...] we’re going backwards and we’re not able to clear our business loan. That’ll come to a halt. I’ll come to get diesel someday and they’ll go, “sorry”, I can’t. But if we could get that Euro, and a Euro is not much to ask for per kilo we’d survive, but there’s no way we’re going to survive the way we’re going. No way at all.

His anecdote is typical of those who said the financial viability of fishing was becoming a problem.

Two problems fishers cited in particular were the poor market for fish, and high fuel prices. The majority landed their fish primarily through Rossaveal and were members of the port’s fishing co-operative, where they sold the bulk of their catch. Of those who commented on the issue (N=16), 81% saw the co-operative as being vital to their fishing operation, including fisher 4:

F4: I cannot work without a co-operative. I can’t. Cannot do it. Impossible. You need to have a co-operative on small boats. It’s a necessity. If that goes we go.

¹⁴³ Combined with those who listed overfishing as the greatest problem, these figures add up to over 100%. This is because many fishers listed more than one problem as the major threat.

In their anecdotes however, only 27% (N=11) predicted even mixed success for the co-operative in the future, with 73% believing it could well fail. None thought it was thriving. A previous study showed that the co-operative in Rossaveal was a focal point of the fishing community and a crucial ally for fishers in helping them achieve good prices for their landings. It was this relationship that allowed them to make a sustainable living [Meredith, 1999]. Our findings showed that the co-operative was no longer able to play this role as effectively. Interviewees described how it was struggling under the forces of globalisation, trying to compete in international markets against international competition. There was little market for their fish within Ireland and buyers representing Spanish, French and Italian markets were able to pay below the market value. The price the co-operative was able to get for the mainstay catch of nephrops was not enough for interviewees (such as fisher 24) to turn profit or even break even.

In addition, rising fuel prices meant that socioeconomic sustainability was becoming even harder to attain. Of those interviewees who brought up the topic (N=9), 89% said that if fuel prices remained at the peak levels they had reached in 2008, then they would not be able to continue fishing. In summary, it is not an inability to catch fish (*i.e.* an ecological problem) that most concerns fishers, but an inability to sell them. Other contemporary studies in commercial fisheries have found the same. Abernethy [2010] found that fishers in the southwest of the UK were now predominantly price-takers, rather than price-makers. Price-setting had become the prerogative of fish buyers, not sellers, and fuel prices had more than doubled whilst the market value of fish remained almost static. Like Abernethy [2010], we found that each fisher was responding to the socio-economic challenges differently. These responses are detailed in section 4.3.

It should also be noted that fishers could contribute and add value to quantitative socio-economic data. In particular, they could accurately describe changes in their fishing gear. Pálsson [1995, p. 8] described a skipper's vessel, nets, and technical equipment as part of that person's culture, a portion of their lifeworld, and merely an extension of the physical

human body. The ability of all our interviewees to provide precise answers for all survey fields listed in question 14 [see Appendix A] suggests that this is indeed the case. Already illustrated in section 3.3 was the proficiency with which fishers could recall engine horsepower. By tracking this from boat to boat, it is shown how an individual fisher's effort profile has changed over the course of their career [see figure 4.3]¹⁴⁴. Institutional data only shows which boats are currently in the fishery. It does not track which individuals are present on each vessel, so cannot be used to comment on each fisher's career changes.

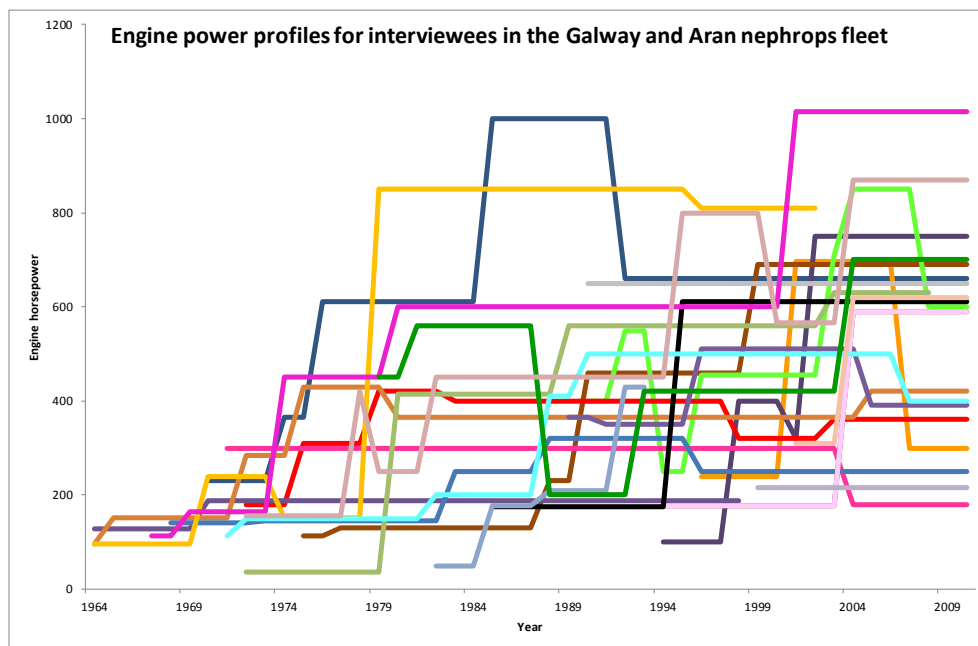


Figure 4.3. The changing engine power profile (*i.e.* on the boats crewed and skippered) of interviewees who worked in the coastal and offshore fleet.

The apparent volume of fishers' knowledge on socio-economic and cultural issues means that the need in fisheries management for a permanent source of such information is an excellent opportunity to integrate fishers' knowledge. Unfortunately, the full socio-economic narrative of fishers in this case study cannot be documented here because of the need to be concise, but the findings that might be of most use to various actors are recounted in sections 4.3 and 4.4.

¹⁴⁴ To compile figure 4.3 and produce livelihood anecdotes of fishers we used the same interview technique as researchers in Canada had [see Murray, *et al.*, 2006, p. 556; Neis and Murray, 2009a]. The relative ease in repeating the technique strengthens the case for integrating an interdisciplinary format of fishers' knowledge research. It may be the simplest way to quickly build up a body of socio-economic information with which to inform fisheries science.

4.3. Fishers' strategies: why fishers fish, and how they will fish

Analysis of how the case study interviews developed demonstrated that fishers do not construct their thoughts as linearly as many of the other actors referenced in this study. Whereas a scientist may look to biological data to find an answer to a biological problem, fishers instead draw on a diverse range of their experiences to make a decision. The interviews were roughly divided by the researchers so that biological, operational and socio-political issues would be dealt with separately [see section 3.2]. However, with the interviewees given free rein to guide the interviews, topics of conversation actually regularly switched between these. A respondent would often be referencing knowledge from each area to make a single point.

It is not a novel discovery. Murray, *et al.*'s [2006] case study of 'Jack' [reviewed in section 2.3], shows that fishers are products of the "socio-ecological networks" in which they exist. It became clear talking to fishers that these networks are their 'ecosystems' and they have to survive in them if they are to make a living. They need to be able to make financial profits within them in the present and they also must plan ahead to make sure they continue to profit from them in the future. They must therefore take a tactical approach, using ecological knowledge to find fish, operational knowledge to catch them, and market knowledge to profit from their sale. At all times they need to be aware of threats to this process, and must therefore be aware of how changes to the ecological, economic, cultural and legislative landscape could affect them. Every fisher we talked to had preferred tactics and perceived potential change differently. Salas and Gaertner [2004] have described the plans fishers make for survival within their socio-ecological networks as their "strategies".

Economic literature has often deemed fishers to follow one strategy; that of profit maximisation [e.g. Pascoe and Robinson, 1998; Asche, *et al.*, 2008]. It is a strategy that is blamed for the over-capitalisation of the world's fisheries and the resultant overfishing [Pauly, *et al.*, 2002]. However, social science and interdisciplinary research published in the last few years has started to dispute this finding, viewing fishers' strategies through the lens

that Herbert Simon would have used. He introduced the ideas of “bounded rationality” and “satisficing” [Simon, 1972], where he theorised that individuals do not always have all the information necessary to take fully rational decisions, nor do they necessarily make them anyway. Human decisions can also be irrational and emotional. Sometimes people may be satisfied to make decisions based on knowledge they know to be a simplification of reality. Other recent research has shown fishers also to be influenced by the actions of their peers, not always acting with their own rational thinking.

Behaviour by fishers that is not orientated towards profit maximisation is detailed expertly by Holland [2008] in observations he made during interviews with fishers in New England, USA. He found that rather than take risks where they believed their knowledge was incomplete, that some fishers would avoid uncertainty. Others would avoid financial or physical risk, building fishing profiles that they believed to be resilient¹⁴⁵ to ecological or socio-economic changes. The varied approach of fishers to risk-taking for financial gain is demonstrated in a French study, where some fishers showed that they were more willing than others to go to sea in borderline, possibly life-threatening weather conditions [Morel, *et al.*, 2008]. Abernethy’s [2010] analysis of southwest UK fishers led her to believe that some fishers minimise their risk by following strategies deployed by their peers. In particular, she found that fishers with more dependents made decisions that avoided financial risk.

The advantage of identifying when fishers are behaving rationally, or are more likely to have a bounded rationality, is perhaps best illustrated through a review of the literature relating to styles of farming, which has a longer history. Because it has existed longer, experts in the field have more experience of interpreting such studies and considering how they should impact future agricultural policy. A number of scholars researching farmers

¹⁴⁵ In a sociological context, *resilience* is a concept that describes the human ability to adapt to changes, potentially sudden and of high magnitudes, through individual responses to external forces. Those who are most resilient, and can therefore recover (and even surpass) the position they occupied before a change, are usually shown to be proactive, persistent, flexible, have a high level of competency with a range of skills and strategies, and know when to deploy them [Demos, 1989].

have been able to identify specific strategies chosen by different groups of farmers, some of which are described in table 4.3. The identification of these has been assessed to have profound implications for the direction of national and international farming legislation.

Table 4.3. Typologies of farmer and their strategies.

Farmer type	Definition	Source
Steward	Aim is to support family and community by ensuring the future of the farm.	Commandeur [2003]
Machine-man	Likes to have the best technology, where possible to replace human inputs.	Van der Ploeg [2003]
Fanatical Farmer	Makes heavy economic outlays to make sure they are on top of new developments in farming. Works hard and strives to achieve.	Leeuwis [1993]
Economical farmers	Keeps costs as low as possible.	Van der Ploeg [2003]
Ordinary farmers	Hard to categorise and often have poor productivity and low economic performance.	Van der Ploeg [2003]
Satisficer	Happy to settle down with the first option they encounter which allows them to make a sustainable living.	Ilbery [1983]
Large farmers	Borrow money to expand so that their operation is in a position to battle for survival in the future.	Van der Ploeg [2003]

From the 1960s until the 1990s European countries (e.g. the Netherlands, France) followed aggressive modernisation policies, prioritising industrial farming (e.g. “machine-men”, “fanatical farmers”, and “large farmers”) whilst ignoring smaller-scale and seemingly less dynamic operations, which they thought would contribute little to the expanding rural economy. This policy has since been reconsidered, as these nations’ governments and the European Commission have started to look towards implementing policy frameworks that allow multi-functionality¹⁴⁶. Through detailed analysis of the separate typologies of farmers, they have started to find value in strategies that are not geared towards maximising output¹⁴⁷. Agricultural

¹⁴⁶ ‘Multi-functionality’ (within the context of academic writing on agrarian issues) is a postmodern term, which allows farming practice to be examined in a more comprehensive manner. Rather than describing farming only from a modernist perspective, where its role in the market is the sole consideration, the concept allows it to be described through the non-commodity outputs which it generates. These include security of production, rural sustainability, and contributions to people’s quality of life [Tudel, 2006]. It is a definition that allows a more detailed analysis of styles of farming, but Goodman [2004] states that it should not be seen as a term whose introduction indicates a change within the rural development paradigm. Instead, it allows for the recognition of previously unidentified complexity within the existing paradigm, including that at finer spatial and temporal scales.

¹⁴⁷ For instance, not only are “economical farmers” seen to be practising techniques that are more sustainable from an environmental perspective, they are

policymakers now realise that they should design policies that do not make “economical”, “steward”, and “satisficer” strategies impossible [Van Der Ploeg, 2000; van Der Ploeg, *et al.*, 2009].

The tendency in fisheries science has been to treat fishing fleets homogenously, as can be seen in the *Stock Book's* generalised assessment of the boats targeting nephrops in FU17 [MI, 2010, p. 303], but the Marine Institute and other European fisheries bodies are now starting to see whether they can discover the same heterogeneity seen in farming communities, in the fishing sector. The method of *métier* analysis¹⁴⁸, where a detailed fishing profile is attached to every trip made by each vessel in the Irish fleet [see examples in table 4.4], is being used to measure differences between fishers.

Table 4.4. Selected *métiers* assigned to boats fishing in the Galway and Aran region. The definitions are adapted from an Excel spreadsheet kindly supplied by Sarah Davie from the Marine Institute.

Metier ID Code	Metier Name	Gear Type	Mesh Size (mm)	Vessel Length	ICES Area(s)	Time	Primary Species (minimum % of
1	Clean Nephrops OTB VIIa	Otter trawl	70-89	12-40m	VIIa	Year round	80% Nephrops
2	Mixed Nephrops OTB VIIa	Otter trawl	70-89	12-40m	VIIa	Year round	45% Nephrops
3	Clean Nephrops OTB VIIb	Otter trawl	70-119	15-40m	VIIb	Year round	80% Nephrops
4	Mixed Nephrops OTB VIIb	Otter trawl	70-119	15-40m	VIIb	Year round	45% Nephrops
15	BSPR OTB VIa, VIIa,b,g,j	Otter trawl	Any	10-40m	VIa VIIa VIIb VIIg VIIj	Year round	30% Ray species 25% Plaice 20% Black Sole
16	Whiting Small OTB VIa,VIIa,b,g,j	Otter trawl	70-99	10-40m	VIa VIIa VIIb VIIg VIIj	Year round	60% Whiting
42	Mackerel Mid-Water VIa, VIIb,j	Mid-Water trawl	<70	18-80m	VIa VIIb VIIj	Oct-May	70% Mackerel

also considered to be contributing positively to the rural economy by sustaining rural income and employment.

¹⁴⁸ VMS records and log book entries are analysed to decide what type of fishing trip a boat has performed each day. Dependent on the makeup of the catch and the apparatus used to make it, the vessel is then assigned to a *métier*. Scientists and managers then compare changes in *métier* across varying timescales to determine whether individual vessels and regional fleets are changing their fishing profiles [Davie and Lordan, 2009; 2011].

The métier data does not however explain strategy, only going as far as to measure heterogeneity of landings profiles. It does not reveal whether economic activity is being optimised or whether fishers are happy with their landings profile. Interpretation is based solely on the reasoning of scientists who make educated assumptions as to which ecological, socio-economic, cultural or operational factors (that they know about) may be causing fishers to change or maintain their operational profiles [e.g. Holley and Marchal, 2004; Davie and Lordan, 2011]. In some cases, a small number of fishing excursions or even a single trip can lead to a fisher being placed in a métier. This does not appear to be a robust method for deciding what strategy a fisher is employing.

Based on modern VMS data, métier analysis is also limited spatially and temporally. Omitted from the surveys are the smallest inshore and coastal boats which frequent specific local ecosystems that larger vessels do not. Also, it does not consider the cultural history of the Galway and Aran fishery before this century, when satellites were not deployed to monitor fishing vessels. Métier analysis can show when fishers move from one type of fishing to another. It can also show how varied their fishing profile is, or conversely, how specialised a given boat is. However, it cannot tell you why any of this activity is taking place. Essentially, it answers the 'what' question, but not the 'why' question. In this section it is investigated whether fishers' knowledge research can help to answer the 'why' question by attempting to define strategies similar to those identified in the types of farming literature.

Abernethy [2010] has recently advanced a set of typologies for fishers based on business strategy literature. I also found that it was possible to categorise fishers in our study, but did not use her typologies. Firstly, this was because her thesis (which is an important companion piece to this study) was published after our fieldwork and analysis. Secondly, as recognised by van Der Ploeg, *et al.* [2009] in their meta-analysis of farming typologies, because typologies can differ from case to case. Here, I advance an alternative set of fishers' strategies¹⁴⁹ based on my own

¹⁴⁹ Broad typologies (e.g. 'fishers-for-volume', 'fishers-for-value) are used here to simplify the discussion. This does not mean that every fisher is wholly of one

analysis of the Galway and Aran fishers, discussing the implications of their existence for Irish fisheries management.

Fishers-for-volume

Figure 4.3 illustrates what has for the most part been a dramatic increase in engine horsepower (a reliable proxy for fishing effort) within a large section of Rossaveal's coastal and offshore fleet. From the mid-1970s skippers looked to dramatically increase their towing capacity. Before this, many of the interviewees said they had been working in inshore potting boats or with seine nets that did not need towing. Many upgraded their vessels at this stage because they wanted to take advantage of burgeoning lucrative markets for whitefish species. One of the most effective ways to catch these was using a demersal otter trawl, and because of the benthic friction encountered when using this gear, they had to get bigger boats with more powerful engines to tow the nets.

Another reason cited for getting a larger boat at this stage was the weather. A distinct characteristic of the Irish west coast is its position on the edge of the Atlantic Ocean, with unpredictable swells and storms. Many interviewees explained that to target the developing coastal and offshore fisheries in the region, they had to trade up to larger, often steel vessels, to ensure safety at sea.

These modern steel boats involve significant purchase, operational and maintenance costs and the skippers on these boats said they were necessarily locked into having to make big fish landings in order to service their financial commitments. Those who were targeting nephrops, for which market value was low, emphasised more than others how important it was that their catches were as large as possible. The title given in this section to fishers like these, whose strategy involved them maximising their catch, is 'fishers-for-volume'.

typology, or that those within a typology have similar strategies. What it signifies is that they have at least one tactic or perception in common.

A number of stimuli were cited by the respondents for a second mass increase in engine power in the 1990s. They were based on newly accumulated ecological, economic, cultural and operational knowledge. The previously mentioned cod collapse on the Back of the Island ground had removed a major source of reliable revenue. At the same time, fishers observed foreign fleets successfully targeting nephrops on the Back of the Island ground and followed their lead, as markets for the species in continental Europe were just being discovered by the Irish. From the late 1980s Aran natives also began to return to the local fishery from the Irish Sea and Scottish waters where they had learned to harvest nephrops with twin-rigs¹⁵⁰. One of our sample pioneered the technique in 1988 on the FU17 and Porcupine Bank grounds where until this time only single-rigs¹⁵¹ had been used. This gear setup enabled the region's fishers to land larger volumes of nephrops with each tow, but they also needed more power to drag the nets and therefore many traded up again between the late-1980s and mid-2000s [see figure 4.4].

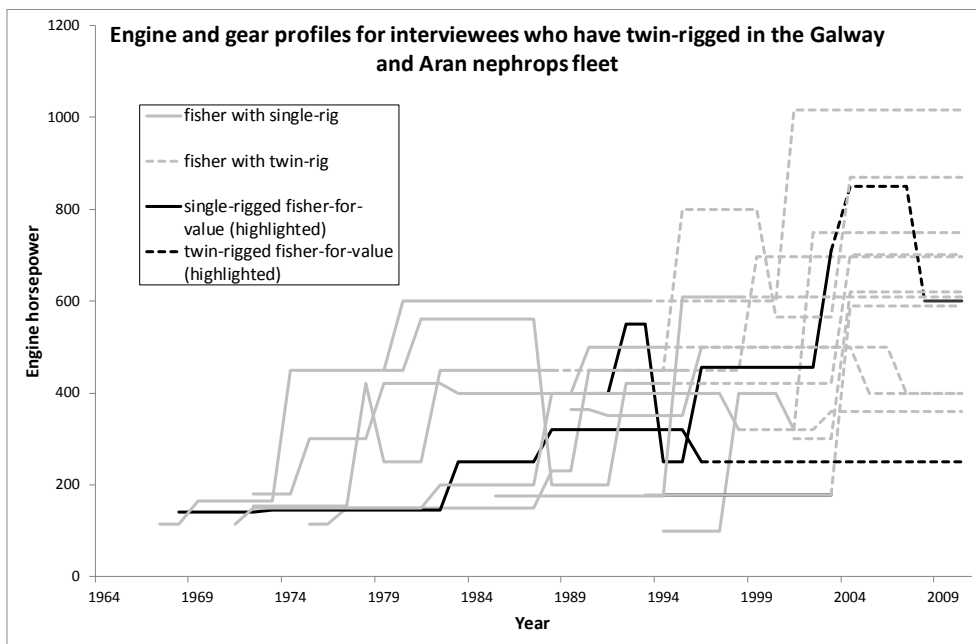


Figure 4.4. Fishing profiles of fishers in the Galway and Aran fleet who have at some stage in their career employed a twin-rig gear.

So far, this composite narrative is fairly homogenous. However, as soon as you begin to consider individual anecdotes, unique strategies are revealed which show fishers' entirely different reasons for 'fishing-for-volume'.

¹⁵⁰ See glossary: twin-rig.

¹⁵¹ See glossary: single-rig.

Fishers 5 and 29 for example were both fishers who gave their motive for trading up as wanting to be ahead of their competitors in terms of fishing and catching ability. Both had modern boats, fitted with the most up-to-date technology and were proud of how they had been the first to trial new gears and fish new grounds. They made the biggest landings possible by using the most efficient gear, fitting twin-rigs and onboard freezers. The latter piece of equipment kept their catch fresh longer, therefore maximising the time they could spend at sea. They shared parts of their outlook with the “machine-men” and “fanatical farmers” in table 4.3, such that they could perhaps be termed ‘fanatical fishers’.

F5: We used to triple-rig. We were kind of the first around here to triple-rig. We were probably the fourth to go twin-rigging. We were probably the third to go freezing prawns. We’re freezing prawns at the moment on board. So we are always trying to stay ahead of it in some shape or form.

IV: What other options does freezer fishing give you?

F29: You can stay at sea longer.

IV: Currently how long are you out?

F29: Fresh, 1 week maximum. Could be 4 days or 5 days but a week maximum. With a freezer you can do up to 2 weeks, especially if you are fishing out here at the Porcupine, where the steaming time is more than 18 hours and 18 hours back, so you’re losing a day and a half where you could be staying out fishing.

Contrastingly, fisher 17 was fishing-for-volume, but for a different reason. He had high levels of debt having purchased his boat on credit in better economic times. He was also employing a twin-rig, had just fitted a freezer and was toying day-and-night to maximise his catch. His only option was to generate as much cash flow as possible to try and service the debt, yet he knew this was not the most profitable way he could be fishing. The markets he was targeting were demanding, with buyers driving down the price with claims that the bulk product he was delivering was of poor quality. This interviewee actually stated that he would rather have retired his current boat and returned to his former single-rig boat, a smaller coastal vessel with lower operating costs. His landings and income would be less, but with less power needed and shorter periods at sea he could reduce his fuel and crewing costs. The struggle encountered by this skipper has similarities with the typology of the “large farmer”.

F17: It’s too expensive. We can hardly make the interest. She’s 18 000 Euros a month. I’d say we have one more year of this boat and she’s [...] gonna be repossessed by the bank. [...] we had to take an additional loan from the bank and the reason we put in a freezer was to try and get added value [...]. We couldn’t catch any more so we are trying to add value. It

seemed to be the way to go, but unfortunately 18 boats are freezing and now the French buyer is fucking us about and we've been waiting since the start of September for money to come back [...] and it still hasn't come back, and he's coming back complaining about prawns that went over in September. He's coming back now. We're in November.

[...]

IV: If somebody was to offer you decommissioning¹⁵², you'd jump at it would you?

F17: Yeah, I think so.

IV: Would you stop fishing?

F17: No, we'd fish in the old boat. [...]. Because we'd actually have a life and we'd have a wage. [...] we're pushed to the limit the last couple of weeks [...]. It's been like the clappers. We did over 6 months without stepping off this boat.

The existence of fishers like fisher 17 is a key finding of this thesis. He was part of the 60% of the fishers-for-volume (N=10) in the sample who were actively looking to reduce their bulk catches of nephrops [see table 4.5]. It shows that there is scope to trade down a group of fishers who want to fish less, but who cannot because they are trapped in a production cycle. As is discussed later in this section, they would rather achieve better value from fishing or settle for a satisfactory income. The implications for a policy such as the CFP are profound. If the findings here can be confirmed more generally, it suggests effort could be reduced through structural fleet reduction¹⁵³, and this could provide an alternative or complement to quota and effort restrictions.

Fisheries policy and legislation had forced others into fishing-for-volume. Fisher 6's strategy options had been constricted by a moratorium on the deepwater species, orange roughy. He had bought one of the largest boats in the Galway and Aran fleet to exploit this fishery on the advice of officials within Irish fisheries agencies. The scientists and managers who had opened the fishery quickly closed it again when they realised it was neither ecologically sustainable nor particularly lucrative [Foley, *et al.*, 2011]. The skipper was left with an unpaid vessel and no obvious fishery in which to use it. The only option open to him was twin-rigging for nephrops on the Porcupine Bank ground, so that he could create the turnover necessary to pay back the loan he had taken to pay for the boat.

¹⁵² See glossary: decommissioning.

¹⁵³ Although fisher 17's previous quote mentions decommissioning, he and the rest of the sample overwhelmingly favoured a continuation of their fishing careers over this option. Of those who commented on the policy (N=10), 80% would not take decommissioning under any circumstance.

Table 4.5. Current primary strategies of interviewees in the coastal and offshore section of the Galway and Aran fleet, and their future goals.

Fisher #	Primary Strategy	Happy with strategy? (Y/N)	Considering in the future	nephrops effort (+/-)
3	fisher-for-volume	Y	n/a	
5	fisher-for-volume	N	target pelagic	-
6	fisher-for-volume	Y	n/a	
10	fisher-for-volume	N	trade down to single-rig	-
17	fisher-for-volume	N	trade down to single-rig	-
23	fisher-for-volume	N	target pelagic	-
24	fisher-for-volume	N	trade down to single-rig	-
25	fisher-for-volume	N	target pelagic	-
26	fisher-for-volume	Y	n/a	
29	fisher-for-volume	Y	n/a	
4	inbetweener	N	trade up to twin-rig	+
8	inbetweener	N	target pelagic	-
9	inbetweener	N	target pelagic	-
16	inbetweener	N	target pelagic	
20	inbetweener	N	trade down to single-rig, target pelagic	-
1	satisficer	Y	n/a	
12	satisficer	Y	n/a	
13	satisficer	Y	n/a	
15	satisficer	Y	n/a	
7	fisher-for-value	Y	n/a	
14	fisher-for-value	Y	n/a	

This shows how fishers' rationality can be bounded by managers' and scientists' equally bounded rationality. Uncertainty over the sustainability of the orange roughy population drove a fisher into an irrational strategy, which is not likely in the long term to sustain either the overexploited nephrops stock on the Porcupine Bank or his own business.

Fishers-for-value

Highlighted (in black) in figure 4.4 are the career profiles of fishers 7 and 14. Both have taken trajectories within the fishery that have resulted in them avoiding the tactic of maximising effort. They have sought operational efficiency in other ways, concentrating on achieving better value for smaller catches by reducing costs and trying to achieve a higher price for each unit of fish sold. This strategy is one where its participants are 'fishing-for-value'. They have much in common with the "economical farmers".

Fisher 14 built a strategy on his ecological knowledge of the inshore grounds on the North Sound and Northwest Corner. He knew these waters better than the other interviewees and was able to identify micro-stocklets where he could catch the medium sized nephrops he was targeting. Operating on calm inshore grounds, he was able to use a smaller boat. These grounds were also the closest to his home port at Rossaveal. Both factors allowed him to keep fuel costs low. By targeting medium nephrops there was also no need to tail the catch, a labour intensive practice, meaning he did not need to pay a large crew. He limited his catch of smaller, tailing nephrops by fine tuning his gear to a degree we did not observe from other interviewees:

F14: We changed a few years ago to other gear [...], the scraper gear we call it, but it is a prawn net. [...]. Basically other boats use a wire with a 2 inch rubber¹⁵⁴ on it. Do you know? Rubbers? We started using these nets with 6 inch rubbers on them. So you have 8 inch high here and then 6 inch here and then up on the wing you come down again to ordinary 2 inch. Right? Now what I found with these was, you were doing away with a lot of the small prawns, you weren't catching it. But the big secret was you were catching more bigger ones, [...], in a big way. We proved this like. [...] I like quality and less work. Less work, more money. Whereas [my friend] can't put bulk out of his head, plenty of boxes like.

Fisher 14 was drawing on diverse knowledge to achieve value, but his primary expertise was his operational knowledge of fishing gear. Fisher 7's worldview was instead based on his keen interest in the marketing of fish. Disappointed with the money he was making in an offshore trawler, he chose to trade down. After decommissioning his twin-rigger he bought a smaller coastal vessel fitted with just a single-rig. The decision was based on detailed research he had done into profit margins of fish sales. His new tactic was to land smaller catches, not just of nephrops, but also of whitefish, flatfish and pelagic species. Traditionally, many Rossaveal-based skippers sold their catch through the local fishing co-operative, but fisher 7 was going to withdraw from it. He had calculated that he would be economically more efficient processing fish in his own small factory and then selling the product direct to tourists on the Aran Islands.

Fishers-for-value are not engaging with the day-to-day risk that some fishers-for-volume take on. As Holland [2008, pp. 336-37] found with an

¹⁵⁴ See glossary: rubbers.

example of a gillnetter in a smaller coastal vessel, the former would prefer to have a long-term low income rather than the chance of a short-term high income followed by a period of loss. The risk of loss is more of a threat to volume fishers, because large landings may not be ecologically sustainable due to the high effort profile of their operations, or socioeconomically sustainable, as markets can become flooded by the bulk landings and premium prices therefore become hard to attain.

Socio-cultural and ecological considerations also motivated fisher 7. He wanted to spend less time fishing, which was possible with a reduced profile. Furthermore, he was keen to create jobs for young people on his native Aran Islands where employment opportunities were few. The factory and restaurant he hoped to set up would fulfil this. Finally, he harboured ecological concerns, worrying that overfishing of whiting fisheries was significantly depleting their stock on the Back of the Island ground. Coupled with this, his considerations for the socio-ecological future of the fishery are the same ones shown by the farm “steward”.

Fishers-for-value are engaging in strategies, like van Der Ploeg, *et al.* [2009] found for those of “economical farmers” and “stewards”, are more likely to be environmentally, and economically sustainable. They are also making non-monetary qualitative decisions (*e.g.* fisher 7’s desire to spend less time fishing and create jobs in his local community), which contribute towards social and cultural sustainability. Holland [2008] made a similar discovery in the New England fishery, where he found skippers who wanted to be at home overnight for lifestyle reasons. Some of these qualitative decisions are an example of satisficing [see next paragraph]. If managers can encourage some of the skippers (identified in table 4.5 as fishers-for-volume looking to trade down) to embark on strategies that focus on value, then the future sustainability of both the ecosystems and fishing communities of the Galway and Aran fishery would be more likely.

Satisficers

The career paths illustrated in figure 4.4 represent only those of the sample of coastal and offshore fishers who at some stage in their career traded up to use a twin-rig. Of the interviewees still actively fishing in coastal and

offshore vessels (N=21), 67%¹⁵⁵ had employed this gear, usually to effect a fishing-for-volume strategy. However, a sizeable minority had not used twin-rigs and within this portion were skippers who said they would never use the more intensive gear. One example is fisher 15 who was using a single-rig on an older wooden vessel to target jumbo nephrops on the Porcupine Bank ground. Like the farming “satisficers” he was happy with the logistics of his operation, which involved the use of less fuel because he did not need the power that a twin-rigger required. He had also continued to use his wooden boat, which meant that he could not go to sea in some of the sea conditions that his colleagues with large steel hulled boats could. Yet, this did not matter to him greatly, as without the purchase of a new vessel he was not pressured into having to make big landings every day in order to service a large debt.

Inbetweeners and the “colleague effect”

Although some of the Galway and Aran fishers could be classed as ‘fishers-for-volume’, ‘fishers-for-value’ or ‘satisficers’, others were harder to categorise. Some of these may be like the “ordinary farmer”; *i.e.* between strategies and perhaps not operating optimally in either an economic or social respect. Some of fisher 4’s comments suggested he fell into this category:

F4: A lot of fellas have moved to twin-rigging, but when I bought the boat she was rigged for single-rigging. And the plan was eventually to have her twin-rigging, but with the high cost of fuel and everything else last summer the single-rig was more effective than the twin-rig. Plus there’s less wear and tear. If I could afford it, I would be twin-rigging in the morning, but things will go down before they go up. I’m just about keeping my head above water.

Equally, fisher 4 could be exhibiting a character trait that Neis, *et al.* [1999b] discovered in their Canada case study: the “colleague effect”. They identified fishers who had traded up as a result of peer pressure. Not wanting to fall behind, either because they might miss a financial opportunity or simply because they did not want to be seen to own seemingly inferior gear, they bought a bigger boat. Fisher 20 in our sample had certainly been subject to the effect, but he now regretted his reaction to it:

¹⁵⁵ This figure differs from that in table 4.6 because one fisher now fishes a single-rig, having previously used a twin-rig.

F20: Well everyone else was doing it. I just joined the club. But I think it was a bad move to go to twin-rigging.

He was not alone. Of the active twin-riggers who commented on their outlook (N=12), 75% said they would support a ban on the activity. Some of them attached caveats to this (e.g. as long as it was banned in every European fishery, if the ban was only applied to inshore fisheries), but were still willing to work with other fishers and managers on the issue. Only 25% would have opposed a ban under any circumstance.

One reason cited for their U-turn on the gear was the need for stewardship, so that the fishery survived into the future. Anecdotal evidence revealed that fishers believed that a clump weight needed between twin-rig nets was damaging habitats and crushing fauna (including nephrops). Fisher 15 frequented the Porcupine Bank ground and recounted how he and his father had fished a specific area of the ground for decades. At first they had fished alongside Spanish single-riggers. He said that within two years of Irish twin-riggers starting to fish the same ground that the grade (size) of the nephrops began to decrease dramatically. Of the respondents actively fishing who described their perceptions of the gear's environmental impact (N=17), 71% asserted that it was causing damage.

A second attributed cause was the economic effect of the gear. Fishers complained that markets, especially locally in Rossaveal, had become flooded since the twin-rig came into use. It had depressed the price to levels where nephrops fishing was no longer an attractive option for those looking to do as well as their peers had done in the 1980s and early 1990s.

It is fascinating to discover that a considerable number of fishers believe twin-rigging to be ecologically unsound and it puts paid to any notion that fishers are not sympathetic to environmental concerns and practices. In the Galway and Aran nephrops fishery there is a conflict of gear that is partially motivated by environmental concerns, which is in reality a conflict between different groups of fishers over access to a nephrops stock, and over what measures are needed to conserve the stock. Whereas a proportion of twin-riggers either feel the gear does no harm, or is bluntly, economically necessary regardless, some of their number and a majority of single-riggers

believe a one net strategy is the only logical gear setup if the fishery is to continue. The situation is summarised in table 4.6¹⁵⁶.

Table 4.6. Summary of active offshore and coastal fishers' views about twin-rigging.

Interviewee status/opinion	N (number)	Percentage
Interviewees who are actively fishing and part of offshore and coastal nephrops fleet	21 of 32	
Number of these who are twin-rigging	13 of 21	62%
Number of these who are single-rigging	8 of 21	38%
n.b. For the remaining fields not all of the 21 interviewees who are actively fishing gave a response or offered an opinion that could be used to populate this table. Therefore, the N (number) of responses on which the final percentage (right column) is based is displayed in the centre column.		
Active fishers who believe twin-rigging causes ecological damage	12 of 17	71%
Active twin-riggers who believe twin-rigging causes ecological damage	5 of 9	56%
Active fishers who would support at least a voluntary ban on twin-rigging	15 of 18	83%
Active twin-riggers who would support at least a voluntary ban on twin-rigging	9 of 12	75%

The widespread feeling of negativity or indifference amongst fishers towards the tactic of employing a twin-rig is a finding that surprised Marine Institute scientists and even representatives of fisheries unions. The nature of their surprise means this is a significant result, as it surpassed their expectations of what fishers' knowledge research could achieve. Effectively it opened their eyes to an opportunity to reduce fishing effort that they had never considered. Twin-rigging is not an activity scientists have been greatly critical of, (preferring instead to attempt to limit temporal and spatial effort), but a switch which catalysed trading down to smaller, less powerful boats would be seen by them as a sensible precautionary measure. In feedback meetings the initial reactions to our statement, that fishers would consider a twin-rig ban, was met with indifference. The Marine Institute employees and the union officials said that other groups of fishers had indicated that they would self-regulate effort before, but that this had rarely come to fruition. However, when we revealed the percentages of those expressing a will to quit (a sizeable portion of our sample) they were

¹⁵⁶ It is important to note that, despite the large percentage that appears to be in favour, the level of support for a ban on twin-rigging would not be as high if the ban was a simple top-down ban on all twin-rigging. Some fishers only supported a voluntary ban. Others only supported an inshore and coastal ban (e.g. on the North Sound and Northwest Corner grounds), but suggested that twin-rigging should continue on other grounds (e.g. on the Back of the Island and Porcupine Bank). Some supported a complete ban, but only if compensation was provided in a monetary form or in the form of favourable fishing concessions. If an actual ban were to be discussed by managers in the future, it seems prudent that the nature of this ban be decided after extensive consultation with fishers.

noticeably more impressed and noted that it was a finding that they could perhaps include in their future recommendations for management.

Only deep reaching one-on-one interviews can engage fishers in a way that teases out contentious issues such as these, hence the surprise of the scientists. The sensitivity of the topic perhaps precludes fishers from bringing it up in front of their peers in the group meetings they are used to having with scientists. The message to be taken from this is that there is more flexibility on the part of fishers themselves than is assumed by the epistemic community¹⁵⁷. Hidden social capital is one attribute of fishers' knowledge – it is an attribute discussed in more detail in section 4.4.

A further set of 'inbetweeners' are those who are forced to fish in a métier they would rather not be part of. Fisheries legislation was becoming part of their knowledge and they were reacting to it. An erroneous assumption of this research was that the fishers would be fishing as they wanted, but anecdotes and narratives revealed by fishers during the interviews showed this not always to be the case. Many of the nephrops fishers we talked to would have preferred to target other species. Of the five 'inbetweeners' identified in the sample, four wanted to target pelagic species in the future [see table 4.5]. A number of fishers cited a dislike for tailing prawns, which was hard and unpleasant work. Others found the activity of otter trawling mundane. They instead wanted to feel more like hunters, having to use their skill and knowledge to find and outwit species with greater mobility. The parallels between these findings and other research identifying fishers' strategies are striking. Holland [2008] observed fishers (in this case 'satisficers' rather than 'inbetweeners') in New England who fished species of lesser value deliberately, simply because they were easier to gut (*i.e.* it was more pleasant work). Also, he discovered a fisher who had sacrificed an effort allocation for a static species (lobster) to instead make the non-

¹⁵⁷ Some commentators may object that my findings simply show that fishers collectively will not agree. This criticism should be mitigated by some of the other findings in this section which show why fishers may not agree. For example, some would not entertain a ban on twin-rigging, as they are financially indebted fishers-for-volume with no option but to use a twin-rig to catch bulk volumes of nephrops. This finding should tell policy-makers that if they can create policy which helps the indebted fisher escape debt, then that fisher may subsequently agree to a ban. This potential criticism is rebutted further in chapter 6.

monetary lifestyle choice of taking part in the more exciting hunting of shrimp and groundfish.

Some Galway and Aran fishers had been refused licences for pelagic fish by the Irish DAFF. Others, like fisher 23, did not have the quota allowance to become more dependent on such species for their livelihood:

F23: My quota this year for the mackerel is only 100 tonne.

IV: And if that was doubled, what difference would that make to you? If it was put to 200 tonnes?

F23: If we had enough quota for mackerel we wouldn't go for whitefish. We'd leave whitefish to the other boats. That would be a great help for the boats here.

Whereas he said he would have preferred to switch from a profile like that of métier 16 [see table 4.3] to one like métier 42, still more interviewees wanted to move from the nephrops métiers (*i.e.* 1-4) to the pelagic one.

Fisher 16's fishing effort would perhaps look the most irrational of all the skippers we spoke to, but like fisher 6 (excluded from the orange roughy fishery) his choices were being dictated by management regulations. Management policy under the CFP limits fishers to a certain number of days-at-sea in each of the ICES zones for each specific gear and species profile. The allocation is based on the track record of the fishing vessel and it is hard to get days allocated in regions or for fishing profiles which the vessel has not previously operated within. Based on their experiences and what they had heard from colleagues fishers (including fisher 16) revealed that they were wary that if they did not use their days-at-sea each year then Irish fishery managers would eradicate the track record and therefore reduce their effort allowance. Fisher 16 was consequently making a trip of over 500 miles from Rossaveal to the east coast nephrops grounds of FU15 (where a days-at-sea regime was in place) because of this worry. The boat he had bought had track record for that fishery but not for his local one (FU17). He was worried that if a track record scheme was also introduced for the FU17 nephrops fishery (where none was currently in place) he would only get a low allowance, because his vessel had only entered the local fleet recently. He was actually losing money on the inefficient trips to FU15 whilst he could have been making a profit in FU17:

F16: I didn't want to go this year because of the price of prawns. It's 2 000 eighths of diesel just to get there. With the price of prawns it's not worth my

while. I'd be better off here giving it a wait for a while. There won't be much there. We went because of the days-at-sea. I got 24 days. Just in case I lose it. Next year comes they will tell you, you weren't here, so you'll get less again. We did 24 days and we left, I did the first 2 trips and my brother did the rest and we went.

His rationality was bounded because he did not know whether managers intended to introduce a rumoured effort management scheme for FU17 (fishers recounted how previous days-at-sea schemes had been introduced without warning by the DAFF). His choice to maintain his days-at-sea for FU15, a risk-aversion tactic, was therefore the most rational decision possible given the knowledge he had. Of those who listed a grievance over legislation (N=28), 36% listed days-at-sea legislation as the one they found most problematic, so fisher 16's predicament was not an isolated case.

Deconstructing the strategies of the 'inbetweeners' and 'satisficers', there are a number of implications for managers. Firstly, some fishers are revealing themselves as latently willing to shift from the nephrops fisheries they work in, which is an opportunity to remove effort from grounds that the Marine Institute and ICES assess as overexploited (FU15, FU16) and close to full exploitation (FU17) [MI, 2010]. What is preventing them diversifying is their poor allocation of pelagic quota or restrictive days-at-sea allowances, which Irish managers could redistribute if they chose. They could also give increased advanced warning of changes in policy, allowing fishers to plan better. Second, uncovered is the unknown desire of many fishers to stop fishing nephrops. Few said they wanted to specialise on one species, instead suggesting that they valued diversity. This portfolio approach to fishing is one that Holland [2008] found also gave New England fishers comfort. In academic terms this fishers' strategy, which gives priority to flexibility, is one that it is a more resilient. It makes economic sense under a Simonian satisficing logic, and also makes good ecological sense. For instance, if the nephrops population were to be hit by disease, as has happened elsewhere [Stentiford and Neil, 2011], the regional fleet would have an alternative livelihood to protect it from economic extinction. The fleet is currently highly, even dangerously, dependent on what fisher 4 called its "bread and butter" of nephrops.

A blueprint for reducing effort in commercial fisheries

The ability to document fishers' strategies in such detail is the single most important finding of this thesis, and the most compelling reason for its integration into the scientific mainstream. When this research was commissioned, it was hoped that tacit knowledge would be uncovered, in the sense of fishers revealing information that they had been reluctant to share. In hindsight that was always an unrealistic goal, but in uncovering diverse fishers' strategies we have found a different tacit knowledge that is a potential game-changer for fisheries managers. Three novel elements of fishers' strategies make them an information source that allows scientists and managers to discover knowledge which they could never possess themselves.

Firstly, the métiers data used by the Marine Institute and by ICES [see Davie and Lordan, 2009; 2011] will only ever tell those who collect it how an individual fishes. Fishers' strategies answer the 'why' question, actually explaining why they choose to fish how they do.

Secondly, a strategy is not just something that lives in the present. It is a plan for what is to come. Therefore, fishers' knowledge is one of the few sources of information that allows a view of the future. A key motive of métier classification and analyses is the prediction of where fishing effort may fall going forward [Davie and Lordan, 2011]. Scientists are trying to forecast how socio-ecological events and new regulation will change fishing patterns. However, in an open-ended interview a fisher can reveal their future plans and describe the deliberation that went into making them. Satellites and the current incarnation of fishers' electronic log books cannot hope to achieve the same.

Thirdly, deconstruction of strategies grants access to the bounded rationality of individual fishers. Each strategy is a window into a person that has not been looked through before. Unveiled is a complex heterogeneity, which if considered carefully by managers could be sensitively exploited to influence fishers' decision-making. It could help managers guide fishers towards strategies that are more sustainable, both ecologically and socio-economically.

All too often fishers have been represented, researched and managed as homogenous groups capable only of irrational, or conversely rational but utterly selfish, profit-maximizing behaviour. Within Europe especially, fishers have been stereotyped as collective plunderers of Hardin's [1968] "commons", fishing stocks for short-term gain and ignoring their future need to continue catching. Their stories of grievance with fisheries science and legislation are usually dismissed as being apocryphal narratives served up for their own self-interest (e.g. so as to pressure politicians into allowing them greater TACs) [Ostrom, 1998; Daw and Gray, 2005]. Analysis of the interview transcripts collected here dispels the idea that they are a homogenous group and shows that their complaints are often highly rational, albeit also bounded.

Immediately evident is that fishers do not share one set of beliefs, opinions and values. Each perception they have is based on considered reflection. During this introspective process they cross-reference a diverse spectrum of their knowledge, including that of fish abundance, the ecological impacts of fishing, the state of the market, gear capabilities, and the influence of policy. Prigent, *et al.* [2008] confirm this finding using cognitive maps, which show how fishers then attach value to each of their perceptions before they make judgements on their future strategy.

However, during their reflections fishers also reference the opinions and actions of their colleagues. Ostrom [1998] has been instrumental in championing the socially bounded rationality of those who make their living from shared commons. Rather than always working for self-interest, fishers are capable of coming together for the common good. Their ability to reason with each other through knowledge exchange means they are quite capable of agreeing on social norms designed to ensure future sustainability of a given fishery. Still, she does note that this perfect scenario rarely plays out in reality [Ostrom, 1998; 2000b]. In industrial fisheries, social norms and common goods can vary widely because of the different scales at which participants operate¹⁵⁸.

¹⁵⁸ For example, the common good of fishers working offshore may compromise inshore fishers' ability to collectively act for their collective interests. Fishers can

Against this positive “colleague effect” may intrude structural constraints: capitalist modes of production such as modernisation may undercut social capital and collectivist strategies and national and international institutions may interact in ways that preclude bottom-up approaches to managing limited resources. In effect, this is what has happened in European fisheries, where instruments of the CFP have constrained fishers’ actions. This was evident in the comments and views of Galway and Aran fishers:

F6: [...] take for example this thing of getting a couple of tonne a month. That’s a joke. A realistic quota like. There is no point just giving you [that], it’s a bit like giving a pauper a cup of tea, it’s better than nothing, but do you know what I mean? It’s better than nothing, but that’s all it is.

F5: I mean we’re a prawn boat, and the biggest prawn fleet in Ireland is the east coast and now, we’re a small island as it is and the only place I can fish from is Hook Head, which is down Dunmore East around to Achill¹⁵⁹. That’s my limitation. This is just coming in after at the stroke of a pen. That I have no days at sea because I wasn’t there. Now if I wanted to sell her next year, I would have been banking on the east coast. Thing must have devalued my licence 4 or 5 000. That shouldn’t be. That is absolutely criminal. It’s not the fact that it’s the days-at-sea, it’s now I have no days-at-sea up there, it’s devaluing your boat. And they’re saying that next year it’s going to come in on the south coast. I mean what are they going to do? Pin you in here?

Top-down legislation can actively restrict fishers’ pathways to the common good. If the legislation conflicts with fishers’ social norms they may even rebel against it by acting irrationally. Yet, Dietz, *et al.* [2003] are confident that external actors can successfully intervene in fisheries management, even helping fishers to change their perception of the common good. To achieve this, external institutions must allow fishers into the decision-making and knowledge gathering process. With this collaboration, legislation that might conflict with fishers’ social norms can be avoided and therefore compliance made more likely.

Returning to the specifics of the case study, through identifying how to help fishers realise their desired strategies, scientists and managers at the Marine Institute, BIM and the DAFF could thereby achieve their own goal of decreasing fishing effort for overexploited species. For instance, removing fishers-for-volume from the FU17 nephrops fishery would bring landings

also take decisions that do not appear rational if their rationality is bounded (*i.e.* they do not have all the knowledge required to identify the common good) or if their social norms do not include the identification of sustainability as a moral behaviour.

¹⁵⁹ Hook Head to Achill can roughly be viewed as the coastline of south and southwest Ireland.

comfortably inside the designated MSY. Managers could achieve this by facilitating the reversal of the “colleague effect” that led to the original effort increases in the fishery. The fishers-for-value and satisficers who traded down or settled for less intensive profiles appear now to be the most content fishers in the case study area. Ostrom’s [1998] theory suggests that left to their own devices the fisher-for-value profile could become the negotiated social norm as it would be for the common good. With many fishers having found twin-rigging to be harmful to the future of the fishery they would recognise this category as more sustainable, both ecologically and socio-economically. Intervention may not even be needed to facilitate this course of events, but a couple of helpful actions by managers could accelerate a transition by making it easier or more desirable.

Firstly, for those fishers trapped in the fisher-for-volume typology, managers could buy out their large boats or twin-rigs, helping them switch to less industrial options. Secondly, legislation barring entrance to more sustainable fisheries could be removed (*e.g.* to the pelagic mackerel fishery which has an ecolabel designation [Southall, *et al.*, 2009]). Thirdly, top-down legislation could be replaced with bottom-up directives. For instance, one fisher suggested that the DAFF should guarantee that track record will not be taken away from fishers if it is not used. Another suggested that if fishers cannot use days-at-sea because of bad weather, then they should be compensated with an extra effort allowance. Fourth, financial support for the local cooperative as well as marketing expertise could be offered to help fishers get the best value possible for their catch. This was something they also suggested themselves [see table 4.7]. With some fishers starting to bypass the co-operative, the organisation was finding it harder and harder to keep operating, yet some fishers could not survive without it. Finally, administrative and technical assistance could be given to help fishers set up their own management (*e.g.* twin-rigging bans).

The hardest effort to attempt to manage is that of the ‘fanatical fishers’. There is a chance that if the majority of their colleagues adopt less powerful vessels, then peer pressure and the “colleague effect” may encourage them to reflect upon the changing social norms within the fishery and follow suit. If not, one suggestion could be for managers and scientists to attempt

to harness their desire to have the best fishing gear, working with them to develop gears that eliminate bycatch and discards. This has proved a successful management option in Sweden [Rihan, *et al.*, 2011].

The timing of these findings is particularly relevant, because a European Commission proposal backed by the scientists of ICES and STECF is seeking to change the plan for management of nephrops stocks in ICES zone VII. If the fishers' strategies detailed here were considered, those implementing the plan would be able to identify obstacles to its success. It proposes mandating the use of a low-bycatch gear and expansion of the days-at-sea scheme (based on track record) across the whole of zone VII (including FU17) [EC, 2010a]. The gear regulation would in effect force fishers from mixed nephrops métiers like 2 and 4, [see table 4.4], to the clean métiers of 1 and 3. It would force them to specialise on nephrops, reducing their resilience even further.

Elements of that plan would be at odds with the strategies of the fishers researched in this case study. Because of the low market value of nephrops, targeting bycatches of anglerfish, ray species, and some whitefish was considered an essential part of their strategy by some interviewees. These extra landings added economic stability to their operations. Banning multi-species nets (one of the options in the plan) would derail the planned activities of fishers, possibly causing them to react irrationally, a warning highlighted by Abernathy [2010, p. 116]. They could for instance land bycatch illegally in their quest to make a living, as has happened in other European fisheries [Daw and Gray, 2005]. For the mandate to be successful the affected fishers would need help in finding alternative income (*e.g.* institutional assistance to help them get a higher price for their nephrops landings). Days-at-sea schemes have already been shown to be one of the primary concerns of fishers. Interviewees said that if one is to be introduced on the west coast of Ireland it must allow them enough time at sea to make a living and it must not prohibit young fishers entering the fishery because of a lack of track record.

The potential of reducing fishing effort through integrating fishers' strategies into fisheries science and management should be attractive to all involved

actors. The opportunity their consideration offers to progress towards socio-cultural sustainability should also encourage the acceptance of fishers' knowledge, especially for fishing industry institutions and the public dwelling in coastal communities. Again though, the results may provide the most added-value for those in the epistemic community who have previously resisted fishers' knowledge. Instead of arguing with industrial representatives over TACs, scientists and managers can formulate management plans that fishers would readily be open to accepting, because they did not prevent them achieving their livelihood goals. Fishers' strategies are discussed again in terms of the overall integration project for fishers' knowledge in chapter 5.

A postscript to this section is addressed to practitioners of fishers' knowledge research. Research in the field has ordinarily focussed on elder and retired fishers, because they have the most historical knowledge. Future research however, should put equal emphasis on young fishers. Strategies, because they are predominantly a forward looking knowledge, are an area where young fishers effectively know more. They have longer left in the fishery and therefore are more prone to reflecting on potential changes to their future fishing practices.

4.4. Fishers' hidden social capital: their ability to be fisheries managers

Stakeholder engagement is becoming a requisite part of the policy forming process as fisheries management devolves from a hierarchical format to more participatory ones [Gray, 2005b]. With the recognition that EBFM necessitates the consideration of socio-ecological networks, state and European institutions are proposing that stakeholders should be included in decisions about how the ecosystems they live in should be managed [DAFF, 2010; EC, 2010b]. There is a growing body of work that suggests stakeholders such as fishers are ahead of managers and policy-makers and have already commenced their own resource management schemes.

Fitzpatrick, *et al.* [2011] note that fishers can use their own knowledge to construct management plans for the fisheries in which they operate and do not need to rely on scientific data. In fisheries science literature this is

called 'reversing the burden of proof'. The forming of a plan involves fishers referring to their experiential knowledge and is thus the same cognitive process as is used to formulate strategies. Fishers' ideas for management are equally part of their knowledge. Ostrom [2000a] identifies the product of fishers cooperating to mutually agree rules and solve dilemmas as their "social capital".

The creation of the proposed management plan for nephrops in ICES zone VII seems not to have involved significant input from Galway and Aran fishers [EC, 2010a]. As discussed in section 4.3 this could lead to conflict between them and managers. Leleu, *et al.* [2012] found in their French case study that where bottom-up approaches involving fishers participation were used to design MPAs, then acceptance was higher. Gerhardinger, *et al.* [2009] found the same in their review of Brazilian MPA governance. Within Ireland itself, fishers contributed management ideas whilst working collaboratively with academics and Marine Institute scientists to manage Celtic Sea herring [Fitzpatrick, *et al.*, 2011]. The researchers involved in that project identified the FU17 nephrops fishery as another location where fishers may be able to reverse the burden of proof. The findings in this section show that was indeed the case. Fishers' management suggestions for the FU17 fishery and those neighbouring it are listed in table 4.7 (overleaf).

None of the ideas seem outlandish and all would appear to be effective ways of either promoting ecological or socioeconomic sustainability, or both. The level of support for restrictions on twin-rigging and the implications of it have already been discussed in section 4.3. Likewise, suggested effort restrictions (in the form of pot number limits and temporal weekend fishery closures) have been implemented previously by scientists and fisheries managers elsewhere [Coles, *et al.*, 2008; Linnane, *et al.*, 2010]. Both would reduce mortality of fish stocks and the latter would also contribute to ensuring cultural sustainability by increasing community spirit.

Table 4.7. Management ideas suggested by interviewees for the Galway and Aran region's fisheries.

	Proposed management regulation	Reasoning
Effort Restriction	Ban fishing on Saturday and Sunday	Fishing has become a 7-day-a-week occupation. Likelihood of overfishing would decrease with less effort. Fishing would be more enjoyable if there was time to rest.
	Introduce pot limit and potting season	Too much effort in inshore fishery causing species to decrease in number and average size.
	Decommissioning should be permanent	Some fishers had been paid off, but then re-entered the fishery in bigger, newer boats. Had caused effort to increase dramatically. Seen as socially unjust.
	Introduce compulsory v-notching of lobsters	Would protect stock from depletion.
Alterations to Gear	Mesh size increase for nephrops nets	Current mesh size for most is 80mm. Increasing to 90mm would allow smaller nephrops to escape. Discards and bycatch would be reduced.
	Mesh size increase for whitefish/flatfish/prime fish nets + ban dual purpose nets	Current mesh is c.90-120mm. Larger mesh (<i>e.g.</i> 180mm) would allow juveniles to escape and grow to breeding age. Discards and bycatch would be reduced.
	Ban all gillnetting	Ghost nets continue to catch fish after they are lost. Ecologically bad.
	Ban twin-rigging	See section 4.3.
	Ban netting for crayfish	Technique is too effective and has caused the crayfish population to collapse.
MPAs	Close individual ecosystems (<i>e.g.</i> Back of the Island, Northwest Corner) to otter-trawling when nephrops are spawning	Hard to market nephrops with green heads (the colour they go when in berry/spawn). Should be allowed to breed.
	Close individual ecosystems (<i>e.g.</i> Back of the Island, Northwest Corner) to otter-trawling when nephrops have soft shells	When nephrops have soft shells their value decreases. Some fishers did not see the point in using quota when price was sub-optimum.
	Ban otter trawling and dredging on inshore grounds	When fishing had started on grounds like Northwest Corner, species like cod had disappeared rapidly. Inshore grounds are also nursery grounds, so should be protected. It prevents potential potting opportunities, which would support more jobs.
	Close all spawning grounds and fish nurseries	Juvenile fish must be protected as they are the future of the fishery.
	Ban twin-rigging on inshore grounds	Populations on Northwest Corner, North Sound and the Slate are too small to sustain an intense fishery.
Marketing	Create local ecolabel or get Marine Stewardship Council (MSC) certification	Would achieve higher price for landings, therefore needing to catch less overall.
	Build a central fish market	Not enough competition (<i>i.e.</i> fish buyers) in Ireland's dispersed ports which causes prices to be depressed compared to global averages.
Broad policies	Abolish all subsidies	There were some large boats in the fishery that had been heavily subsidised, but were not profitable. Stocks were being depleted for no socio-economic gain.
	Introduce co-management	Policies will work better if fishers manage their own fishery.

Talking to fishers through a map during interviews allowed fishers a rare opportunity to identify specific areas where they would like to see spatial restrictions on effort, including closures. The spawning grounds and fish nurseries marked on figures 4.1 and 4.2 were all suggested as potential permanent or temporal MPAs. The suggestion of closing nephrops

stocklets to trawling while the prawns in that locality are in berry¹⁶⁰ appears scientifically valid, as one scientific study concluded that trawling causes loss of eggs from females [McQuaid, *et al.*, 2009]. Indeed, a Scottish fishery achieved ecolabel status for its product through stating in its management plan that no berried females would be landed [Mason, *et al.*, 2002]. Therefore, it makes potential economic sense (because of the higher price that can usually be achieved for ecolabel products) as well as ecological sense. Some interviewees actually suggested themselves that they should try and achieve ecolabel status for their products¹⁶¹. The fact that their ideas for environmental management are ones that have led to other fisheries achieving this status is added evidence that their ideas would be appreciated by managers, environmental NGOs and the general public. The existence of such knowledge should break down conceptions that fishers are plunderers of the sea and reveals that they could actually be partners in conservation.

It would be naive to use the results in table 4.7 to state that fishers are green champions. As in the case of a potential twin-rigging ban, some of the sample, especially fishers-for-volume disagreed with their colleagues. However, neither should it be said that management ideas are limited to a small minority of fishers. In addition to the support for twin-rigging restrictions 71% (N=14) supported increases in the mesh size of nets and 24% (N=25) were in favour of introducing MPAs fully closed to fishing, with another 48% (N=25) open to the idea of MPAs that were only closed temporally or to certain types of gear. Only 28% (N=25) were against MPAs of any form.

Despite the identification of the FU17 fishery by Marine Institute employees as one where the burden of proof could be reversed, during feedback they showed surprise at some of fishers' management ideas. This partially explains the feelings that fishers conveyed during interviews. They were frustrated that they could not find an audience amongst the Irish scientists

¹⁶⁰ See glossary: berry.

¹⁶¹ It should be noted that other interviewees were more sceptical of ecolabels. They would only put effort into achieving certification if a higher price could be attained for their product, but they were sceptical over whether that value could be gained.

and managers for their social capital. They were also frustrated at the epistemic community's preference for focussing on ecological issues such as discarding and overfishing, when they believed the real problems in the fishery were socioeconomic issues and policy ones that prevented them from fishing sustainably:

F7: Well us here being from the Aran Islands, our prawn ground is like that. So that was our bread and butter. That was really where 90% of the Aran fleet was paid, there. Now, I've gone into the Marine Institute maybe six or seven weeks ago, looking to manage that. I don't care what's going on here, there, anywhere. I want the local fishermen to manage that.

F26: We might be only 20% of the problem, whereas we may be 100% of the solution if it was worked out.

N25: BIM were very good going back years ago, but in the last couple of years they haven't been very helpful to the fishermen. Going back to the '80s and '90s BIM were very good to fishermen, but lately they've kind of turned a blind eye. You see BIM have gone away from building boats and all this like. Maybe where BIM should be going is into the marketing of fish. Do something about where the markets are.

This frustration is not isolated to this case study. Despite the language in policy proposals (e.g. the reform of the CFP), fishers elsewhere have also become frustrated at the lack of institutional support. The North Sea RAC, frustrated at waiting for a scientific long-term management plan for a nephrops fishery, wrote its own proposal [NSRAC, 2010]. Additionally, fishers asked to take part in fishers' knowledge research in the UK, which had MPA discovery as its goal¹⁶², withdrew some of their support for the project when they found they were not able to comment fully on where the MPA sites should be [des Clers, *et al.*, 2008].

However, feedback in interviews was not that fishers wanted to embark on a course of self-management, (which should discourage those pushing a radical form of fishers' knowledge). They had attempted to agree rules for the fishery in the past, but it had not worked¹⁶³. They were reluctant to force rules on colleagues who did not agree with them, but thought that with help they may be able to introduce some management for the common good of the fishery. Of those who commented (N=21) 81% would have chosen to

¹⁶² The aim of the study was to collect fishers' ecological and operational knowledge, which scientists and managers could then analyse before they chose potential MPA sites.

¹⁶³ Members of the Galway and Aran Fishermen's Co-operative had tried to agree on a proposal to increase mesh size in their nets, but the majority had disagreed with the proposal during an open meeting.

work with BIM as a partner agency in management. Generally, they were more suspicious of the Marine Institute, because they had only irregular communication with them and they had viewed them as the source of some top-down legislation which had harmed their livelihoods. They were strongly against working with the DAFF who they saw as being aggressively against the interests of the fishing industry.

The realisation that fishers do not necessarily want to take the lead role in mobilising their knowledge has implications for this research and the wider integration of fishers' knowledge. It is worth highlighting one sentence from fisher 21's quote in section 3.4: "We tell you [researchers] and you take it from there, you know what I mean?" It is also worth remembering the findings of section 3.3, where it was shown how fishers could directly generate some hypotheses themselves, but others could only be generated from their tacit knowledge using the expertise of the researchers on the *Irish Fishers' Knowledge Project*. It seems clear that if fishers' knowledge is to be fully discovered and conveyed to scientists and managers like those at the Marine Institute and DAFF, then fishers' knowledge researchers may need to become full-time actors in fisheries research. They may be the only actors working in fisheries management with the skills necessary to discover tacit knowledge and to identify how fishers' socio-ecological knowledge also influences their strategy and contributes to their human capital. This finding is discussed further in section 5.4 and the concluding chapter 6.

More communication is needed with the Galway and Aran fishers if their social capital is to be used for the common good. They have the software (in the form of management ideas that would promote ecological and socioeconomic sustainability) for collaborative co-management. However, they do not have the hardware (*i.e.* the legislative capability and the institutional support) required to physically manage their fishery. Scientists may have more faith in their management plan for nephrops in ICES zone VII, but this top-down directive could destroy the social capital that exists locally, as has been the case when actors of the Irish state have to some extent failed to engage bottom-up with various environmentalist groups who have an interest in becoming involved in environmental management

[Flynn, 2007]. If this capital was lost in the fishing community then any chance of actually managing fisheries successfully could well be gone. For this reason, integration of fishers' management knowledge seems preferable for the epistemic community.

4.5. Institutional paralysis: the final obstacle to fishers' knowledge?

The ultimate finding of chapters 3 and 4 is not to do with whether Irish fishers actually have knowledge. Nor is it to do with how any knowledge they do have can be collected and rendered. What it is to do with, is how fishers' knowledge is constituted. Irish fisheries scientists and managers have ordinarily privileged hard scientific data, especially of the ecological variety, over the softer data that makes up most of fishers' knowledge.

The findings in chapter 3 show that Irish fishers have novel knowledge of fish stocks at scales that current scientific assessments cannot accommodate. In section 4.1 it becomes clear that fishers' ecological knowledge could be used to identify a shifting baseline on the Irish west coast that the epistemic community seems almost unaware of. Narratives of fishers seem an obvious compliment to EBFM, able to fill the information gaps within incomplete scientific records. They can be mapped and partially quantified, producing outputs which can be easily understood by scientists, managers and stakeholders within the general public. Sections 4.2 to 4.4 provide evidence that an opportunity exists for fishers' knowledge to become a pillar of a broadened fisheries management paradigm. Accessing of fishers' socio-economic knowledge, their strategies, and their social capital could allow fisheries managers to escape the pitfalls of reactive management. Instead of having to defend their decisions to fishing industry and environmental lobbies, they could work with fishers to proactively design workable legislation. Where fishers' social capital is hidden, fishers' knowledge research could be the precursor to mobilising it in the management process. Influenced by fishers' knowledge and desires, the legislation would likely be socio-economically palatable to fishing communities like the Galway and Aran one.

Yet, almost two decades after Daniel Pauly noted that the inability of population ecologists to listen to fishers' anecdotes meant they could not identify shifting baselines, and a decade after Robert Johannes warned biological scientists that if they failed to listen to fishers' knowledge they would "miss the boat", little of the kind of knowledge championed in this case study is used in scientific assessments of fisheries. In spite of policy-makers' commitments to greater participation in fisheries management there seems to be little integration of anything close to the fishers' knowledge described here. Structural and ideological inertia of institutions within the epistemic community may be to blame for the continued isolation of fishers' knowledge, which it seems is not getting the symmetrical treatment to scientific knowledge that McGoodwin and Neis [2000] say it deserves.

Nothing will change until Clonakilty changes. [Fisher during feedback session for *Irish Fishers' Knowledge Project*]

Clonakilty is the location of the DAFF's fisheries administration. Almost uniformly, interviewees described their experience with this department as negative. The anecdotes they told of interaction with state officials were of occasions when they had been subject to top-down state control and coercion. Particularly upsetting for them was the perception that the DAFF was not working to support the fishing industry. They believed the department's strategy for reducing effort in the fishery was to put fishers out of business, by criminalising them for fisheries infractions if necessary. Whether this is the motive of Irish fisheries managers or not, it certainly shows the working relationship between fishers and the state agency is not one conducive to the activities of participatory research and co-management.

In chapters 1 and 2 it was identified that Canada may be one of the leading locales for the conducting of fishers' knowledge research, and for the integration of any resultant findings into fisheries science. This view is further supported in chapter 5, where the relative success of Canadian fishers' knowledge research and the partial integration of its findings are attributed to the introduction of state policy which mandates participatory research and bottom-up co-management. Irish and European actors (e.g.

the Marine Institute, the DAFF, ICES, the EU) have attempted to do the same by setting up and supporting the RACs, but these institutions do not seem to have been able to promote the type of fishers' knowledge that this thesis has found to be valuable.

Firstly, the RACs role has been one of responding to scientific advice, not of imparting their own knowledge. Complaints levied by the NWWRAC to DG MARE and the Commission are of concern with the lack of opportunity to contribute to science and management. In particular they are frustrated at the lack of engagement over ecosystem health, gear operations, and socio-economic issues [Lambourn, 2007; 2010]. Without a change in their role, the RACs will not have a chance to impart the richest parts of fishers' knowledge.

Secondly, the structures of the RACs themselves do not allow them to collate the knowledge of the fishers they supposedly represent. The fishers of Galway and Aran complained that their union representatives were not always able to support their strategies or voice their ideas. For this reason, many of the interviewees had opted against unionisation. Both Lordan, *et al.* [2011] and Hoare, *et al.* [2011] noted that the Irish union heads were more inclined to support Marine Institute programmes that involve fishers in data collection than the individual fishers who were supposed to take part in them. This is perhaps because whilst the representatives are restricted by the RAC's remit of commenting on scientific data, fishers would rather convey their own views on the state of the fishery. The top-down scientific surveys do not allow them this opportunity. Furthermore, union representatives are not able to speak on behalf of all their members (as has also been the case in Denmark [Christensen, *et al.*, 2007]), either because their individual interests conflict or simply because it would take too much time to voice every narrative and idea [Griffin, 2007]. It is unrealistic to expect the four Irish representatives on the region's RAC [see NWWRAC, 2011b] to take to each meeting the individual narratives collated here. To have at your fingertips, ecological and socio-economic knowledge at the smallest scales and from over half century for even just the Galway and Aran fishery is impossible. A smaller scale of representation may need to be found for fishers where their individual narratives can be heard. If not,

future regional efforts to collect data and manage fisheries collaboratively, such as the GEPETO project¹⁶⁴ [CCR.S, 2010], will likely fail because they lack the detail necessary to ensure that the management decisions taken are the correct ones. For fishers' knowledge to be effectively mobilised in projects like GEPETO, management must be operationalised for the smaller scales at which many fishers operate (e.g. at the FU level for nephrops fisheries).

In this chapter the gradual rise of Irish EBFM has been charted and it shares common structural ground with fishers' knowledge, making them a reasonable fit (e.g. similar scales, their more qualitative nature). Some of the barriers raised to the integration of fishers' knowledge by Marine Institute fisheries scientists could well disappear with this rise. However, if the rise of EBFM is an illusion, simply lip service, the barriers are likely to remain in place. Old habits appear to die hard. Conflicts within ICES show that some fisheries scientists still prefer population ecology [Wilson, 2009, p. 195] and MSY continues to be the focus even in an ecosystem approach [ICES, 2011a]. An addiction to precision has left qualitative and subjective data outside of the paradigm [Hauge, 2011]. The most notable example of institutional paralysis towards adopting fishers' knowledge in the context of this case study is perhaps found in a previous study in the Galway and Aran region. An excellent study by a Marine Institute employee recognised fishers' knowledge¹⁶⁵ in the region [Meredith, 1999], including the example of how whitefish populations had declined. It also specifically stated that fishers have "strategies" within the fishery, finding that many were employing more intensive gear so that they could catch more nephrops. Finally, it identified the social capital within the fishery, noting some fishers' desires to ban gear like twin-rigs. Yet, there is little evidence that this

¹⁶⁴ This is a project designed to assist the long-term fisheries management plans for European waters. A collaboration between the Southern Regional Advisory Council (RAC) and fisheries scientists, the goal is to create a marine atlas of shared knowledge and understanding that will be used as an information source when planning fisheries management. It will include "fishermen's know-how and practices". Whilst it will integrate fishers' knowledge, the scale of the management units it plans to consider are closer to the scale of a large eco-region than the local scales at which fishers' knowledge is abundant.

¹⁶⁵ Although this study does not use the term 'fishers' knowledge' or any of the variants listed in table 2.1, many of the interview methods used and the interdisciplinary approach taken are the same as those used by the applied social scientists conducting fishers' knowledge research.

information has played a significant role in the agency's *Stock Book* assessments or management recommendations.

It is argued here that fisheries scientists and managers should learn to adapt their worldviews to deal with the complex nature of fishers' knowledge. Continued attempts to manage fisheries without fishers' knowledge simply because it does not fit traditional science models may not just be arrogant, they may also be naive. A source of novel data that could greatly improve the management of fisheries is currently being wasted and/or lost. The risk for the exponents of fishers' knowledge identified in chapter 2 is that fisheries scientists and managers become preoccupied with integrating the other challenges to their discipline [identified in section 1.5]. In particular, the turn towards real-time management of fisheries may widen the gap between biological fisheries science and the newer socio-economic approaches to marine research. As catch data is calculated instantly, the institutional patience needed to interview fishers and process the outputs may evaporate.

Acknowledged also, is that fisheries scientists are not generally ideologically averse to the integration of fishers' knowledge. Some of the most positive feedback to our results was from Marine Institute employees. In feedback meetings they seemed particularly enthused by the idea that fishers were keen to work with managers to eliminate practices that they saw as damaging to the ecosystem (e.g. some twin-rigging effort). The positive reaction of those at an ICES conference to some of the results in this chapter and the potential inclusion of fishers' knowledge in EBFM [see sections 5.2 and 5.3] is added evidence of goodwill in the epistemic community towards fishers' knowledge research. The reason that biological scientists like those at the Marine Institute may not be able to find reasons to integrate it is because they are just that, biological scientists. Trained in hard scientific techniques, the narratives produced during open-ended interviews are a world away from what they have dealt with before.

However, they are coming close to recognising their potential. When analysing their research programme, senior Marine Institute scientists recognised that participatory research could allow them to "develop[...]

long-term management plans that integrate biological, ecosystem, economic, and social objectives” [Lordan, *et al.*, 2011]. ICES affiliates also recognised that through working closely with fishers they could collect purely qualitative information that started to explain why, rather than just how fishers changed their fishing patterns, and also allowed them to predict how these may change again in the future [Rihan, *et al.*, 2011]. Rihan, *et al.* [2011] go on to conclude in their discussion that limitations in integrating fishers’ knowledge may be scientists’ own. They note that not all of their colleagues enjoy dealing with fishers’ narratives, and that some only feel comfortable collecting it via highly structured questionnaires. They conclude:

It is hoped, therefore, that this information-gathering exercise will continue and evolve over time to become an integral part of the assessment process, complementing fisher information from other sources. This hope, however, will depend on an appropriate mechanism for delivery of the information at the correct time and in a format suitable for the stock-assessment procedures of ICES. [Rihan, *et al.*, 2011]

Success for the integration project for fishers’ knowledge could therefore be a lot closer than some of the results in this study and some other literature suggests, but what is needed to ensure this outcome? Discussion in chapter 5 and conclusions in chapter 6 outline a path to a full integration of fishers’ knowledge that would not compromise its content.

4.6. Summary: chapter 4

A number of findings were made in this chapter that strongly support the idea that a reformist integration of fishers’ knowledge is possible.

Firstly, it was found that fishers’ knowledge would be an excellent complement to Irish EBFM. The high quality of the historical ecological narratives of Irish fishers, and their ability to describe (and map) ecosystems at a fine spatial scale, proved that their knowledge could be an information pillar for scientists and managers employing the ecosystem approach.

Secondly, the concept of *fishers’ strategies* was described. Built from a combination of their ecological, socio-economic, cultural and operational

knowledge, these show how fishers intend to act in the future. Not only do their strategies explain 'how' fishers carry out their operations, but they also show 'why' they do. It was stated that this facet of fishers' knowledge is the only source of information scientists and managers could use to see not only how the fishery might operate in the future, but also 'why' changes may occur. It was speculated that by identifying fishers who wanted to fish-for-value, managers may be able to decrease fishing effort in a fishery, which would be a compelling reason for them to integrate fishers' knowledge.

Thirdly, hidden social capital was discovered to be an aspect of fishers' knowledge possessed by the skippers of the Galway and Aran fleet. It was found that they had many ideas for how to manage their fishery, mainly motivated by their desire to fish more sustainably, both from an ecological and socio-economic perspective. It was suggested that several fisheries actors would like to integrate this capital into their work in order to meet shared goals of wanting to achieve such sustainability (and this suggestion is explored further in chapter 5).

5. Fishers' knowledge: crossing the social and political barriers to acceptance

In the first chapter of this thesis, a number of new approaches to fisheries science were highlighted that could replace or reform the population ecology paradigm. Despite this apparent demand for change the fisheries science landscape actually remains relatively static, as can be seen in the Irish case in section 4.5. Natural scientists, whose tools are quantitative statistics and models, have retained their dominance as principle advisors to the managers of state and supra-state fisheries. However, criticism of their methods continues and a lively debate has ensued where the central issue is whether population ecologists should keep these privileged roles or indeed have any role at all.

The second chapter analysed and explained the concept of fishers' knowledge itself. The intellectual history of the idea was explored, with an important distinction made between reformist and radical approaches to interpreting and applying the knowledge. The latter variant was deemed to be an attempt to unseat the historically dominant, state-led, top-down, quantitative, natural science format of fisheries management. On the other hand, the former was seen as a proposal to augment and compliment the numerical data collection, calculations, and modelling of population ecology. Rather than being a confrontational challenge to the existing fisheries science, it was concluded that reformism was an effort to re-balance the sometimes excessive focus on reductive quantitative data with the rich qualitative anecdotes of fishers.

This fifth chapter builds on the findings of the case study of chapters 3 and 4, where institutional interactions with Irish fishers and their knowledge were introduced and discussed. Noted, were a number of institutional barriers to fishers' knowledge. The proposed moves identified in chapters 1 and 2, towards using fishers' knowledge in fisheries science, are meaningless if those who are empowered to decide what form fisheries research should take are unaware of its existence, or are opposed to its inclusion. Despite the two decades of discussion about the apparent value of fishers' knowledge, references to it and citations of it remain rare in

fisheries management and policy. Here, a broader analysis of fisheries institutions is made (*i.e.* one that extends beyond Ireland) and the implications of the political landscape for fishers' knowledge and its research are discussed. Where political or institutional barriers to the concept are found, they are deconstructed in order to assess why they exist and whether they could or should be overcome.

Essentially, this chapter considers further the feasibility of what Soto [2006] describes as an "integration project" for fishers' knowledge. Her excellent thesis undertakes a comprehensive review of fisheries management literature, outlining the disciplinary, institutional and cultural barriers to fishers' knowledge. She then analyses how these are structured, and which management approaches either enforce them or act to break them down. The basis for her research is stated as being a previous lack of focus on these barriers, the relationship between them, and on interactions between them and other discourses (beyond fishers' knowledge research). Specifically, she notes that sociocultural issues have largely been ignored (as I attested was the case in the third, primarily radical 'wave' of fishers' knowledge research), and so have been the roles and natures of the scientific and other fishery stakeholder communities. Their power to intervene in fisheries policy from the point of view of integrating fishers' knowledge is little explored [Soto, 2006, pp. 16-18]. I aim to supplement her findings through performing an institutional analysis that begins to address the further research needs she identifies in her conclusion; one that looks at how integration of fishers' knowledge could meet the goals of all stakeholders [Soto, 2006, p. 232]. Where she identifies the barriers, and which approaches to management either raise them or break them down, I investigate what specifically about the content of fishers' knowledge might be valuable to each management approach, and whether it is of enough value to break down further barriers to fishers' knowledge that would otherwise remain.

Integration of fishers' knowledge has been recognised by some as a way to empower fishers [Warner, 1997; Jentoft, 2005]. Such an act would necessitate a re-balancing of power elsewhere in the institutions managing fisheries and any challenge to the existing power relationships would be

considered dramatic. With a task of this magnitude, the question of whether the fishers' knowledge integration project is feasible becomes pertinent. Is either one of the reformist or radical projects even plausible? Would fishers' knowledge be compatible with the existing institutional setup? With a reformist vision of fishers' knowledge institutionally accepted, the very institutions that had accepted it would logically need to restructure to accommodate the information. What would those reformed institutions look like? If the radical variant of fishers' knowledge were accepted, would that require total abolition of current fisheries institutions? If so, what would replace them? Would such changes in the present day institutional landscape be possible, or even useful?

Also central to this chapter's mission, is to query who takes on the challenge of pushing fishers' knowledge to the fore as part of a potential radical or reformed fisheries management. Additionally, what are their apparent motives for taking on this challenge? So far in this thesis I have mainly talked about integrating fishers' knowledge as an information source. In this chapter I also ask the question, do fishers' knowledge researchers themselves need to become part of mainstream fisheries management? The evolution of the concept of fishers' knowledge described in chapter 2 shows that anthropologists and applied social scientists have made, and will continue to make, a case for its value. This is despite the evidence in chapter 1 showing that these academics have been peripheral in fisheries research to date. Surely more powerful, or at least more numerous and diverse actors are needed to champion fishers' knowledge for it to become mainstream? If challengers do step forward, do they have the power or powerful allies needed to succeed in achieving their goal?

In section 5.1 the nature of institutional landscapes is described. In particular, the reason behind why some actors become dominant is outlined. Also introduced is the idea of how scale is an important concept to consider when analysing fisheries institutions and their actions.

Sections 5.2 to 5.5 identify the institutions and actors who engage with fisheries and their management. They also define how they are constituted at each recognisable geographical and temporal scale. The knowledge produced at each scale will be described and then cross-referenced with its

owner's political power in order to ascertain whether it too is similarly empowered or disempowered. Any barriers to integration of an actor or institution and/or their knowledge will be identified.

Section 5.6 is used to evaluate whether the knowledge of the fisheries science communities has been challenged internally or externally, and whether any challenge brings with it a chance for fishers' knowledge to be widely recognised in fisheries management policy. If the integration of fishers' knowledge is deemed possible then it will be assessed whether this might be via a sudden Kuhnian paradigm¹⁶⁶ shift, or as part of a more gradual post-normative broadening of the existing paradigm.

5.1. Institutions and actors in fisheries politics: who are the knowledge brokers?

Institutions are found in any activity that has a socio-economic dimension, and actors either act from within them or in relation to them [Jentoft 2004]. Fishing, with its complex ties to different human actors and local as well as global markets is therefore predisposed to having multiple types of institution. Jentoft [2004] reminds us that too often it is said that knowledge is power, when really power is more often the ability to use any knowledge possessed. The amount of knowledge needed to make that power seem legitimate may be minimal. In the case of fisheries then, empowerment is not assured when an actor or institution thinks it has the knowledge to assess and manage a fishery, but when it also has the ability to use that knowledge to create fisheries management policy itself [Jentoft, 2005].

Experience beyond fisheries provides evidence that once an actor or institution becomes empowered, then it can be quick to dominate a paradigm. These bodies are defined by Haas [1989] as "epistemic communities"¹⁶⁷.

¹⁶⁶ A detailed description of what a Kuhnian paradigm is can be found in section 5.6.

¹⁶⁷ Haas [1989] used the case study of pollution in the Mediterranean Sea to identify how a community of scientists could coordinate their actions to influence national and international policy. A group of interdisciplinary scientists were able to take advantage of an area of uncertainty to advance their shared ideas of how

Shared and coordinated knowledge therefore allows a community to form, but for it to become epistemic it must be integrated by, or into, already powerful institutions (e.g. governments). The reason that scientific communities so often become epistemic communities is because their research usually coincides with government agendas of doing what is perceived as good by citizens [Haas, 1989; Weale, 1992]. Perhaps the largest incentives for politicians to empower scientific elites are the gains that can be made in respect to the associated economy-of-scale. Referral to a single actor or institution at a national scale achieves great savings in financial costs and time for a government. When the same elite begins to function within international institutions there are similar savings to be achieved by sharing the costs of research, as well as the additional bonus of being able to accumulate a larger consensual knowledge. International agreement often adds legitimacy to political decisions [Weale, 1992].

Once formed, epistemic communities are not just those who have had their knowledge empowered, they effectively become the knowledge brokers. Kuhn [1962] argues that in a paradigm, the orthodoxy (*i.e.* the epistemic community) do not legitimate their privileged position through continued production of scientific data. They do not need to. Their approach has already become that of the political elite, and therefore it is not challenged. Through their integration into the networks of power their lifeworld has become the same as that of governments. The result of this is that other communities do not necessarily have a chance to advance their knowledge. With no uncertainty perceived to remain, governments do not need to seek

marine pollution should be managed. By providing a coordinated response to an area of policy uncertainty, this scientific community was able to convince some Mediterranean governments of the need to empower their knowledge to solve the pollution problem. The initial success of the policies based on this scientific knowledge encouraged governments to learn the same principles and norms of the scientists. Consequently, their affiliation with scientific knowledge convinced them to appoint the same scientists who had produced the knowledge to powerful roles in government, especially in environment ministries. Having used their knowledge to achieve political power, the community of scientists was then able to influence other Mediterranean nations, who had initially rejected the scientific approach. They were also able to feed their knowledge into international governments such as the UN, which could then perpetuate their scientific ideals in its institutions. Finally, they were able to influence sectors of government beyond the environment by introducing policy that affected them. Those influenced included the departments of industry and tourism which oversaw the corporations and businesses who were the most active water polluters. These state actors lacked the shared ideas needed to solve the pollution problem themselves and thus could not compete in the policy arena with the scientific community.

other actors or institutions to solve problems. The knowledge of non-epistemic communities can only be empowered if the epistemic community decides to utilise it.

Weale [1992] and Wilson [2009] are amongst the commentators to identify fisheries management as one of a number of environmental disciplines where governments have followed the trend since the 1960s for installing groups of scientific experts into epistemic communities. As already detailed in chapter 1, it was population ecologists using quantitative techniques and models to assess fish stocks who came to dominate the paradigm. Both Weale [1992] and Wilson [2009] point in particular to the creation of the ICES as a key moment. The birth and spread of this epistemic community are explored further in sections 5.2 to 5.4.

The concept of a paradigm with a permanently dominant epistemic community is not unchallenged. In the very same work that he defined their orthodoxy, Kuhn [1962] himself describes how paradigms can shift. He outlines how scientific revolutions can occur when anomalies that are not explained by the accepted scientific knowledge cause a field of research to enter crisis. A new paradigm, whose knowledge better explains reality, could then take the place of the failed one. According to Sterman and Wittenberg [1999] these new paradigms are constantly being proposed, but will fail unless that which they seek to replace is experiencing a Kuhnian crisis. This implies that if alternative or non-scientific institutions had proposed to manage fisheries using their knowledge in the 1980s, then they would apparently have failed. However, as concluded in chapter 1, the scientific methods of population ecologists have come into question since the 1990s due to anomalous fish population collapses which they cannot explain. With the paradigm deemed to be in crisis, a shift should occur that empowers new actors and their knowledge as epistemic.

A paradigm shift is not a certainty though. There are other theories that challenge both the idea of Kuhnian paradigm shifts and those of unchanging epistemic communities. More recent thinking has stressed the

need to move away from the idea of static paradigms. Post-normal¹⁶⁸ thinking would instead allow for a more gradual change to occur, where paradigms are not replaced, but are constantly broadened to include multiple conceptual approaches [English, 2001; Wilson, 2009]. Research in other disciplines suggests that this paradigm broadening could take the form of an interdisciplinary approach that incorporated different knowledge cultures [see King, *et al.*, 2002]. These arguments relate closely to two critiques of the epistemic communities identified by Haas [1989]. Although they differ, both support the idea that actors and institutions outside of the epistemic community do have a role to play, even whilst the epistemic community continues to exist. Toke [1999] argues that interest groups beyond the scientific community can help to shape environmental policy with their own independent knowledge. They do not have to frame their own opinions in the empirical domain of those that dominate the paradigm. Dunlop [2000] builds on this in saying that the epistemic knowledge itself can be challenged. She does not subscribe to the stable knowledge system of Haas' [1989] dominant scientific community. Instead she describes a more complex network of actors and institutions where many interest groups can both question the accuracy of epistemic knowledge and propose additions or compliments to it. Meppem's [2000] "discursive communities" could be such a network, as they are 'institutions' where transdisciplinarity, reflection, and methodological pluralism are encouraged so that flexible policy outcomes can be found for ever changing sustainability issues.

These post-normal approaches can only exist if there is still scientific uncertainty, which is the case in fisheries management. The crisis of

¹⁶⁸ 'Normal science' can be understood in the context of Kuhnian paradigms. It is where most scientists within a discipline work in a similar manner because they share a view of how research should be done or about a scientific theory. This position will only change if their position is challenged by a new scientific discovery that contradicts the norm. Kuhnian normalist thinking then dictates that a paradigm shift will occur and the old normal position will be replaced by a new normal position that again most scientists agree upon. The concept of 'post-normal' science is more flexible than Kuhnian normal science. It does not assume that there is a right way and a wrong way to conduct research within a discipline, and it does not necessitate that most scientists operate in a similar manner. Instead, it is a concept that accepts that there is more than one way to approach research within a discipline and that there is scope to accommodate multiple scientific theories, even if some conflict. Post-normalism permits scientists of different beliefs or methods to work alongside each other to fill each other's knowledge gaps and/or to collectively formulate new theories [Funtowicz and Ravetz, 1990].

management described in chapter 1 and the uncertainties identified in the Irish *Stock Book* [see chapter 3] could also be interpreted as not a total failure of the paradigm, but as a partial failure of the methods of population ecologists. According to Wilson [2009] this is exactly the situation, with the scientists of institutions like ICES “overselling”¹⁶⁹ their ability to address all uncertainty simply through the use of positivist methods. The reality is they cannot describe entirely the nature of fish populations and interactions with them. Thus, rather than a total paradigm shift, it is also possible that the interest groups highlighted by Toke [1999] and Dunlop [2000] could become gradually empowered alongside population ecologists as they use their knowledge to solve uncertainties that the scientists cannot explain.

The task in this chapter of identifying the broad challenges to epistemic knowledge, and barriers to these challenges, is not as simple as just identifying the political actors and institutions involved. When considering which institutions and actors hold power over decision-making and of privileging knowledge typologies within a fishery, Griffin [2009] says it is important to consider the twin dimensions of scale and time. She notes that this is to be considered unusual when dealing with epistemic communities, where governments commonly attempt to erase space and time to make the position of their dominant institutions look normative. However, in her European case she shows that when considering fisheries it has been the ability to control these two elements that has represented power. Both the temporal and spatial scales at which institutions are interacting with knowledge are considered within the analysis in this chapter.

Griffin’s [2009] belief in the need to consider scale and time is supported by other work that shows these dimensions to be important in fishery operations. Fisheries have been defined as socio-ecological networks [Neis and Felt, 2000b, p. 20; Murray, *et al.*, 2005] and the variety of knowledge cultures that are at work within these networks operate at different scales from the global to the local [Perry and Ommer, 2003]. Any knowledge

¹⁶⁹ Their problem was that their official catch data was not always complete and was not always as precise as they advertised publicly. Even with efforts to improve their data collection (*e.g.* real-time monitoring of fishing effort and catches with satellites and computers), it is unrealistic of them to perceive that they can eliminate all uncertainty from fish stock assessment.

accrued in these systems is therefore also attributable to a scale, whether this knowledge is formed during fishing activities [Pálsson, 1995], the conducting of science [Rice, 2005], or the formation of management policy [Griffin, 2009]. Actors or institutions possess knowledge and thus the scale at which they accrue that knowledge is important. If accrued at a scale where the respective actor or institution is powerful, then that knowledge is much more likely to be that which is used for analysing all fisheries activities. The opposite is of course true for knowledge which is delivered at a scale where the producer or procurer is disempowered. This has already been shown to be the case in the thesis' case study, for instance where fishers' knowledge of nephrops habitats was of a scale below that used in some of the empowered Marine Institute's scientific surveys [see section 3.3].

Additionally, actions of those in socio-ecological networks, including knowledge creation, are temporal [Perry and Ommer, 2003]. As was shown in chapter 2, and in the case study in chapters 3 and 4, fishers' knowledge can vary from that accrued over decades to that produced in real-time. The same power relations are resultantly at work when considering timescales for fisheries management. Knowledges produced at a timescales that match those of decision-makers are likely to have an advantage when it comes to being empowered.

5.2. Nation-state governance

In this section a distinction must be made between the role of the state in developed and developing nations. Involvement in fisheries management in the latter has generally been to a lesser degree. These states have lacked the funding and institutional capacity to undertake scientific research or design and enforce policy. This has been especially evident in their larger-scale, offshore industrial fisheries [Christie, 2006; Mora, *et al.*, 2009]. The resultant paucity of state institutions has meant that scientific knowledge production has been rare in these regions, which can be said to be "data-poor" regions [Johannes, 1998]. In the developing world the state has therefore not historically been a notable barrier to the integration of fishers' knowledge.

As was seen in some of the ethnographic studies of chapter 2, local communities of fishers have been able to use their knowledge to self-regulate small-scale fisheries without a high degree of state coercion or collaboration [Gray, 2005a]. Anecdotal knowledge relating to any aspect of the fishery can be used, no matter what its spatial or temporal scale. Attempts to scale-up up this knowledge however, despite some promising work [Bavinck, 1996], have been problematic. In this scenario, fishers' knowledge in the hands of fishers has been far from able to solve all uncertainty in developing nation fisheries. It is probable that institutions above the scale of the community would be needed to empower fishers and their knowledge over a wider geographic area. The remainder of this section will assess whether this would be likely, or even possible, with greater institutional capacity. This will be done by looking at examples of developed world countries where such capacity is usually present.

One way to look at the developed nation-state is as a single actor that has dominated fisheries management. This is a dominance that has been legitimised through law. The United Nations Convention on the Law of the Sea (UNCLOS) empowered the state as the supreme arbiter in marine management [Jentoft, 2005]¹⁷⁰. Additionally, its power has been enshrined democratically. The responsibility of the state to its citizens means it has had to manage its environment sustainably and fisheries effectively for them [Gray, 2005a]. The evidence of this domination could be judged apparent through the ability that national governments have had to empower the institutions which have become the knowledge producers of the epistemic communities. During the 20th Century, states were the only actors with the funds and sufficient institutional capacity to employ people who had this level of authority [Wilson, J, 2005]. Those ordinarily chosen for the task have been the population ecologists who came to occupy national fisheries science institutions (e.g. the DFO in Canada, the Marine Institute in Ireland) [Gray, 2005a; Symes, 2007]. This scenario would be of a

¹⁷⁰ UNCLOS gives the nation-state jurisdiction over its territorial waters to a distance of 200 miles from shore in area called its exclusive economic zone (EEZ).

classically stable paradigm, occupied by a scientific elite who accounted for all uncertainty¹⁷¹.

If this were always the case then the task of politically integrating fishers' knowledge would be daunting. With few anomalies, government would not be seeking new knowledge to replace that of the scientists and the state would not try to empower actors or institutions that relied on fishers' knowledge. The only remaining possibility would be to convince the epistemic community's scientists of its need. This would be at least equally as hard, [for the reasons that can be seen in section 5.4].

It is overly simplistic however to look at the state as a simple unified actor. A second way to look at the involvement in fisheries management of the developed nation-state is as a looser, more complicated association. The reality is that the state is represented by a plethora of agencies, ministries, think-tanks and quasi non-governmental agencies (QUANGOs) [Symes, 1995; Mikalsen and Jentoft, 2008]. As in other disciplines [see Ikenberry, *et al.*, 1988], the nation-state's fisheries management apparatus can actually be viewed as a "black box" of actors and institutions which can be unpacked and analysed. Each of these is part of government, but retains the ability to react differently.

This reality means that it is not the actual government which has dictated the knowledge that has been empowered. Government is a centralised, singular unit and its actual role has been to de-centralise through selecting a system of governance which empowers multiple institutions and actors. These have then undertaken fisheries management and designed fisheries policies. Each of these has effectively been given the role of choosing which knowledge enters use [Gray, 2005a; Symes, 2007].

Splitting of power this way represents a significant opportunity for those who put weight in fishers' knowledge, as there is a chance that they can take a share. Where this may not be possible is when all agencies

¹⁷¹ It would be almost identical to that which Haas [1989] identified as controlling pollution policy in Mediterranean waters.

empowered by the state continue to interact solely with the epistemic community of population ecologists. This would maintain an inert paradigm that would prove a continuing barrier to fishers' knowledge and this is the case under the scenario that Gray [2005a] calls "hierarchical governance". De-centralisation in this form of governance is minimal with a small number of bureaucratic and scientific institutions of the state taking the lead roles in a top-down, command-and-control regime [Gray, 2005a]. Public sector scientists and bureaucrats produce science, provide advice and perform management for the ministries and ministers in charge of fisheries [Eno and Gray, 2005; Frid, 2005; Gray, 2005a]. On the face of it the barriers to fishers' knowledge here are no different to if there was a single state institution, an unmovable epistemic community of population ecology experts.

Fishers' knowledge is not scaled to fit the yearly or national outlook of departmental reports produced by population ecologists and civil servants. Instead it is accrued mostly locally and over irregular timescales. Its qualitative nature makes it too time-consuming to comprehend for busy government employees and ministers who find it more convenient to compare quantitative statistics in tables and graphs [Wilson, DC, 2005; Wilson and Delaney, 2005]. It is also alien to the lifeworld of political elites who have rarely been employed as manual workers in a primary industry. There is no incentive for state institutions to be creative and engage with new knowledge systems when they are successfully managing sustainable fish populations with few complications [Soto, 2006].

Until recently, hierarchal governance was pervasive in fisheries management. It is the system under which national institutions of fisheries science such as the Directorate of Fisheries Research (UK) and the Scientific and Technical Institute for Marine Fisheries (France) came to prominence. Also, it is the structure that has allowed the nation-state to dominate Europe's CFP. Politicians representing a number of European countries colluded to inaugurate the scientific body of ICES, which provides the majority of the population data for fisheries management in the region [Rozwadowski, 2002], as is detailed further in sections 5.3 and 5.4.

However, these stable networks are under threat and may already be consigned to history, because the status quo of hierarchical governance has come under pressure, not just from those it excludes politically and intellectually, but from within. State institutions are beginning to question their own legitimacy and that of their fellow state actors, as was seen within the DFO and Canadian government during the collapse of the northern cod fishery [see section 1.1]. Uncertainty in both the knowledge of the epistemic community and the validity of continuing to eschew other actors and their knowledges has led to state actors either working against or with each other to introduce new models of governance. It is the re-distribution of power that occurs during the switch to new governance regimes that potentially offers a share of power to fishers' knowledge, where pure hierarchical governance did not. With an increased number of avenues for integration of fishers' knowledge, it may be possible for its suitors to find actors that seem amenable to such a process, whilst avoiding ones that appear hostile.

It would be a mistake to say that the epistemic science community has not responded to the identification of scientific uncertainty, such as that which helped to precipitate the northern cod collapse [see section 1.1] and that which is also clearly evident in Ireland's *Stock Book* [see section 4.1]. The community now includes a broader scope of biologists such as specialists in EBFM, whose knowledge they have started to treat symmetrically to their own. The reasons and implications of this are explained further in section 5.4. However, population ecologists have certainly prevailed, as stock-assessment remains part of fisheries science in Canada [Lane and Stephenson, 2000; Rice, 2005] and is also the key method for assessing fishery health in other countries like the UK [Cefas, 2010b] and Ireland [MI, 2010]. The stability of nation-state fisheries departments like the science branch¹⁷² of the Canadian DFO is attributed by Lane and Stephenson [2000] to the fact that their occupants are highly specialised and are less likely to move horizontally between departments. Consequently, they maintain independence from other government departments, growing

¹⁷² The DFO's population ecologists operate in the 'Science' sub-section of the department. In total the DFO is constructed of six sub-sections [Lane and Stephenson, 2000].

internally and interacting more with the knowledge in their own corporate memory rather than with external knowledge.

Scientists who maintain total confidence in population ecology would likely be hostile to the integration of fishers' knowledge. An effort to target them in the hope that they would exert influence on their policy-making masters in the civil service and government could be a mistake. The existence of uncertainty in the results of population ecology does however open a door for fishers' knowledge. For the radicals of chapter 2 it presents a still available opportunity to challenge and unseat the epistemic community and replace them in the state fisheries institutions which they have continued to occupy. For the reformists of chapter 2 it highlights empowered scientists in national institutions who doubt their own knowledge and may be amenable to experimenting with fishers' knowledge. The possibility of both these scenarios is evaluated in section 5.4.

Civil servants and bureaucrats of the public sector represent a different challenge and opportunity to the integration project for fishers' knowledge. The institutions in which they sit are much less stable than those of science. Lane and Stephenson [2000] highlight that an inertia of personnel and thought is less evident, because these mostly non-scientific employees do move horizontally between departments that may be overseeing activities such as industry liaisons, budgeting, enforcement, policy formation, and communications. They maintain links with a diverse network of institutions and each time they make a connection it is an opportunity to integrate fishers' knowledge across the network.

For those looking for these opportunities it will be important to understand the institutional undertakings of fisheries management bureaucracy in each nation, which vary wildly. For instance, although the Canadian DFO does house the state's scientists, it also has a civil service staffed branch for policy and planning that looks at the economics and strategic aspects of the fishery [Lane and Stephenson, 2000]. It is reasonable to assume that a department such as this would not just have a demand for ecological advice, but also for socio-economic and operational data. The global case studies reviewed in chapter 2 and this thesis' Irish case study make it clear

that fishers' knowledge is rich in these kinds of data. It certainly seems like state actors could be enticed to integrate both fishers' ecological knowledge of spawning grounds and shifting baselines as a partner to EBFM [see section 4.1], as well as their strategies and human capital. Knowing why fishers fish and how they intend to fish would be of significant value to these bureaucrats planning the future of a fishery.

The political inertia noted in section 4.5 and that Soto [2006] describes in state-led fisheries science also appears less evident within the public sector. The UK's Department for Environment, Food and Rural Affairs (Defra) recently produced what seems like a dynamic plan for the future of fisheries management, which extends their role far beyond the activity of supervising population ecologists and implementing policy [Defra, 2007]. In *Fisheries 2027: a long term vision for sustainable fisheries*, they set a framework for policy development in which they reference paying an equal amount of attention to social and economic issues as to ecological ones. They also designated that this would in part be done through engaging with different stakeholders. Outlined are specific aims to engage with local as well as industrial fishers in a number of ways. These include designing more sustainable fishing gear, formulating management plans, and collecting or contributing fisheries data [Defra, 2007]. If they found in their engagement with fishers similar findings to we found in Galway and Aran they could go a long way to achieving their vision for 2027.

Any discovery in UK fisheries of, for instance, strategies that showed 'fishers-for-volume' looking to trade down to become 'fishers-for-value' would allow Defra to build bottom-up policy that helped to achieve both the ecological and socio-economic sustainability they aim for. UK fishers have similar management ideas to Irish ones [see Moore, 2003; NSRAC, 2010] and these could be included to give any management plan legitimacy in the fishing community, therefore encouraging fishers to act rationally (as Defra would surely desire). In particular, the references in *Fisheries 2027* to the scale of the local and the socio-economic context would appear to play to some of the strengths of fishers' knowledge, areas where they could perhaps contribute better information than empirical science could (e.g. Aran and Galway fishers' better knowledge of nephrops stock locations

[see section 3.3] and of the effect of onshore markets on fishing effort [see section 4.3]). It is too early to judge whether Defra's policy and similar international ones are merely rhetoric, or whether they will actually result in increased real-world engagement with marine stakeholders.

The institutional structure of the civil service also highlights different pathways for integration of fishers' knowledge. Within the Canadian DFO for instance, the population ecologists and bureaucratic elements report independently and directly to elected politicians [Lane and Stephenson, 2000]. The consequence of this is that whether non-scientific bureaucrats embrace fishers' knowledge or not, the epistemic scientists who are likely hostile to the concept will still get the chance to advance their knowledge to the ultimate policy makers in government. This presents a significant barrier to radicals trying to replace the epistemic knowledge, because they would have no chance of stopping the flow of this empowered information. The more likely option in the Canadian system is for a reformist approach where civil servants allied to fishers' knowledge could convince fisheries ministers that the two knowledges should be used together.

For radical advocates of fishers' knowledge, increased opportunity exists in the alternate structure of UK fisheries management, where the science body that performs population ecology feeds its research not directly to ministers, but via the civil service institution of Defra¹⁷³ who are permitted within reason to act autonomously, as is proved by some of their management actions. They were able to use their budget to decommission fishing vessels even though some politicians disagreed with expenditure in this area. This was partially because the wider implications of this management action still aligned with broader government policy [Brown, 2006]. If radicals could therefore persuade institutions like Defra to act as their agents and introduce a management plan based fully on fishers' knowledge, they could marginalise the population ecologists. Through building a strong alliance they could re-populate state fisheries science institutions with themselves as part of the new epistemic community.

¹⁷³ Senior civil servants at Defra are legislatively empowered by the minister in charge of fisheries to ensure that the output of scientists at the Centre for Environment, Fisheries & Aquaculture Science (Cefas) are appropriate for the management plans that Defra itself designs [Cefas, 2010a].

The radical approach may seem plausible in theory when dealing with agencies of the civil service, but the reality is far removed. A wholesale conversion of those at institutions such as the UK's Defra to sole reliance on fishers' knowledge does not seem likely to succeed. The networks that civil servants have built up still rely heavily on fisheries science, including population ecology. For instance, the same Defra document which sees a future where fisher inputs are part of fisheries management still awards primacy to scientific ecological data as the source of information for the task. It specifies that integration of fishers' knowledge would be through the existing scientific community [Defra, 2007]. Strong alliances exist between the non-scientists and scientists in the public sector and they will not be broken. Although they may sometimes have disagreed with the other's views or actions, as was the case within the Canadian DFO after the collapse of the northern cod fishery [Hutchings, *et al.*, 1997]¹⁷⁴, their relationship of epistemic reinforcement pervades.

The alternative for radicals is to wait for a shock that sends the established paradigm into crisis. Such events are not unknown. In the UK, successive disease outbreaks in livestock (of BSE and foot-and-mouth) triggered a crisis of confidence within the institutional networks of agricultural policy-making. The Ministry of Agriculture Fisheries and Food (MAFF) had overseen an era where the interests of industrial agriculture were their priority. Any science conducted on its behalf supported that vision. Resultantly, it did not have access to the necessary expertise to deal with the public health scare (BSE) and rural conflict (foot-and-mouth) that the diseases caused. With its reputation irreparably damaged, the UK government replaced the institution with a new one, Defra. With a broader rural remit, rather than simply agricultural, Defra has moved focus from agricultural efficiency towards environmental issues, public health, and animal welfare [Van Zwanenberg and Millstone, 2003; Winter, 2003]. As the CFP is heavily criticised [Daw and Gray, 2005], radicals may hope that it

¹⁷⁴ The scientists of the Canadian DFO believed that the eventual output of their institution was being filtered by bureaucrats. They wanted to blame overfishing for decreases in cod populations, but with this seemingly deemed to be politically sensitive, it was omitted. Views popular with fishers, but contested by scientists, that seals and environmental change were to blame for fish mortality, were not expunged [Hutchings, *et al.*, 1997].

collapses like the MAFF did when it was under pressure, leaving space for them to substitute it with a policy based on fishers' knowledge.

Is this really a solution however? Waiting for a collapse could mean waiting a lifetime, because such events occur by chance. What is more, a policy such as Europe's CFP is more robust than the UK's MAFF, because it is held in place by multiple governments rather than just one. Even if the CFP was to be replaced, there is no guarantee that the visions of radical exponents of fishers' knowledge would replace it. As was shown in section 1.5, there are many others waiting to step into that void.

Instead, a reformist approach in which those favouring fishers' knowledge take advantage of the connections between civil servants and epistemic scientists may be more successful. The willingness of civil servants to introduce and promote alternative approaches, including fishers' knowledge, is increasingly evident. This is exemplified by the case of a senior employee of the UK's Defra and a colleague of his from the Canadian DFO¹⁷⁵ convening a theme session entitled *Communication and Knowledge Management* at the recent *ICES Annual Science Conference* in 2010¹⁷⁶ [see ICES, 2010]. The content of this session is summarised in this quote:

Perhaps the strongest message from the session was the increasing emphasis that is being put on engagement with the fishing industry and other stakeholders: over half the papers addressed case studies involving various ways to do this. Such engagement is valuable in enabling the development of better knowledge to inform policy, and also in ensuring that researchers, fishers and other stakeholders are better informed when engaging with fisheries policy making and in making their own operational decisions. It brings a new focus to research and data analysis activities, requires new approaches and modes of communication, and extends the scope of the relevant science. [MariFish, 2010, p. 4]

A qualification should be made however when considering bureaucratic actors as conduits for the fishers' knowledge. Like the state's scientific

¹⁷⁵ The session was co-convened by John Lock (Defra) and Pierre Pepin (DFO).

¹⁷⁶ Attended by scientists and civil servants from various national institutions, the session allowed some presenters (including this author) [see Hind, 2010; Massé, *et al.*, 2010; Rossiter, 2010] to show how fishers' knowledge could be used as a compliment to existing fisheries research. A summary report of the session, also authored by Defra staff, shows the consensus opinion of most participant actors was for the inclusion of fishers' knowledge in scientific activity [MariFish, 2010].

organisations they also tend towards operating at national scales. Most of their management and policy is designed for this large scale and it may again prove difficult to summarise fishers' mostly local knowledge in the reports of these institutions. A chance that this may not be a barrier is a recent commitment by these institutions to more regional management, like in Canada and the UK [Rice, 2005; Defra, 2007, p. 9]. If this becomes a policy trend in all nations then this could open up opportunities for fishers' knowledge.

The final institution of the state to which extensive consideration must be given is that of elected government, in particular fisheries ministers. How can they be influenced by the other state actors? Clearly the knowledge of population ecologists has exerted influence on politicians. This is most apparent when viewing the readiness of politicians to enforce top-down coercive quota restrictions for fisheries which have been recommended by their nation-state scientists working within institutions such as ICES [Karagiannakos, 1996]. Changes in the civil service have also seen ideologies move up the command chain. A change in public sector structure in the UK, where the mandated advisory body for fisheries changed from MAFF to Defra, saw a change in policy direction. Rather than just focussing on fisheries as simply a resource, the minister was impelled to introduce environmental concerns. The more interdisciplinary nature of the new department was also reflected in the borrowing of subsidy policies from agriculture [Brown, 2006]. Referencing the Irish case study findings in sections 4.3 and 4.4 it is possible to theorise a scenario where incoming civil servants could look to take advantage of human capital in a fishery. They could advise politicians to subsidise fishers whose only barrier to trading down and fishing more sustainably is a debt that prevents them selling a boat more suited to a fishing-for-volume strategy. In summary, ministers could decide to include fishers' knowledge in policy if they are influenced by advisors affable to the concept.

The power of politicians and ministries to act autonomously as actors or institutions should not be underestimated. Civil servants and scientists do not share the electoral mandate of the populous that a politician has. The results of their policies for fisheries management must be politically

acceptable. The total collapse of the northern cod fishery would have upset not only fishers and those who make their living from the fishery, but also great proportions of the national electorate who like to be surrounded by healthy natural environments and thriving coastal communities. If politicians can thus be convinced that new information such as fishers' knowledge can prevent politically unacceptable occurrences, then there is a chance to bypass the epistemic community of scientists and speak straight to policy-makers about its value. Fishers' strategies could be particularly appealing to politicians because of the novel opportunity they offer to deliver more ecological, socio-economic, and cultural sustainability [see section 4.3].

Politically unpalatable crises are not the only trigger for policy shifts. The ideological fingerprints of elected parties and officials also cause them to act of their own volition. Brown [2006, p. 9] tells how the personal inclinations of ministers in charge of fisheries has led them to favour policy that either favours an expanded fishing industry or in contrast, a restricted fishing industry with more emphasis placed on environmental concerns. Ideologies of elected politicians can of course change and this is especially the case if they come under electoral pressure. Lobbying and public opinion could also induce a new policy approach [see section 5.5]. A review of recent developments in fisheries shows that a combination of both crisis and ideological change has seen governments act to move from hierarchical to other forms of fisheries governance. With these changes come new barriers and openings for fishers' knowledge.

The first shift in governance was to the "market governance" also identified by Gray [2005a]. From the 1970s onwards governments increasingly started to follow neo-liberal ideologies. This period coincided with an anticipated "tragedy of the commons"¹⁷⁷ crisis, where it was perceived that fishers without ownership rights would overexploit fisheries for short-term financial gain [Jentoft, *et al.*, 1998]. Epistemic scientists from within Europe's nation-state funded ICES proposed the idea of ITQs

¹⁷⁷ Hardin's [1968] seminal paper described a "*tragedy of the commons*" where multiple users acting independently for short-term self-interest deplete a resource to extinction or near extinction. The theory leads to the argument that with shared long-term interests a renewable resource would be managed sustainably by its users.

[Rozwadowski, 2002], which as an economic instrument of free-trade appealed to most developed world governments.

Later governance shifts have been less centralised and are all moves towards Gray's [2005a] final format of "participatory governance". Again the changes can be attributed to crises and changing political ideologies. The difference in these cases, are that for the first time the state seems to be reflecting on its own limitations. In particular it appears to be questioning whether its own scientific institutions and civil service agencies can solve fisheries problems independently of external actors.

The continued crisis of quota management and a new social crisis of overfishing¹⁷⁸ have coincided with what could be considered as a further crisis of political legitimacy. Citizens (or stakeholders in a resource) are no longer content for the management process to lack transparency. They want it to be open and they want to be involved. Likewise, the rise of an environmental consciousness with its associated protests has led to the creation of NGOs who demand a say. This politicisation of the resource cannot be satisfied by the epistemic scientific community who traditionally have neither been transparent nor represented resource users [Wilson and Delaney, 2005]. The response of the state has been to instead devolve decision-making to all stakeholders, including fishers, to close the perceived "justice deficit" [Hernes, *et al.*, 2005]. Here, the state does not exercise its political legitimacy through election, but instead through participation of stakeholders in the fishery. In theory it permits stakeholders to collectively exercise their knowledge, communicate, and influence policy [Gray 2005a]. It has attempted to achieve as wide a representation as possible by opening up governance to actors from new disciplines from outside of government and below the national scale [Jentoft, *et al.*, 1998; Lane and Stephenson, 2000].

¹⁷⁸ A social crisis has occurred in the last decade in the once thriving industrial fisheries of the developed world [Coffey, 2005]. The collapse of the northern cod fishery led to direct job losses for tens of thousands of Canadians, which incurred significant on-going costs in terms of welfare payments for the federal government [Finlayson and McCay, 1998; Kurlansky, 1998]. Rising costs of diesel and falling prices for fish commodities also led to extreme financial hardship in the European fisheries [Brown, 2006].

The involvement of new actors and the introduction of new disciplines presents a myriad of new chances to attempt to integrate fishers' knowledge. Firstly, newly empowered actors with allegiances to the social sciences are likely not to be hostile to its inclusion. Secondly, non-state actors could influence already empowered state actors that the concept is a good one. Thirdly, and perhaps most promising, is that fishers themselves could become empowered at multiple geographical scales and have the best opportunity yet to inject their experience into science and management. Care should be taken over the nature of engagement with these potential allies however, as they could also prove to be detractors and therefore enemies of fishers' knowledge.

Most of the state's moves towards participatory governance have commenced through the implementation of co-management. This has not represented full devolution of power to all stakeholders as it has only brought fishers into power sharing arrangements with state institutions, but for this reason neither does it appear to be a barrier to fishers' knowledge [van der Schans, 1999]. The goal is to mutually and equally decide on how a fishery should be managed [Jentoft, 2003; Gray, 2005a; Jentoft, 2005; Rice, 2005]. The management ideas that Galway and Aran fishers had for their fishing grounds [see section 4.4] is surely the kind of information that those looking to co-manage fisheries would look to integrate.

When the Canadian minister dissolved CAFSAC as a response to its failure in the northern cod crisis, it was to co-management he turned. He set up new government institutions and QUANGOs to conduct science and consult with the fishing industry [Rice, 2005]¹⁷⁹. These were mandated to take into account regional variation, as the focus on the cod stock as a national entity meant that local indicators of population collapse had been missed. They were also mandated to incorporate the experiential knowledge of fishers, because this was the knowledge that had warned of the collapse, but which had been ignored [see chapter 1; Neis, 1992; Rice,

¹⁷⁹ The Canadian Science Advisory Secretariat (CSAS) was created and mandated to conduct smaller scale regional fisheries science, whilst the Fisheries Resource Conservation Council (FRCC) was set up to consult widely with the fishing industry on management options and then report directly to the Fisheries Minister [Rice, 2005].

2005]. The global trend towards such participatory governance has been comprehensive, with many developed nations (e.g. the USA¹⁸⁰, the Netherlands¹⁸¹) adopting similar institutional frameworks so as to increase fishers' participation and in some cases to invite them to contribute their knowledge [Hall-Arber, 2005; van Ginkel, 2005].

In contrast to the goals of this approach, the actual integration of fishers' knowledge under the approach seems to be close to nil. Even though fishers have managed to get a seat at the table of management, they have not necessarily been empowered to decide management policy. Rare have been instances where they could use their knowledge or where other actors have tried to access it. This was evident in Ireland where our interviewees complained that the DAFF were not engaging constructively with them [see section 4.5]. Not in any of the cases mentioned in Canada, the USA, or the Netherlands did even a single fisher share the same power as an individual politician [Hall-Arber, 2005; Rice, 2005; van Ginkel, 2005]. In most cases they were also further down the power ladder than the scientists from the epistemic community.

Their position was more an advisory one than a decision-making one. Even where they could make decisions it tended to be over which scientific advice to use or which top-down government policy they would prefer, rather than on anything where they could advance their own knowledge [Hall-Arber, 2005; Rice, 2005]. This shows how hard it is for the epistemic community to be receptive to new knowledges even when they attempt to devolve management. Most of the debate within institutional co-management forums has remained devoid of the socio-economic dimension that fishers' knowledge could contribute to immensely [Soto, 2006] and therefore engaging with socio-ecological constructs like strategies and management ideas will also have been limited. Fishers have generally not been allowed the power to steer the debate themselves on their own terms.

¹⁸⁰ The USA set up regional management councils for fisheries management, such as the New England Fishery Management Council where fishers could assist in choosing management policy [Hall-Arber, 2005].

¹⁸¹ In the Netherlands, rather than regionalising co-management, different sectors of the fleet were encouraged to organise themselves in multiple specific-interest groups at the national scale [van Ginkel, 2005].

On the few occasions that fishers could express their knowledge in their own terms there were problems of communication. Away from its location of accumulation, fishers' knowledge can prove hard to understand [Murray, *et al.*, 2005]. This proved to be the case at open meetings in Canada, where although contributions of raw anecdotal knowledge from fishers were appreciated and seen as constructive, they still rarely made it into reports and policy because they were hard to translate into the language of the scientists and civil servants who still authored the outputs [Rice, 2005]. The analysis of fisheries management literature in Ireland in sections 3.3 and 4.1 showed that although there was space for narrative inputs from fishers, that it was usually limited to just a few lines or pages in documents generally exceeding a hundred pages.

In the Canadian case, further obstacles to fishers' knowledge were also present in the new institutional structures. Firstly, the format of most co-management meetings was similar to the conferences of scientists and politicians. They remained totally alien to the lifeworlds of most fishers. When they turned up to open meetings, sometimes they found it hard to speak in front of such a large group of peers, or where the institutional language was so different to their own [Rice, 2005]. Even in meetings where fishers are permitted to speak, what a fisher may say in an open meeting could be very different to what they say in a face-to-face setting¹⁸². Secondly, the meetings were also commonly conducted on the annual or bi-annual timeframes of scientific outputs. Fishers' knowledge, as already discussed, does not always run to these set temporal periods. The inflexible gap from one meeting to the next meant knowledge had either lost its relevance in the interim period or contrastingly was too distant to be referred to when the questions being asked by meeting organisers were about changes that had occurred since the last convening. Thirdly, although regionalisation had occurred in most countries, the geographic scales of fisheries management were still at least at the meso-level, so the majority of fishers' knowledge accumulated at the local level was still not relevant. Taking these last two points into consideration, even if similar stakeholder engagement had occurred in the locale of our Irish case study,

¹⁸² As described in section 2.2, fishers' knowledge may be very individual and it is perhaps thus best communicated in a setting where a fisher can take time to reflect.

the limited spatial and temporal considerations would have led to significant events, such as the shifting of Galway and Aran's ecological baseline [see section 4.1.3] and the more contemporary highly localised species extinctions [see section 4.1.1], probably going unnoticed. Finally, many of the meetings limited fisher attendance to invited representatives [Rice, 2005]. As the experience of every fisher is different it would be hard for that representative to know everything. Even if they did, there would be no time to share it all with managers in the formal setting. Other barriers to fishers' knowledge caused by limited representation are discussed in section 5.5.

The sector of the industrial fishery where empowerment for fishers has been more successful is for the smaller boats in inshore fisheries. A more devolved manifestation of participatory governance has sometimes been implemented here through community-based management [Gray, 2005a]. It involves participation not just from fishers, but an extended group of stakeholders ¹⁸³ interested in the marine resource (e.g. people's organisations, women's groups, NGOs, scientists, local officials).

On these smaller management committees, fishers have been equally empowered in decision-making [Knapman, 2005; Davis, *et al.*, 2006]. Closer analysis¹⁸⁴ of the local institutions set up to manage these though

¹⁸³ These actors collaboratively have sole decision making powers for a fishery within waters exclusive to the community concerned. Pioneered in the artisanal fisheries of developing states such as the Philippines [Alcala and Russ, 2006], community-based management is starting to appear in isolated one-off examples in the developed world. One example is the Eastport Peninsula in Newfoundland, Canada where the DFO has given a community the right to manage its own lobster fishery [Murray, *et al.*, 2005; Davis, *et al.*, 2006]. A hybrid of community and co-management has also been active in UK coastal waters, where Sea Fisheries Committees (SFCs) of local-government officials, scientists, NGOs and fishers manage inshore waters via a combination of local and national legislation [Knapman, 2005].

¹⁸⁴ Murray, *et al.* [2005] describe how the influence of DFO scientists is still exerted in Eastport, Canada. The scale of management has moved to the local where fishers' knowledge is accumulated and meetings are more regular, so should allow the inclusion of fishers' temporally diverse knowledge. But, even without these barriers, epistemic knowledge pervades. This is partially because although allowing autonomy, community-based management is still enabled by national legislation. A possible further explanation for this is the continued involvement of government employees and scientists from the epistemic community on management boards. Their significant experience in the field of management may enable them to dominate and frame discussion in these proceedings even where they do not have sole power. This assumption is consistent with Grafton's [2000] findings in Canada's pacific halibut fishery, where it was found that

shows that state influence is still omnipresent. In both the footnoted examples, of Eastport, Canada and the UK's Sea Fisheries Committees (SFCs), the knowledge that management is built on is not that of fishers, but that of scientific surveys.

The outlook for fishers or scientists pushing the state to include fishers' knowledge appears at a shallow viewing to be poor. Recent moves towards participatory governance have not seen the state surrender its role in the hierarchy. Symes [2007] perceived that the state often appears to publicly promote participation for fishers by implementing this system, where really it is centralising power further. The nation-state's move to devolve management may even have increased its power by expanding it to a local level where previously the state had no involvement [Jentoft, 2005]. The redistribution of power, even where it has empowered fishers does not seem to have created institutions or empowered actors that frequently use the types of fishers' knowledge described in chapters 2 to 4.

Deeper analysis however, shows that the more recent changes in governance, state infrastructure and policy may be the innovations needed to create a multi-disciplinary network of numerous state and non-state actors. The increased infrastructural complexity is seen as a barrier by Soto [2006] due to the fact that an increased number of actors will have to be convinced of the validity of fishers' knowledge¹⁸⁵.

Her conclusion however, is not true for the more gradual chipping away at a paradigm that Dunlop [2000] says is possible. The scientific institutions of the state seem to have remained fairly hostile to fishers' knowledge since participatory governance was introduced, but the same has not always been the case for the multitude of civil servants and politicians. A number of these seem attracted to the project of fishers' knowledge and seem to be trying to incorporate it into co-management arrangements. They have the

communitisation of a fishery resource had not introduced stakeholder knowledge, but just dressed up subjugation by the state as it empowering its citizens.

¹⁸⁵ From a radical perspective her opinion stands true. It would be necessary to change the mindsets of all actors almost simultaneously to totally replace the epistemic knowledge. Quantitative population ecology is such a major part of the corporate memory of the agents empowered by the state, that it would be logistically overwhelming.

ability to act autonomously, which means it would be possible to convert them individually to the concept of fishers' knowledge. Where fishers' knowledge has been included so far it has been by actors such as this, and it has always been associated with participatory governance. A reformist approach to the inclusion of fishers' knowledge could and should take advantage of this, especially through pushing fishers' strategies and management ideas, which appear to potentially be so valuable to these actors.

A premature postscript must be added to this section. Another series of crises and ideologies have entered the political domain at nation-state level that threaten the project to incorporate fishers' knowledge and the participatory governance approach through which it may best be realised.

The first of these is an international economic crisis that is bringing with it the threat of cuts on government spending in fisheries related institutions. In previous economic downturns, such cuts were made in the UK [Brown, 2006] and Canada [Lane and Stephenson, 2000]. Participatory techniques have been judged in the past to be costly [Gray, 2005a; Soto, 2006]. Yet, this is not necessarily true. The costs of simply talking to fishers can be very low and a number of case studies (of which the Irish case study in this thesis should be considered one) show how collection of fishers' knowledge can be a fairly inexpensive exercise [Johannes, 1998; Soto, 2006; Hind, 2010]. For an integration project to be attractive to politicians in the current economic climate it must be proved to be cost-effective.

The second potential threat is an increasingly strong environmental movement that has been able to influence the state. They have successfully begun to appeal to like-minded politicians, scientists and civil servants and have instigated a form of governance known as "environmental stewardship" [Gray, 2005a]. In this system governments have started to move away from fisheries as resources, where fishers are the primary physical actor, to the system of EBFM. The strong, if rocky, relationships between governments and fishers are being replaced by new relationships with environmental actors. The latter have now achieved input into co-management arrangements instead of (or alongside) fishers [Gray,

2005a]. If fishers' knowledge is to be accepted it may have to be compatible with environmental stewardship and its agencies. The implications of this environmental turn are analysed in section 5.5.

5.3. International governance

Where the state is not in authority, international governmental institutions have primarily exercised the remaining power. The political legitimacy and power of international governments however is granted by the nation-states who are members of these larger institutions. It can be assumed that they will have acted similarly to nation-states and most significantly will have given the same degree of authority to an epistemic community of population ecologists. Similar obstacles to integration of fishers' knowledge may then be present. The barriers of scale to fishers' knowledge may be even more pronounced at the international level.

Importantly, international governmental institutions may have the power to bypass institutions of individual states. Where states are hostile to the concept of fishers' knowledge, it may be possible to sidestep any barriers they raise through convincing these international actors of its worth. Keeping in mind the findings in section 5.2, unpacking the larger black box of international governance could reveal even greater numbers of actors willing to accept and disseminate fishers' knowledge.

At the global scale, the UN has sometimes simply acted to legislatively empower the state (e.g. the implementation of UNCLOS), which has partially helped to support hierarchical governance [Jentoft, 2005]. More commonly however, since at least the commencement of the 1990s, it has encouraged the same participatory fisheries governance and inclusion of socio-economic criteria that the nation-state has embraced. Table 5.1 shows how successive laws or treaties have shown commitment to the participation, knowledge and even de-centralised decision-making of stakeholders (*i.e.* fishers). The Rio declaration may allow the integration of fishers' ecological knowledge like that exhibited in chapter 3 and section 4.1, and the Code of Conduct for Responsible Fisheries (CCRF) and

Agenda 21 may even be compatible with the integration of fishers' strategies (both) and management ideas (Agenda 21 only).

Table 5.1. UN (FAO where specified) laws and treaties that can be applied directly or indirectly to fisheries management. The sample here are the *United Nations Convention on the Law of the Sea*, the *Rio Declaration*, *Agenda 21*, the *FAO Code of Conduct for Responsible Fisheries* and the *FAO Reykjavik Declaration*. This content analysis, mapping the policy considerations in each statute, is adapted directly from Turrell [2004].

		Stakeholder involvement	Stakeholder Knowledge	Socio-economic Factors	De-centralised decision-making
UNCLOS	1982			x	
Rio Declaration	1992	x	x		
Agenda 21	1992	x	x	x	x
CCRF	1995	x	x	x	
FAO Reykjavik Declaration	2001	x			

Perhaps less encouraging is the more recent Reykjavik Declaration that requires only the collection of the biological scientific data produced by the epistemic community. This is evidence that the UN, like the nation state still puts faith in technical expertise of fisheries scientists to solve the uncertainty in fisheries assessment. Friedrich [2010] supports the view that that the UN, through its Food and Agriculture Organisation (FAO), has not necessarily managed to empower fishers or their knowledge. Despite the rhetoric of the Code of Conduct for Responsible Fisheries (CCRF), the majority of fisheries management policy decided by the UN and FAO is based on the advice of civil servants and scientists working either in UN institutions or seconded from similar nation-state institutions. Institutional capacity to ensure integration of fishers has not been overt at this scale, which would prevent them from having a chance to relate their own experiences of the fishery. The best position fishers have been able to achieve so far is that of observers at scientific meetings.

In any event, the ability of the UN and its institutions to give fishers' knowledge widespread support is far from clear. UNCLOS is binding for the nation-state, but adherence to other policy instruments (e.g. the CCRF), is optional [Bogdandy and Dann, 2010]. With soft policies it can be hard to quantify how influential they can be. A more sensible strategy may be to engage the international governments who can introduce hard management stipulations which must be carried out.

The best example to discuss here is the EU, because it appears that other regions have modelled their institutional networks for policy coordination on those of Europe [Rozwadowski, 2002, p. 267; Bogdandy and Dann, 2010]¹⁸⁶. The analysis of this area is therefore likely to have wider relevance.

According to Gray [2005a], fishing policy within the EU has shown a tendency towards centralisation and hierarchical governance, whilst other European policies have done the opposite. Evidence of this can be seen when analysing the actor-networks that the EU has empowered to manage its fisheries, which have not always been its own.

Historically, the knowledge that has informed the CFP has been externally produced by nation-state scientists through their work in the intergovernmental organisation of ICES. This magnified institution of the epistemic community then passes its expert advice to the civil service constituted European Commission [Daw and Gray, 2005; Hatchard, 2005]. Whilst ICES is an institution of multiple nation-states, the Commission also has its own super-state science advisory body, STECF. STECF however is little different to ICES, as it is heavily comprised of the nation-state scientists who also sit on ICES [Daw and Gray, 2005; Hawkins, 2005]. The Commission, specifically DG MARE, evaluates ICES advice within STECF before finally introducing management proposals to the legislators in the Council of Ministers [Wilson, 2009]. There has been no consideration of fishers' knowledge in this process. Their only chance to participate was through the minimal representation they achieved as individuals in nation-state elections [Hatchard, 2005]. European fisheries management has therefore been almost identical¹⁸⁷ to nation-state hierarchical management. Not only has the role of ICES as the epistemic knowledge community

¹⁸⁶ ICES is one of the main institutions of EU fisheries management (despite not actually being an official institution of the Union). It is the direct inspiration for the North Pacific Marine Science Organisation (PICES) established by the states surrounding the Pacific [Rozwadowski, 2002].

¹⁸⁷ The only difference being that the stocks which have been managed are continental, not national [Wilson, J, 2005]. The CFP has been judged by many to be the most top-down scientific policy in the EU [Daw and Gray, 2005; Frid, 2005] and the thumbprint of empowered knowledge (*i.e.* population ecology) is clearly visible in the management instruments of the policy. These are quota management, technical specifications for fishing gear and fishing effort restrictions [Daw and Gray, 2005].

reaffirmed the power of the nation-state, but also that of the EU. The Council of Ministers who have had final say over what constitutes the CFP are all elected fisheries ministers from each member state [Daw and Gray, 2005; Hatchard, 2005]. Although fishers can lobby these individuals or unions, and have on occasion done so successfully, the lack of access to actual decision-making has precluded the activity of their bottom-up participation [Coffey, 2005; Daw and Gray, 2005]. As far as integration of fishers' knowledge is concerned, the significance of a state-dominated EU and CFP means that the obstacles and inroads are almost identical to in section 5.2. Early management under the CFP for instance has been judged equally unsuccessful in its ability to incorporate any local knowledge because of its attention only to fish populations at the grand scale [Daw, 2008; Griffin, 2009]. The EU institutional network may again house allies of fishers' knowledge in the civil service. Yet, the close relationship between political leaders and fisheries scientists that radicals would like to see broken appears unbreakable.

A nuanced difference does exist however, which exponents of fishers' knowledge may be able to take advantage of. This is the slight variance in behaviour of nation-state fisheries scientists when they operate within the larger institution of ICES. The national stock reports (e.g. the *Irish Stock Book* [MI, 2010]) that represent a collaboration between nation-state science institutions and ICES are admittedly no departure from epistemic population ecology. However, the content of ICES' in-house magazine¹⁸⁸, *ICES Insight*, shows that when operating with other nation-state scientists at ICES meetings, the scientists are able to relax their loyalty to their nation-state's interests and engage in independent scientific endeavour. Radical backers of fishers' knowledge would likely not be willing to engage with this epistemic community to take advantage of such independence, but for reformists with the same allegiances it should be a welcome opening.

¹⁸⁸ A report on an ICES working group on North Sea herring shows how nation-state fisheries scientists, chaired by a fisheries expert from the Dutch government's Institute for Marine Resources and Ecosystem Studies (IMARES), moved beyond their remit of population ecology to investigate environmental influences on herring populations [Dickey-Collas, 2010]. The environment having an influence on fish stocks, not just fishing effort, is a theory often advanced by fishers as part of their knowledge. It is interesting that this is discussed in an ICES working group, but is often omitted from nation-state stock reports, which usually focus on fishing effort. This possibly reflects the freedom of independence shown by fisheries scientists when working in the semi-closed forum of ICES meetings.

Perhaps these more relaxed scientists would be willing to overlook some of the issues to do with the subjectivity and imprecision of fishers' knowledge that the Marine Institute scientists raised to our case study [see chapter 3] in order to meet some of their burgeoning data needs (e.g. to support EBFM)? Actions to take these openings are already underway. The presentations about fishers' knowledge which were permitted at the *2010 ICES Annual Science Conference* [see section 5.2] are an example of this.

In the last decade the EU has tried to move away from centralised nation-state governance. Their policy of the Cod Recovery Plan (CRP) can be seen as an attempt to empower the region in place of the nation¹⁸⁹. Like in many cases of governance shift, the implementation of the policy was triggered by a crisis. The shift has opened up further opportunities to integrate fishers' knowledge.

The biggest shift in European fisheries governance has come recently and mirrors to some extent the same ideological transformation that the state has undergone. The Commission realised that despite the best scientific endeavour, most fish stocks were overexploited and this was (like in many national fisheries) down to quotas and restrictions being ignored by fishers who were struggling to survive in the fishery. The response to this was in the 2002 reform of the CFP by the Commission which promised greater consideration of stakeholders and their knowledge, with the goal of increasing compliance and socio-economic conditions within the fishery [Griffin, 2009; Stöhr and Chabay, 2010].

Their flagship policy, in what is certainly a move towards participatory fisheries governance, has been the creation of the previously mentioned Regional Advisory Councils (RACs). These are co-management forums where delegates from the fishing industry and from other fisheries interests (e.g. environmental institutions, consumers groups) can comment on fisheries stock assessments and fisheries management plans. Scientists

¹⁸⁹ Advice from its scientific advisors, who thought the North Sea cod was close to a Newfoundland style collapse, encouraged the bureaucratic actors at the Commission to introduce management measures that reduced cod quotas and fishing effort. This reduction was below levels seen as permissible by its member states, which believed cod a crucial species for the socio-economic survival of their fishing industries [van Ginkel, 2005; Gray, *et al.*, 2008].

and representatives of international government are present, but only as advisors and observers, respectively. The RAC can also collaboratively generate their own ideas and put forward their own proposals, but they do not have power of decision-making. They can only pass their advice to DG MARE at the Commission, who may then consider their recommendations in the management policy that they design for the Council to approve [Dunn, 2005; Eno and Gray, 2005; Hawkins, 2005; Symes, 2005a].

The focus of the RACs has mainly been to offer advice on eco-region fisheries, and currently seven of them are in operation [Long, 2010]¹⁹⁰. Regionalisation in this fashion brings the CFP more in-line with the EU's principle of subsidiarity [Gray, 2005a]. From one perspective the RACs could be considered to have continued the pattern of solely supporting single-stock management as has always been the case, such as in the case of the horse-mackerel [Hegland and Wilson, 2009]. However, a more in-depth commitment to local considerations of multi-species fisheries is apparent through the example of the creation of a sub-group within a RAC to look into the potential for marine spatial planning [Dunn, 2005]. Such consideration should bring into play the consideration of fishers' detailed ecological and operational knowledge.

Symes [2007] believed that if RACs were successful in their goal of providing meaningful representation for the fishing industry then there would be little need for the politicians of the nation-state and Council. With fishers and scientists collaborating successfully, the Commission could introduce management policy that was popular and promoted sustainability of fisheries. The extent to which RACs have been effective in achieving this empowerment for fishers and their knowledge can be seen in the publications that seek to evaluate the performance of these institutions in advance of the 2012 CFP reform¹⁹¹.

¹⁹⁰ The current RACs are for the Baltic Sea, the North Sea, North-Western waters, South-Western waters, the high-seas or long-distance fleet, pelagic stocks, and the Mediterranean Sea [Long, 2010].

¹⁹¹ Griffin [2009] cites bureaucrats from both the nation-state and the Commission praising the RACs for introducing greater collaboration and understanding between fishers. Experience so far is believed to show a trend of where RAC participants can agree, then policy makers will follow their advice [Hawkins, 2005; Griffin,

However, like the move to participatory governance at the scale of national government, RACs have mainly reinforced the barriers to fishers' knowledge.

One reason for this is the stage of governance at which fishers have been included. RACs have generally only been permitted to enter governance at the stage of evaluation. Their role has been to comment on scientific knowledge, not introduce their own [Griffin, 2009; Linke, *et al.*, 2011]. Despite the agreement on the pelagic RAC, more often than not they have reverted to the historically common position of fishers questioning the methods of stock assessment and the quotas they result in. This has been particularly prevalent within the Baltic RAC [Stöhr and Chabay, 2010; Linke, *et al.*, 2011]. It is similar to some of the disagreements in the Canadian experience of co-management described by Rice [2005], where the data of the epistemic population ecologists was all that was on the table.

Criticisms over who should be participating have also been levied at the RACs. When scientists and fishers colluded the Pelagic RAC was successful [Linke, *et al.*, 2011], but the structure of RACs is actually intended to be an independent voice for non-science interests. Scientists were only introduced to advise the Pelagic RAC due to a specific request from those on that RAC [Linke, *et al.*, 2011]. When fishers and other RAC members have been able to challenge scientific advice, like on the North Sea and Baltic RACs, policy makers have still tended to use the quota restrictions recommended by the technical community of ICES [Stöhr and Chabay, 2010]. Future reforms of RACs suggested by Linke, *et al.* [2011] therefore call for scientists to be included on RACs as more than observers, because it is only when collaborative advice comes from RACs that politicians listen. An institutional structure of this form would leave only room for a reformist vision of fishers' knowledge integration, with radicals unwilling to share ground with population ecologists. Whilst the RACs have not so far introduced much fishers' knowledge, they have got fishers and those seen as hostile to their knowledge at the same table and agreeing.

2007]. The case study of the western horse mackerel stock (considered by the Pelagic RAC) proved that fishers and scientists could collaboratively forge management policy for a fishery, which was then implemented without alteration by DG MARE at the Commission [Hegland and Wilson, 2009].

With increased exposure to each other, fishers should have more chance to show fisheries scientists how useful their knowledge can be. The hostility of scientists towards fishers' knowledge could be eroded with increased exposure.

As institutions however, the main failing for RACs may not be the sporadic inclusion of scientists, but who they exclude. Firstly they may exclude a majority of their fishers and their knowledge. The presence of fishers on RACs is limited to a small number of individuals (usually union officials), who often represent only the most commercial section of the industry [Griffin, 2007; 2009; Long, 2010]. This phenomenon was again detailed by Rice [2005] in the Canadian experience of participatory governance and is discussed further in section 5.5. Essentially, the implication of such limited representation for fishers' knowledge is that not all will have a chance to impart their knowledge. Therefore, the heterogeneity of this knowledge (deemed to be so important in chapters 3 and 4) can be entirely missed. Secondly, often excluded within RACs are environmental interests and those of the public. Environmental NGOs have complained that as minority members of RACs their opinions are usually marginalised in favour of those expressed by industry [Griffin, 2007]. Also, citizen participation on many of the RACs (e.g. the North Sea RAC) is limited to one representative from a consumer group, which seems far from fully participatory [Griffin, 2007]. Bearing in mind these caveats, a situation where fishers' knowledge does become part of the information that underpins the Commission's management of European fisheries could be undermined by a challenge at a later date from disenchanted environmental institutions and individual citizens. Challenges like this should be foreseen, and are trouble-shot here in section 5.5.

Regionalisation through designation of RACs for each scientifically defined eco-region has also failed to empower fishers at the scales where they could best impart their knowledge. Firstly, their creation has allowed few opportunities for fishers to contribute either real-time knowledge or historical knowledge, despite these being the temporal scales at which fishers' knowledge probably operates best. This is because activity within the RACs has generally been limited to commenting on scientific stock

assessments which already have a frequency (usually annual) imprinted on them by scientists [Symes, 2005a]. Secondly, from a spatial perspective, each RAC has to consider science and management in large expanses of sea (usually incorporating territorial waters of several countries). Its mandate to comment on assessments of stocks at this scale results in a failure to give significant consideration to fish populations at the micro-scale, even though this is the scale at which most fishers interact with stocks and are thus most knowledgeable about them [Griffin, 2009]. Therefore, like with the stakeholder engagement conducted by nation-state governments [see section 5.2], the RACs are probably not structured with the spatial and temporal sensitivities to capture either Galway and Aran's shifting ecological baseline [see section 4.1.3], nor its more recent localised species extinctions [see section 4.1.1]. This assumption is borne out in the failure of the NWWRAC to highlight many of the specific findings of chapters 3 and 4.

Ultimately however, the main concern when considering the RACs as conduits for integrating fishers' knowledge is the fact that these institutions are 'second-class institutions' in the EU's actor-networks. Their role is only advisory and no decision-making power is afforded to them [Hawkins, 2005; Symes, 2007; Stöhr and Chabay, 2010]. Even in the case of the accepted horse-mackerel management plan, DG MARE was not prepared to accept it without first getting ICES to review it [Hegland and Wilson, 2009].

More positively, creation of RACs and a commitment to participatory governance does at least bring fishers' knowledge onto the playing field in an EU context [Coffey, 2005; Hatchard, 2005; Symes, 2005a]. The 2012 CFP reform has the potential to further affect political power structures. Proposals in a green paper suggest that RACs should take a more important role and that stakeholder knowledge should become more prominent [Long, 2010]¹⁹².

¹⁹² The signing of the Lisbon Treaty has given the Commission the chance to re-direct power from the nation-state and its epistemic scientists towards the Commission and other fisheries institutions (e.g. RACs) [Long, 2010].

5.4. The scientific community

The institutions that have dominated fisheries science are those within nation-state and international governments, which are funded and trusted by politicians and supported logistically by civil servants. Population ecologists became part of one of Haas' [1989] epistemic communities by meeting Svein Jentoft's criteria of not just possessing a knowledge about fisheries, but also having it empowered by those with political power [Jentoft, 2004; 2005]. Their historic hostility to any form of knowledge that is not their own is perhaps the biggest barrier to integration of fishers' knowledge. If they in hegemony cannot be deposed, or convinced of the value of integrating fishers' knowledge, then its integration is compromised.

Undoubtedly, the key institution in fisheries science is ICES, as it incorporates most European government-employed fisheries scientists, and it is also the source of inspiration for the formation of other global fisheries institutions (e.g. the North Pacific Marine Science Organisation, known as PICES) [Rozwadowski, 2002]. An analysis of ICES' history shows that through aligning themselves with government objectives and ideology, they were able to become part of the epistemic community. During the latter part of the 19th century, led by the pioneering population ecologist C. G. Johannes Peterson, European biologists started to carry out studies discovering patterns of fish migration and distribution. They realised that through international cooperation they could scale-up their knowledge to give a more complete picture of European fish stocks. Their successful growth of their approach occurred because not only did it coincide with the technocratic ideologies of governments at that time, but it also came at a time when nation-states were looking to secure more resources to trade so that they could increase their own power in growing international markets. Where scientists saw an opportunity to understand fish stocks, governments saw an opportunity to catch and sell more fish. The larger European scale proposed for assessing fish stocks by the scientists matched perfectly the scale that governments needed to protect its fish resource and manage its fishing fleets [Rozwadowski, 2002]. ICES' rise, and that of population ecology, suggests that other pioneer led communities (e.g. fishers' knowledge research led by individuals such as

Robert Johannes and Barbara Neis) should be able to achieve empowerment through the same alignment.

This is not the case however, because that assumption ignores the inertia in government that occurs once a settled Kuhnian paradigm is active. National and international governments continue to fall back on population ecology during times of crisis, even when the crisis has been blamed on that group (e.g. during the northern cod collapse in Newfoundland) [Soto, 2006].

The loyalty of governments to biological scientists shows that the sort of radical challenge that Toke [1999] believes is possible, is likely no longer an option in the fisheries management paradigm. The remaining option is therefore that proposed by reformist fishers' knowledge researchers; an integration of fishers' knowledge within the epistemic community. Whilst this could be campaigned for through a direct approach to government actors, their willingness to revert to scientific institutions like ICES suggests that a more effective approach could be made to biological scientists.

The problem with this approach may be the degree of hostility encountered during attempts to make it successful. Soto [2006] identifies many reasons for the lack of credence given to fishers' knowledge by the scientific community, which include, but are not limited to; fishers' knowledge being of a poor quality, a class divide between the two actors, a distrust of fishers who may be dishonest or biased to advance their own self-interests. All of these were apparent in chapter 3, where the Marine Institute expressed enthusiasm for only limited parts of fishers' biological and operational knowledge. The most important difference, and perhaps that which underpins the other ones, is simply the vast difference between fishers' and scientists' knowledge. Fishers' knowledge is highly social, anecdotal and qualitative, whilst scientists' is biological, statistical and quantitative. Agrawal [1995a] argues that this sort of difference is hard to overcome as empirical researchers find it difficult to understand qualitative material from beyond their discipline's boundaries.

The scientists of ICES did not start to work together through a marriage of convenience, but through a shared belief. They had the total faith that Haas [1989] said is present in an epistemic community when it thinks it can solve all uncertainty within a discipline (*i.e.* that of fisheries management). The evidence since its formation points to this politically chosen community protecting their power at all opportunities, not willing to share space or agendas with other disciplinary approaches and their actors. Equally, they have sought to defend their institutions from occupation by external ideologies and from funding cuts [Lane and Stephenson, 2000].

Significant though, has been the emergence of EBFM as a product of uncertainty within the community of population ecologists. They realised that their models did not account for the dynamics of more than one species of fish living in situ and that their stock assessment calculations may be erroneous as a result. Yet, the idea to shift from single-species population management to integrated management of multiple species was not their idea. It instead came from terrestrial scientists whose lifeworlds overlapped with fisheries scientists in shared agencies (*e.g.* the FAO).

As a result of this influence, a tentative consensus developed in fisheries institutions that the ecosystem approach may contribute to solving their own uncertainty, and a working group was set up at ICES to consider EBFM and advise the European Commission on the possibility [Wilson, 2009]. Similar science sub-sections have appeared in national fisheries institutions (*e.g.* the Oceans section of Canada's DFO) [Lane and Stephenson, 1999], and recommendations for EBFM now appear within the scientific advice of countries like Ireland [see section 4.1; MI, 2010, pp. 26-28]. EBFM appears to perhaps have become part of the epistemic community previously dominated by population ecology. The scrutiny biological scientists are now giving to the knowledge of EBFM practitioners suggests they are treating it symmetrically to their own knowledge, a situation that means its integration is underway or at least possible [McGoodwin and Neis, 2000].

Why were the epistemic communities perhaps able to become infiltrated by experts from another discipline? As Finlayson and McCay [1998] identified,

it was because these practitioners were already connected to the paradigm. Scientists are prepared to give a chance to peripheral experts who they believe to have pedigree, and whose knowledge they perceive to be of a high quality. As quality is something they associate with their own work and experience, then they must see elements of their own methods and processes in the actions and knowledge of these actors. EBFM has been accepted to an extent because it shares some of the modelling approaches and experimental techniques of population ecology. A barrier to fishers' knowledge may be that it is not assigned the same pedigree status, because its analytical processes are not methodical and appear colloquial to population ecologists [Funtowicz and Ravetz, 1990; Wilson, 2009].

Despite the potential barrier, the chances (like for EBFM) to perhaps become a part of the epistemic community's lifeworld are there for fishers' knowledge. The chance to speak about fishers' knowledge at ICES conferences [Hind, 2010; Massé, *et al.*, 2010] and publish on the topic in the *ICES Journal of Marine Science* [Degnbol, 2005; Johnson and van Densen, 2007; Shephard, *et al.*, 2007] are such examples. Further proof of a willingness within the epistemic community to engage with fishers' knowledge comes through the actual commissioning of fishers' knowledge studies¹⁹³ by national fisheries science institutions.

Nevertheless, the threat of collapse to this reformist approach still exists if it cannot quickly demonstrate the pedigree that scientists expect, perhaps introducing a permanent obstacle to the acceptance of fishers' knowledge. This is a troubling scenario, because as Soto [2006] says, biologists often have too high an expectation of fishers' knowledge, hoping that it can produce the same quantitative results as their research efforts. This may have been the case in this thesis' case study, where scientists certainly

¹⁹³ A study to investigate stocks of the fish species orange roughy involved nation-state fisheries scientists at the Irish Marine Institute and partially referenced the knowledge of fishers [Shephard, *et al.*, 2007]. Their subsequent commissioning of the *Irish Fishers' Knowledge Project* (of which this thesis is part) shows that they are considering the concept for a more regular role in fisheries management. The Canadian *Coasts Under Stress* program is another example of how interdisciplinary scientists have been tasked to work together to see if fishers' knowledge can be a useful accompaniment to biological data [Finlayson and McCay, 1998; Murray, *et al.*, 2005].

expected more than could be delivered from fishers' knowledge research when it came to documenting discards and bycatch [see section 3.3]. To be successful, fishers' knowledge will have to overcome this issue by finding other commonalities within the existing science paradigm. It must introduce information about fish populations and the ecosystem which population ecologists and EBFM experts can use. As was shown in chapters 3 and 4 this is perfectly possible, especially at new scales where scientists themselves struggle to collect data. Johnson [2008] describes how the future of fisheries management is not just the annual reports at a national scale. It will also be producing information at the micro-level and in real-time. Fishers' knowledge can perhaps meet this need and it is therefore a potential avenue for building an alliance with fisheries science. Indeed, the willingness of Marine Institute scientists to consider using the maps we produced of micro-scale fishing effort for nephrops [see figure 3.3] to improve their UWTV surveys for the species gives hope in this respect.

With the likely integration of EBFM into mainstream fisheries science there may also be opportunities for those pushing fishers' knowledge to take advantage of the not always recognised heterogeneity in the biological sciences. Frank and Brickman [2001] note that disciplinary approaches beyond that of population ecology will be needed to implement EBFM. Sub-disciplines of science such as behavioural ecology and genetics will become more relevant. Looking at the example of the collapse of the northern cod, there was clearly a different community of Canadian natural scientists doing research in these sub-disciplines that were perhaps in competition with population ecologists at the DFO [Hutchings, 2000]. Primarily based at universities [Neis and Felt, 2000a], which often had different funding streams and research foci to the DFO, they engaged with fishers' knowledge and discovered sub-populations of cod and unknown migrations of the species. These discoveries had fundamental implications for the management of cod stocks by population scientists [Hutchings, 2000; Wroblewski, 2000; Murray, *et al.*, 2008a]. Looking at the Irish case study in this thesis, the hypotheses of inter-species competition in table 3.3 and the possible spawning migrations mapped in section 4.1.2 would be of interest to scientists of these ecological sub-disciplines. Therefore, fishers' knowledge researchers willing to work with biological scientists should also

be approaching these researchers, not forgetting that they are as likely to be based in universities as in national science institutions and multinational ones like ICES.

This method of integrating fishers' knowledge within the existing scientific community would be criticised by the radicals of chapter 2, because it would compromise what they believe fishers' knowledge to be. It was shown in section 2.4 how the epistemic community can get the wrong idea about what fishers' knowledge is, and Holm [2003] also warns about the dangers of framing fishers' knowledge in scientific terms. Population ecologists can ignore its valuable social and operational content and also focus too heavily on it as a source of empirical data, rather than as a collaborative technique [Soto, 2006]. A reformist integration project might run the risk of perhaps encouraging the hijacking or undermining of the concept. Agrawal's [1995a] advice should be heeded however. He states that whilst translation of stakeholder knowledge can be a problematic within a reformist approach, a radical approach can marginalise stakeholder knowledge in the longer term by seeking to integrate it where there is no mechanism of empowerment. If it cannot even be considered by the epistemic community, fishers' knowledge will never be part of fisheries science and management. If it can be brought about, the ideal scenario would be the facilitation of fishers' knowledge by scientists, rather than transformation, to give a "knowledge commons" [Wilson, DC, 2005].

The review of epistemic communities shows that they are certainly hostile to a radical approach, but also reveals that informally (and increasingly formally) they are open to new approaches that can complement their knowledge, especially when they align with political ideology. Reformist advocates of fishers' knowledge have set to work on building alliances with moderates in the epistemic community, but their infiltration is admittedly still slight. The epistemic community had been ignorant of fishers' knowledge until recently because they shared few institutional networks with actors that possessed it. Now that scientists are taking part in institutions such as RACs, they are starting to acknowledge its existence. Their intellectual hostility to anecdotal qualitative data means they may still be the biggest impediment to fishers' knowledge, but with this great challenge comes the

biggest opportunity. As can be seen from the involvement of Marine Institute employees in both a new management plan for the Galway and Aran nephrops fishery, and in the directing of the effort of the Irish fleet towards certain fishing profiles (with the help of *métier* analysis) the role of scientists is expanding. Their role is no longer one of simply measuring fishing effort, but of finding ways to reduce it. Significant inroads to integrating fishers' knowledge in the mainstream can be achieved if fishers' strategies can be marketed successfully to scientists as a tool to help them perform this developing role. The positive reaction of the Marine Institute scientists to the potential for getting 'fishers-for-volume' to trade down [see section 4.4.] again gives hope to the integration project. If the majority of fisheries scientists do choose to integrate fishers' knowledge, then because they are epistemically empowered, it will almost certainly become part of the fisheries science and management mainstream. Care must be taken however to ensure that any format of fishers' knowledge they adopt is not overly empirical [see section 2.4], and is true to the informal routes of the concept.

The scientific community is not simply constituted of population ecologists and EBFM experts. It would be remiss in a thesis about fishers' knowledge not to consider those (mostly from the social sciences) that research it. In section 4.4 it was noted that Irish fishers' did not always feel able to convey their knowledge to the epistemic community (e.g. when they disagreed about management ideas they had for the fishery). It has also been noted at various stages that much of fishers' knowledge is tacit, including elements of their biological knowledge [see section 3.3] and perhaps their strategies, which they may not recognise explicitly as 'knowledge' that needed reporting to scientists. Yet, these are some of the dimensions of fisheries' knowledge that may be most likely to convince the epistemic community and the other actors in this chapter of the need to integrate fishers' knowledge. The landmark finding in section 4.3, that fishers in the Galway and Aran fishery broadly speaking wanted to implement trading-down strategies to decrease their effort and fish-for-value (which would lead to greater ecological and socioeconomic sustainability in the fishery), would likely not have been made without our fishers' knowledge research. It is perhaps key then that fishers' knowledge researchers must themselves

become integrated if fisher's knowledge is to also achieve this status, occupying roles in national fisheries science institutions and within organisations like ICES alongside population ecologists and EBFM practitioners. This could be problematic, as Jentoft [1998] highlights that a decade ago social scientists (with the exception of economists) were "effectively absent" from fisheries management. However, there are now signs that this is changing with high profile empowered scientists at ICES advocating cross-disciplinary research that includes social scientists [see section 5.6; Degnbol, *et al.*, 2006]. Additionally, although far from the case in every nation, the civil service fisheries institutions of influential countries like the USA [Anderson, *et al.*, 2003] and the UK [Catchpole, *et al.*, 2005] are starting to include social science as part of their work plans. If this trend continues then fishers' knowledge researchers will have a chance to integrate themselves into the epistemic community. It is a little early to tell whether the move to the social sciences will be as convincing as the move to EBFM or whether it is merely rhetoric, so at this stage it can only be hypothesised that this could be a crucial step towards integrating fishers' knowledge. The development should be monitored in future research and reformists advocates of fishers' knowledge should seek to fill any available roles in empowered fisheries science institutions.

5.5. Other actors

The fishing industry

The fishing industry would be expected to seek forums to design policy that fits their needs and allows them to meet their social and economic goals. Where they may be expected to struggle, is when they try to actually mobilise fishers' knowledge within the political process, because their own institutions may not have the power or capacity to fully integrate it.

In chapter 2 it was noted that to a larger extent the concept of fishers' knowledge has been fleshed out in the traditional or artisanal fisheries of the developing world. In these environments, fishers typically employed low-intensity fishing methods. It has only been latterly that an attempt has been made to shift the approach to developed world fisheries and their management regimes. The Irish case study in chapters 3 and 4 is part of

this attempt. In developed world fisheries the boats are more industrial and greater variety exists within fleets. There are both large-scale, industrialised, capital-intensive fishing interests and lesser-scaled, but still commercial, coastal fishing communities operating smaller boats and using more traditional fishing techniques and technologies.

In these commercial fisheries the added complexity can actually create a stark and basic division between fishers, which is essentially a class divide [Soto, 2006]. The most industrialised are usually powerful institutional players, while coastal and inshore fishers are often marginal and lacking the institutional organisation to exert influence [Soto, 2006; Symes, 2007]. Smaller fishing interests do not get a chance to enter the political process, because the more wealthy unions of the highly commercial fleet (often backed by seafood corporations [Durrenberger, 2003]) are able to use their greater influence to outmuscle them [Hatchard, 2005]. This occurred during the collapse of the northern cod. The industrial offshore fleet, whose vessels were operated by seafood corporations, were able to communicate to scientists and politicians that the cod stock was healthy, whilst the inshore fishers in the small NIFA union were not able to be heard when they warned of the impending stock collapse [Neis, 1992; Finlayson, 1994; Kurlansky, 1998]. Disputes between and even within fishers' unions and associations are common, with further cases being documented in Canada [Apostle, *et al.*, 1998; Rice, 2005], Norway [Apostle, *et al.*, 1998] and the Netherlands [van Ginkel, 2005, p. 115].

This is problematic for the integration of fishers' knowledge, because different groups of fishers have different knowledge of fisheries based on their varying operational experiences [Clarke, *et al.*, 2002; de Vos and Mol, 2010]. Those who do not have influence cannot integrate their knowledge. The heterogeneity of fishers' knowledge gets lost, with crucial narratives or information not being integrated by the epistemic community. Griffin [2009] identifies that the knowledge which is subsequently most often excluded is the micro-scale, historical and traditional, because this is the knowledge predominantly possessed by the coastal and inshore fishers with the least influence. If we had not interviewed inshore fishers in the Galway and Aran region we would have missed part of the shifting ecological baseline

documented in section 4.1.3, because undiscovered would have been narratives of local extinctions of crayfish, queen scallops and some small bay nephrops stocklets [see also section 4.1.1 and table 4.2].

Also problematic is an additional crisis of representation associated with fishers' unions and associations. These institutions have come to occupy the majority of the advisory positions to politicians and scientists [Rice, 2005; Mikalsen and Jentoft, 2008] as well as the representative roles on management bodies (like the EU's RACs) [Griffin, 2007; 2009]. Yet, fishers act individually and their knowledge is their own. The heterogeneity of Galway and Aran fishers' knowledge is seen frequently in chapters 3 and 4. It is impossible for chosen representatives to express the views and impart the knowledge of all those they represent. For instance, if fisher 14 had been excluded from this study it would not have been possible to record a potential change in abundance of nephrops in a small stocklet that was little surveyed by Irish scientists [see figure 3.7]. None of his colleagues or union representatives reported this knowledge despite having opportunities to do so, as it was not part of their lifeworld. Likewise, representatives on the UK's inshore management bodies are generally ex-fishers and therefore they have good historical knowledge of fisheries, but they do not have the real-time knowledge of active fishers [Knapman, 2005]. The same omission of heterogeneous knowledge has occurred in Canada during the DFO's regionalisation of government, which has allowed some fishing experts to impart constructive knowledge, but included the knowledge of no one beyond them [Rice, 2005]. This can leave unionised fishers frustrated with their representatives who they may feel are not expressing their views [van Ginkel, 2005], and indeed our Irish interviewees complained of this [see section 4.5].

Most damning of all maybe is a statistic from Norway (and comparable to situations elsewhere), that 60% of fishers in the country are not even members of unions [Hernes, *et al.*, 2005]. For this reason alone, any attempt to build unions into the sole exponents of fishers' knowledge would be deeply flawed. A number of the fishers identified in table 4.5 as looking to trade down with the aid fisheries management were not unionised and therefore a significant opportunity to make the Galway and Aran fishery

more sustainable was being missed because managers were not even being made aware of this human capital. Even where fishers are represented in participatory governance they do not always feel that they are listened to [Gelcich, *et al.*, 2009; Pita, *et al.*, 2010], so any approach which uses fishers as a direct advocate for their knowledge may be set up to fail. In Canada, where they tried to hold open meetings so that everybody could contribute, fishers found the meetings to be too crowded or too intimidating for them to speak at [Rice, 2005].

A barrier is also raised to fishers' knowledge, because they often fail to seek to advance it themselves. Firstly, this can be attributed to the fact that goals of participation for fishers do not align with their knowledge. Neo-corporatism has worked its way into the institutional settings where fishers and epistemic communities meet. Instead of putting their resources into collecting and passing on knowledge, highly politicised fishers' representatives often spend their time lobbying and negotiating for higher quotas [Symes, 1995; Rice, 2005]. The success of this technique, which has undoubtedly led to curbing of quota reductions by politicians [Daw and Gray, 2005], makes it less likely that they will seek to use their knowledge in future. When they have actively attempted to reach collaborative decisions, instead of advancing the multi-scaled socio-economic knowledge of their own lifeworlds, the union representatives have often formed their discussions in the single-scale biological language of scientists. This is partially because they have found it the best way to contest the scientific stock assessments [Rice, 2005], and partially because this is the only language of institutions such as the RACs [Stöhr and Chabay, 2010]. This is certainly true to some extent in Ireland, as was evident from Irish union representatives expressing the same disappointment in the subjectivity of the *Irish Fishers' Knowledge Project's* quantitative results as the Marine Institute scientists did [see section 3.4]. Where fishers have been able to introduce original knowledge in meetings in Canada, the difficulty of translating it means it has not made it into final reports [Rice, 2005].

Secondly, fishers may deliberately want to hold back their own knowledge. Fishers do not always share the same goals as scientists and environmental NGOs. They do not necessarily value the precautionary

approach or the need for pristine ecosystems [Stöhr and Chabay, 2010]. For this reason they may wish to withhold ecological knowledge which they believe could be used against them [Soto, 2006] (although it did not seem to be the case in our Irish case study). Previous studies that use fishers' inputs have certainly shown that they may be exploiting fisheries more heavily than scientists at first predicted [see Dobby, *et al.*, 2008], which would certainly be evidence for scientists and politicians to introduce more aggressive cuts in quota and fishing effort. Their knowledge could also be used against them by their colleagues, because it would perhaps reveal secret fishing grounds [Maurstad, 2002]. Ultimately, fishers may be apathetic towards participation, as their previous experience has led them to believe that nothing positive can come from their involvement and that they are rarely listened to anyway [Wilson and McCay, 1998; Symes, 2007].

However, caution must be taken not to crudely over-simplify divisions between fishers. It can also be a mistake to focus on difference between fleets, when these differences do not necessarily result in different interests and identities. Fishers at all levels have commonality and in all likelihood share some of the same knowledge [Clarke, *et al.*, 2002]¹⁹⁴.

The Dutch fishery shows how neo-corporate unions who may be hostile to fishers' knowledge can be outflanked. New governance institutions called "study groups" have created a flexible actor-network which allows groups of fishers with different profiles, goals and knowledge to organise in groups of varying scales. Crucially, the knowledge introduced at the meetings of study groups was not imposed on the fishers. It was theirs, generated from the bottom-up, and where groups wanted to withhold secret information, they could. The result was to bring fishers from different localities together in cooperative national arrangements. The broad interests within the groups and the variable scales meant that any knowledge could be introduced, no matter of what nature. The groups also met at least five times a year,

¹⁹⁴ Clarke, *et al.* [2002] found that although a minority of fishers were not willing to take part in wide consultation, perhaps because it bypassed their powerful roles as individual representatives for the fleet, small-scale inshore fishers and large-scale offshore fishers in Hong Kong were happy to collaborate and express their opinions in a shared forum.

opening up the temporal scale and permitting contributions of currently relevant elements of fishers' knowledge [de Vos and Mol, 2010].

For researchers trying to integrate fishers' knowledge then, they must be careful not to take for granted the support of fishers for their mission. If fishers are against integration of their own knowledge, or do not see the reason for it, there is surely no reason to continue to value their knowledge. Any project to do so would be undermined by their lack of support. They must also be careful not to construct a further barrier to fishers' knowledge by raising the expectations of fisher participants in collaborative research. As Daw [2008, p. 187] found, they often hope that their participation will result in management that favours them, which is not necessarily the case. If fishers' expectations of fishers' knowledge research are not managed, then they could be disappointed by the results and withdraw from future research.

However, the tensions between fishers and their own institutions are not primarily over objections to the principle of using their knowledge in fisheries management and policy. The tensions are, as Wilson and McCay [1998] assess, over whether they feel their participation is legitimate. Fishers do not want to be duped into participating if that participation is in effect a coercive attempt to silence their individual voice. For this reason, fishers' knowledge practitioners should be wary of supporting institutions like the RACs, which are top-down creations of government and are also dominated by neo-corporate representatives of fisheries unions. An effort to create new bottom-up forms of representation for fishers may not only excite them about the outcomes of participation, but also allow a much more complete version of fishers' knowledge to be mobilised.

The green movement

As late as the start of the 20th Century, fisheries governance was mainly contested between national and government institutions and fishers themselves. This institutional playing field has expanded in the last decade. A green movement has emerged from an extreme, peripheral position to become a powerful mainstream force [Radcliffe, 2002]. This movement has traditionally been aligned with a precautionary EBFM approach, where

fisheries are not seen so much as an industrial resource, but as a holistic resource for society. There is an eco-centric position, rather than the anthropocentric one of participatory governance [Radcliffe, 2002] and therefore the movement is a threat to integration of fishers' knowledge. Noted earlier in this chapter and in chapter 1 was that EBFM and fishers' knowledge are competing discourses. EBFM has had similar problems to entering policy as fishers' knowledge has [see section 5.4], but it is now looking probable that it will become more widely implemented [Jones and Ganey, 2009; Rosenberg, *et al.*, 2009]. If that is the case, then participatory governance with fishers and their knowledge at the centre of co-management institutions (like the RACs) could be bypassed altogether.

Section 5.4 highlighted that some of the focus on the ecosystem (at the expense of the fishery) was driven by practitioners of EBFM who have perhaps entered the epistemic community. Also significant however, has been the political strength that environmental actors such as NGOs have sometimes been able to exercise. Environmental NGOs rose to prominence globally during sustainability debates in the 1980s and 1990s [Van Rooy, 1997], influencing policies such as those formulated by the FAO. These policies have fed down into national and international governments, who themselves have become ideologically greener [Radcliffe, 2002; Brown, 2006]. As was seen in section 4.1 this has certainly been the case in Ireland. Likewise, recent governmental policy initiatives for fisheries, such as Europe's CFP reform of 2002 and its Commission's *Biodiversity Action plan for Fisheries* [Dunn, 2005; Eno and Gray, 2005; Symes, 2005b; 2007], put the ecosystem at the heart of fisheries management. Ensuring the socio-economic sustainability of a fishery as a policy brief is starting to become secondary to the issue of environmental protection.

Environmental NGOs are beginning to sidestep the forums where fishers and their knowledge could be heard. Dissatisfied with the amount of influence they have been able to exercise as minority members of the RACs [Griffin, 2007], where their opinion is that too often the policy that comes out of these favours the fishing industry, some have responded by using their funding and public backing to directly lobby politicians to introduce more ecosystem orientated policies [Radcliffe, 2002; Hatchard,

2005]. When lobbying, they are usually more organised, more experienced at communicating their ideas and more united than the fractious fisheries unions. Therefore, they have often been very successful in influencing the empowered politicians over which knowledge to use in fisheries management [Radcliffe, 2002; Dunn, 2005; Eno and Gray, 2005]. The knowledge they have so far generally preferred is the empirical expertise of the biological scientists in institutions like ICES [Gray, *et al.*, 2008; Stöhr and Chabay, 2010].

The green movement has not just been limited to NGOs. Governments, influenced by the green movement, have introduced a new type of participatory governance in the form of environmental stewardship. The difference between this form of participatory governance and other forms is that it does not usually involve fishers. Instead, governments, scientists, QUANGOs and environmental NGOs work in coalitions to manage fisheries using EBFM [Gray, 2005a]¹⁹⁵. The knowledge used to inform environmental stewardship is not bottom-up local knowledge (*i.e.* the type possessed by fishers). It cannot be, because it does not involve those whose lifeworlds are primarily within the ecosystems it seeks to manage. As Gray and Hatchard [2007] state, it is the top-down scientific knowledge of institutions such as ICES who advise many environmental NGOs and institutions. Those who favour EBFM seem to be entirely capable of building alliances that are politically powerful and are hostile to fishers' knowledge.

However, to look at the green movement as in direct competition to fishers is a mistake. Firstly, NCAs and environmental NGOs are far from universally opposed to active fisheries. Whilst some have remained extreme (*e.g.* Greenpeace) and have refused to join the co-managed RACs [Griffin, 2007], others have been enthusiastic to work in these¹⁹⁶ or similar

¹⁹⁵ In the UK, the government has created QUANGOs called nature conservation agencies (NCAs) to manage inshore fisheries. Their role has included preventing ecosystems from degrading by creating MPAs where fishing practices are limited and even banned [Eno and Gray, 2005; Knapman, 2005]. In Australia, the public sector NCA, the Queensland Parks and Wildlife Service, has been given complete control to manage the extensive fisheries of the Great Barrier Reef MPA with no legislative need to include fishers [Day, 2002].

¹⁹⁶ The Royal Society for Protection of Cruelty to Birds (RSPB) chairs the spatial planning sub-group on the North Sea RAC [Dunn, 2005]. The World Wildlife Fund for Nature (WWF) is a member of several RACs [see section 5.6].

collaborative arrangements [Dunn, 2005; Eno and Gray, 2005]. Rather than settle for environmental stewardship agreements between themselves and government, NGOs have also pushed for fishers to be involved in regional co-management ¹⁹⁷ [Dunn, 2005]. Additionally, regional and national governments have used NGOs specifically to collect fishers' knowledge to help with MPA design [Edwards, *et al.*, 2009; McClintock, *et al.*, 2009]. Both of these are positive developments for the fishers' knowledge integration project. These forms of stakeholder engagement will expose NGOs to the opportunities for greater sustainability that are relatively obvious when fishers' strategies are understood (e.g. trading down to 'fish-for-value') [see section 4.3], as well as to the ideas that fishers like those in this thesis' Irish case study already have for management using tools like MPAs [see table 4.7]. The realisation by NGOs that fishers' knowledge may be more valuable to them than they first thought in helping them to achieve their own goals may lead to them accelerating its integration. NCAs and NGOs are quite often negatively perceived by fishers who think they will stop them from fishing [Dunn, 2005], but the examples in this paragraph show that this is not the case for many of these institutions. It should be possible to form the same alliances to mobilise fishers' knowledge with them that it is with governmental institutions.

Perhaps a less obvious opportunity for fishers' knowledge to be integrated, but potentially more significant is the gradual shift from population ecology to the ecosystem approach favoured by the green movement. Fishing organisations have feared EBFM, as they are wary that it may bypass them in management and policy [Daw and Gray, 2005], but deeper analysis and the findings in chapter 4 show this should not be the case.

Firstly, an ecological approach cannot ignore the human element of ecosystems. Fishers are part of the socio-ecological ecosystem that is the marine environment. Their social and operational knowledge is crucial to understanding ecosystem dynamics [Radcliffe, 2002; Kliskey, *et al.*, 2009]. Secondly, much of the information that is needed for EBFM is qualitative, especially descriptions of short and long-term changes in ecosystems. Wilson [2009] notes that epistemic science institutions like ICES simply do

¹⁹⁷ The WWF in particular has lobbied for fisher involvement in management.

not have the in-house expertise in this area. His observational study of ICES found that scientists within ICES had acknowledged that they would have to increase the range of stakeholders they consulted to find this information. Fishers are perfectly placed to meet this need, with excellent experience of local ecosystems over long temporal scales [Kliskey, *et al.*, 2009; McLeod and Leslie, 2009]. As was concluded in section 4.1.4, fishers' ecological knowledge could become a key information pillar supporting Irish EBFM. In particular, referencing fishers' historical knowledge would allow NGOs to construct an ecological baseline that supported their calls for improved conservation policy. Through spatially mapping fishers' micro-scale knowledge of spawning grounds and fish nurseries it could also better inform the planning of the MPAs that environmental NGOs are generally so supportive of.

To complement the attempts to convince environmental NGOs about the value of fishers' knowledge, reformist advocates of fishers' knowledge could additionally target the ICES scientists identified by Wilson [2009], as their needs may also ally them to the concept. EBFM introduces a need to manage ecosystems of *any* geographical scale at *every* timescale. It is significantly more complicated than population ecology [McLeod and Leslie, 2009; Wilson, 2009]. Fishers' knowledge has struggled to meet the demands of population ecologists, because it did not align well with the national or international scales, and the annual frequency needed to make stock assessments. However, it is much more likely to be able to match the scales of EBFM, which are often local and occur across a variety of timescales [Griffin, 2009].

This final point, which suggests compatibility between fishers' knowledge and EBFM discourses, is an important one, because as is seen in the case study results presented in chapter 4, this argument proves to be one of the most important findings in this thesis. The implications of this are positive for a reformist approach to fishers' knowledge, because of the willingness of its advocates to position it alongside and within other disciplines. For radical fishers' knowledge researchers, unwilling to translate fishers' knowledge so that it better aligns with scientific approaches, the implications are less positive.

The public

For many centuries fishers have globally been seen as heroes in the eyes of a public who have not sought to become involved in fisheries management [Kurlansky, 1998; Oliver, 2005]. For that reason, there was never a prospect of them becoming an obstacle to the integration of fishers' knowledge. This has changed in recent years through the influence of the green movement, parts of which have turned the public against their former heroes.

A post-modern environmentalist movement realised that their lobbying of governments was unpopular, because it was often causing top-down environmental legislation to be brought upon a public who were not receptive to being coerced. These environmentalists, (often extreme NGOs like Greenpeace and Sea Shepherd), have responded by becoming experts in managing a media that the public is a lot less hostile to [Radcliffe, 2002; Oliver, 2005]. They are often successful in inserting their opinion into national news media articles about fishing policy where fishers themselves are not asked to comment [e.g. Hood, 2010; Eilperin, 2012; Harvey, 2012]. Oliver [2005] takes the extreme, but valid view¹⁹⁸, that the green movement has succeeded in depicting fishers as plunderers of the oceans, responsible for turning fisheries into marine deserts. Environmental NGOs have been able to bring the public and fishers into conflict [Radcliffe, 2002; Gray, 2005a].

Public opinion on fisheries issues, at least in some states, now tends to side with a more precautionary environmental approach. A recent survey for the DFO found that 62% of Canadian citizens would rather have healthy fish stocks than a thriving fishing industry [Environics Research Group Limited, 2007]. The fact that government institutions are sourcing their opinion shows that the public have become powerful enough to influence government policy. Whilst environmentally admirable, their stance may have become harmful economically to a fishing community that is in socio-economic decline [Coffey, 2005; Daw and Gray, 2005]. The most worrying

¹⁹⁸ Oliver is the editor of a UK and Ireland weekly trade newspaper for the fishing industry, so his views are understandably sympathetic towards fishers. However, the publication of his cited is part of an academic compilation, so his contribution is likely to be seen as fair by the editor of that book.

development for fishers is that this policy is being quickly implemented without their consultation and without their knowledge inputs¹⁹⁹. The public have gained even more power in recent years, with CFP reforms promising their increased representation in fisheries management and the EU parliament empowered to influence the Commission on their behalf [Long, 2010]. A petition signed by 28 500 individuals asked for the information that is empowered by the CFP reform and in EBFM, to be that of the scientific community:

“Putting the environment first means following scientific advice and imposing strict criteria on those seeking access to fisheries resources.” [PEW Environment Group, 2010]

Not all public opinion poses a threat to fishers and their knowledge. Despite their belief that fisheries health should be prioritised over the fishing industry, 89% of Canadian citizens were of the opinion that fishers should have more involvement in fisheries management [Environics Research Group Limited, 2007], and they would likely see integration of the Irish fishers’ human capital discovered in section 4.4 as a desirable development.

Sections of the media also favour the fishing industry. Local papers (operating at scales where fishing communities are important actors) have been more aligned with fishers’ interests and have even publicised fishers’ knowledge [Oliver, 2005]. On occasion, they have been able to influence national media²⁰⁰. Television coverage, such as the *Discovery Channel’s* high profile (USA set) *Deadliest Catch*, commissioned for its dramatic footage of fishers at sea, has also brought the public closer to fishers again [Blackford, 2008]. A recent UK programme, *Channel 4’s Hugh’s Fish Fight*, even launched a campaign which has integrated fishers’ knowledge. The presenter travelled to sea with trawler skippers to show what they thought of Europe’s CFP management measures for fisheries discards. The knowledge that fishers displayed on the program has been picked up by the

¹⁹⁹ The Darwin Mounds, an important Scottish fishing ground, were closed after a public outcry about their exploitation being unsustainable without industry having even a chance to make its case for their use [Oliver, 2005].

²⁰⁰ A rise in monkfish quota in the Southwest of the UK can be attributed to this network [Oliver, 2005].

public²⁰¹ and environmental NGOs and used to lobby national fisheries ministers and EU bureaucrats [Fish Fight, 2011]. If the public could see that some fishers' strategies are orientated towards sustaining local environments and coastal fishing communities (as was seen in the Irish case study in section 4.3) then they may lobby for greater inclusion of fishers' knowledge in fisheries management.

Such examples add weight to arguments stating that fishers' knowledge could be used to show the fishing industry in a better light [Soto, 2006]. Yet overall, the threat to a fishers' knowledge project from public opinion is unpredictable, which makes it a barrier that advocates will find it hard to logistically overcome. What those promoting it can do, is ally fishers' knowledge with institutions and actors that the public favour (e.g. environmental NGOs, fishers themselves) as well as the concepts favoured by those institutions (e.g. EBFM).

5.6. Giving them what they need: allying actors and institutions with fishers' knowledge

The challenges and barriers raised to fishers' knowledge in this chapter at first glance seem daunting and raise questions over the potential success of any integration project. Most worrying maybe is that fishers are now at the table of fisheries management, but that their opportunities to actually contribute knowledge remain limited. Moves to participatory governance have often been only rhetoric, or else their contributions to institutional networks (e.g. RACs) have simply replicated the top-down hierarchical ones of the epistemic community [Gray, 2005b]. When opportunities do arrive for fishers to contribute their knowledge, it seems policy-makers would still rather defer to the scientific knowledge of the population ecology community. The participation that fishers have achieved hitherto has therefore led fishers' knowledge to being one of Foucault's [2004] "subjugated" knowledges.

However, this conclusion is overly-pessimistic and ignores clear opportunities set out in this chapter, which show that a reformist integration

²⁰¹ Over 750 000 individuals worldwide (most from the UK) had signed a petition in favour of the messages in the programme as of 13 December 2011.

of fishers' knowledge is possible. Governmental and scientific institutions have needs for new sources of information to address both uncertainty in the biological findings of population ecologists, and also to meet emerging needs in different areas (e.g. ecology, socioeconomics). There is the potential to chip away at the integration project by satisfying these needs, using fishers' knowledge (if possible) when and where they arise. Such an approach is representative of the gradualist one Dunlop [2000] theorised necessary to broaden a Kuhnian paradigm.

Critics might say that this is a contrastingly overly-optimistic assessment on my behalf, and that ultimately fisheries scientists will halt such an integration because fishers' knowledge is not of the right pedigree. They will not give it symmetric treatment in comparison to their own scientific knowledge, treatment that McGoodwin and Neis [2000] essentially state is necessary for its integration. This would be true if all fisheries scientists were ideologically opposed to information that was not of the quantitative nature they have used in the past, but as was seen in section 5.4 this is changing. Wilson's [2009] observational analysis of ICES also shows that fisheries scientists are in the process of redefining how hard data information needs to be to be considered in order to have pedigree:

We need the change to take place that we move to the systematic qualitative²⁰² information, we can't take this on board in the old-fashioned way that says you have to predict numbers. This requires a cultural change for us and for managers. [Anon. ICES scientist in Wilson, 2009, p. 205]

Identified in section 5.4 was that fisheries scientists remain the most important actor to the integration project, because so many other important agencies in fisheries management defer to them. It is they who are now inviting new approaches to complement their existing work:

[...] fisheries science must be pragmatic and open to perspectives, assumptions, insights and methodologies of all disciplines as required in the specific case. In our view, Harriss [a scholar of international development] has a point when he contends that "academic disciplines are saved from themselves by cross-disciplinary work, whether through multidisciplinary[it]y, when arguments from within different disciplines are set side-by-side, or through more rigorous cross-disciplinary exercises that attempt to integrate

²⁰² Here, the ICES scientist is not using 'qualitative' as a social scientist would. They are referring to quantitative or statistical data that cannot be precisely expressed [Wilson, 2009, pp. 204-05], but this still represents a softening of the institution's outlook.

the theoretical and methodological frameworks of different disciplines”.
[Degnbol, *et al.*, 2006]

This quote is from a paper whose primary author is Paul Degnbol. Since writing the paper, he has become ‘Head of Advisory Services’ at ICES [ICES Secretariat, 2010]. If the appointment is an endorsement of his views, which seems probable, it proves that this invite is extended to any discipline, including that of fishers’ knowledge research.

Some may still criticise my stance, saying that once scientists see how different fishers’ knowledge and scientific knowledge are, they would reject the former anyway. The hostility to the concept documented in section 5.4 shows that under certain circumstances this may be true and I agree with Gray’s [2005b] view that a direct integration project into population ecology would at best be slow and fractious. However, in this chapter it has also been shown that fishers’ knowledge could be directly offered to EBFM entrepreneurs (in the scientific community, government and green movement) as a ready-to-use tool. They would be more likely to integrate it into their work, because the scales at which they conduct research match those of fishers’ knowledge [Griffin, 2009]. Additionally, they are already open to using the mix of qualitative and quantitative information in which fishers’ knowledge is delivered. If it became an integral part of their work, then it would also be integrated into mainstream science, as EBFM is close to making that transition itself.

It may be seen as a risk to attach fishers’ knowledge so firmly to a research field that is not yet a fully established part of the epistemic community, but EBFM is closer to becoming part of the Kuhnian paradigm of fisheries management than it might be thought. Government institutions, such as the European Commission, are already looking to work in conjunction with the institutions who are members of RACs in order to develop a suite of indicators to support EBFM within a reformed CFP [Rochet, *et al.*, 2007; iMAGE, 2011]. Environmental NGOs (*e.g.* the WWF), who sit on the same RACs²⁰³, are also pushing the epistemic community to integrate EBFM more rapidly [WWF, 2007]. Most significantly, biological scientists are now

²⁰³ As of 13 December 2011, the WWF are members of the Baltic, Long Distance, Pelagic, North Western Waters, South Western Waters and North Sea RACs.

heavily invested in the ecosystem approach. Table 5.2 lists the ICES working groups that have ecosystem management as their primary goal. They represent 21% of the total number of working groups within the institution [ICES, 2011d]. Figure 5.1 then shows how in the last thirty years, ICES' own journal has become one of the main conduits through which ecosystem research is published [ICES, 2011b].

Table 5.2. List of ICES working groups whose main role involves the consideration of biodiversity or ecosystem science. The table is compiled from full survey of the working groups listed as active on 13 December 2011 [ICES, 2011d].

Working Group
Biodiversity Science
Ecosystem Assessment of Western European Shelf Seas
Ecosystem Effects of Fishing Activities
Effects of Extraction of Marine Sediments on the Marine Ecosystem
Integrated Assessments of the Baltic Sea
Integrated Assessments of the North Sea
Integrating Surveys for the Ecosystem Approach
Integrative, Physical-biological and Ecosystem
Large Marine Ecosystem Programme Best Practices
Marine Planning and Coastal Zone Management
Mixed Fisheries Advice for the North Sea
Multispecies Assessment Methods
North-east Atlantic Continental Slope Survey
Northwest Atlantic Regional Sea
Small Pelagic Fishes, their Ecosystems and Climate Impact

Therefore, not only is the risk minimal if fishers' knowledge is attached to EBFM, but it also acts to introduce the concept to the many institutions who subscribe to the ecosystem approach. This dramatically increases the chances that they will integrate fishers' knowledge in its own right. In chapter 4 it was seen that fishers' knowledge could to a considerable extent inform EBFM in Ireland. It was also shown that other dimensions of fishers' knowledge (e.g. strategies, human capital) could likely support more sustainable and more cooperative formats of fisheries management, therefore meeting the goals of many fisheries institutions, including those within the epistemic community.

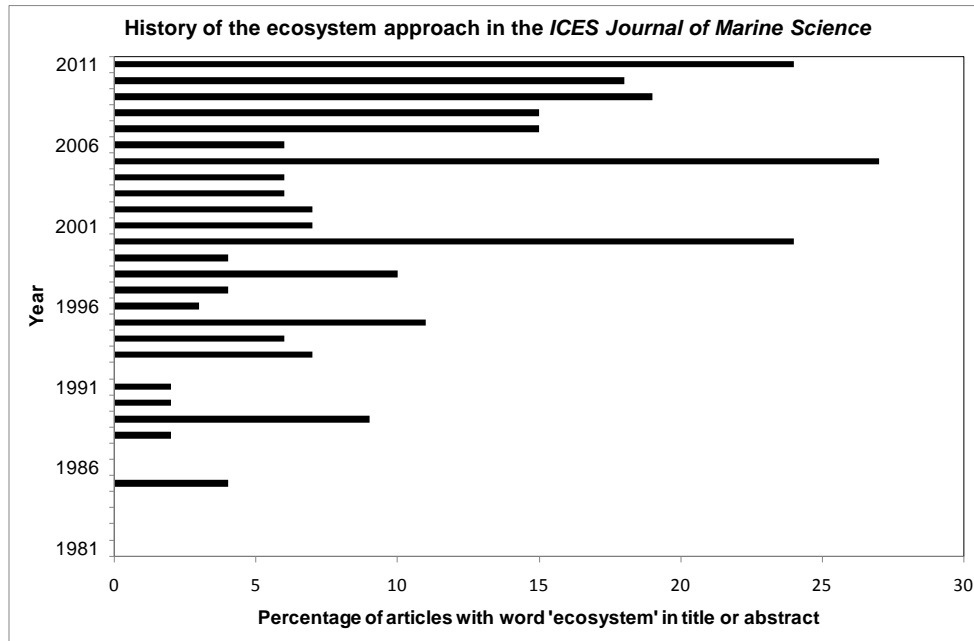


Figure 5.1. The growth of ecosystem publications in the *ICES Journal of Marine Science* from 1981 to 2011. This chart was compiled through searching the publication (online) for instances where the word 'ecosystem' was mentioned in an abstract or title. The early peaks in 2005 and 2006 are explained by the publication of special issues relating to ecosystem sciences.

Finally, the significance of Degnbol, *et al.*'s [2006] previously cited quote along with the endorsement of both population ecology and EBFM by governments and environmental institutions should be noted. It is that there is little institutional appetite for emotive challenges to existing science. Only welcome are approaches that position themselves alongside what is already in place. The direct challenge Toke [1999] theorised possible to epistemic communities is therefore highly unlikely in the case of the fisheries management paradigm, and thus so is the that of radical fishers' knowledge researchers.

5.7. Summary: chapter 5

The discussion in this chapter built on the discussion of types of fishers' knowledge research in chapter 2, partially through considering the results of chapters 3 and 4 and partially through analysis of fisheries governance literature. In particular, it attempted to identify the political and institutional barriers to the radical and reformist approaches to integrating fishers' knowledge and assessed whether they were surmountable. It was found that the reformist approach was more likely to be successful, because it would find more institutional allies who might help to facilitate its integration.

Ultimately, it was shown that although actors and institutions such as those within the civil service, governments and the green movement might find various parts of fishers' knowledge to be usable in their day-to-day activities, that the only community which could realistically catalyse its full integration was the epistemic one. This precludes a radical approach to integration, as it could not work in the same arena as the established hard science.

However, it was stated that even a reformist integration is far from certain. It would still meet a number of obstacles that might derail it. Theorised, was that the best chance for the reformists, may be for them to concentrate their efforts on convincing the practitioners of EBFM of the qualities of fishers' knowledge. EBFM shares the scales and less quantitative nature of fishers' knowledge, and is close to being part of the scientific mainstream itself. If fishers' knowledge could become a partner to EBFM it may not have to overcome obstacles thrown up by other actors in order to gain its integration.

6. Conclusions and significance of research

During the course of this thesis the possibility of fishers' knowledge helping to solve the 'crisis' within fisheries science and management has been investigated. This has been done through a review of existing fishers' knowledge research, a practical examination of how Galway and Aran fishers' experiences could be recorded and interpreted to aid fisheries management on the west coast of Ireland, and a stock-take of the needs of fisheries institutions. The findings are re-emphasised and debated in this chapter.

In the first section, 6.1, the key arguments and most significant findings of the previous chapters are recounted. In section 6.2 these are then collated to answer the research questions posed in section 1.3 and to convey an overall argument. The penultimate two sections are dedicated to the contribution of this work to the activity of fishers' knowledge research. Section 6.3 includes a discussion of the original contributions made, but also considers how they complement and refute previous research. Section 6.4 is used to suggest what the wider significance of the findings presented here may be and whether they should inspire any changes to how future research is conducted and considered. In the final section, 6.5, the limitations of this research are listed, as are more specific recommendations for future research that may allow them to be overcome.

6.1. Reiteration of chapter arguments and findings

Chapter 1 provided an overview of the fisheries management paradigm. The purpose of this exercise was to assess whether fishers' knowledge was part of the fisheries science mainstream, and if it was not, to discover if there was the mobility within the paradigm to accommodate it in the future.

It was found that the paradigm has been dominated by the hegemony of population ecology, but that failures of this empirical science to provide the necessary information for managers to sustainably manage fish stocks had triggered a crisis. It was pointed out that the paradigm may now be on the cusp of reform or even total transformation, although the former appeared more likely. Whilst it was clear that population ecologists had

acknowledged and responded to the crisis, it was also apparent that economists, ecologists, sociologists and indeed other biologists had begun to argue for their own visions of how the paradigm should look going forward. It was against this backdrop that the concept of fishers' knowledge was situated and explored. In particular, it was discovered that fishers' knowledge is actually an idea that has been circulating for some time, and yet remains marginal and ambiguous as a concept.

The crucial observation was that neither the existing fisheries science regime, nor its challengers were systematically applying fishers' knowledge to any great extent: it remains a 'boutique concept' and an object for pilot studies and experiments. The questions then became, under what conditions could fishers' knowledge be rendered more workable and acceptable? Could or should it be mainstreamed? Would it complement the existing population ecology or would it be situated within the emerging critiques of traditional fisheries science?

To assist in the answering of these questions, a series of more structured research questions were set out in section 1.3. Their investigation would allow the utility of fishers' knowledge to be measured alongside and against both the outputs of population ecology, and those of the alternative approaches already competing with the dominant science. A review of the potential pitfalls to researching fishers' knowledge was set out in section 1.4. These were identified in order to make sure that the findings in this study were of the quality needed to answer section 1.3's research questions emphatically.

The scope of **chapter 2's** literature review was to detail how fishers' knowledge is defined by those researching it, and also to determine how they conceived it being used in fisheries science and management. A notable dichotomy was identified in the research community, between 'radicals' who see fishers' knowledge as a challenge to population ecology, and 'reformists' who prefer to see it as a compliment to natural science research.

A timeline emerged of four sequential ‘waves’ of fishers’ knowledge research [see figure 2.2], some of which could be described as radical challenges to the way fisheries management is conducted. Others are better viewed as attempts to reform existing scientific practices. The first wave was conducted by amateur natural historians, but their work was usurped in the mid-20th century when the work of full-time population ecologists became dominant instead [Murray, *et al.*, 2008a]. Most recently, a fourth wave has emerged from the activity of population ecology itself, yet it seems it may not be investigating the fishers’ knowledge that is described in most literature. Its focus is entirely directed towards fishers’ collection of quantitative scientific data. Care must be taken in order to stop this wave from sidelining other discourses, as if that happened, much of fishers’ knowledge and its potential would be sidelined.

However, the most important research waves in the context of this research were the second and third. It is from these that two broad challenges to the dominant fisheries paradigm are emanating. One is a radical challenge that seeks to depose the idea that population ecologists always know best when it comes to assessing the biological state of fisheries. The other is a reformist challenge, which suggests that fisheries science could be reformed for the better if the existing quantitative biological data was complimented with the sometimes qualitative and socio-economic knowledge of fishers. It is a challenge that essentially seeks the symmetrical treatment of scientific knowledge and fishers’ knowledge. In general, the radical challenges have come from ethnographers in the second wave and the reformist ones have been made by applied social scientists in the third wave [see figure 6.1].

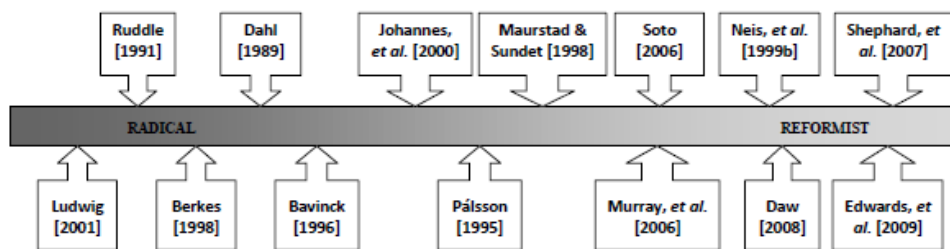


Figure 6.1. A sliding spectrum of some of the radical and reformist challenges to the dominant fisheries paradigm. The work of all authors cited here is reviewed in chapter 2.

The identification of these radical and reformist challenges to the current fisheries paradigm is novel to this research, and it contradicts Holm's [2003] view that fishers' knowledge researchers are not seeking to integrate fishers' knowledge in its true form. The literature reviewed provides examples of where researchers are pushing fishers' knowledge that (amongst other things) can be qualitative, anecdotal and socio-economic (therefore helping to answer Q¹ affirmatively). The differences between the radicals to the left of the spectrum in figure 6.1 and the reformists on the right is that the latter are generally looking to house this knowledge in the existing structures of fisheries management, where the former are advocating the setting up of new management approaches with fishers' knowledge at their heart.

The implication of there being two different challenges from fishers' knowledge research is that they bring with them two differing chances of successful integration of the concept. The reformist challenge is less direct and asks for less change. For this reason it is perhaps more likely to succeed, unless the radical challenge can demonstrate that it would yield effective management approaches and results which are at least as good (or bad!) as traditional fisheries management.

The case study detailed in **chapters 3 and 4** allowed the opportunity to begin to test whether an integration of either a radical or reformist format of fishers' knowledge was in reality possible. Could it compliment and add to existing fisheries science, and could it be of use to those managing Irish fisheries? If so, would the actual integration be of the format of fishers' knowledge recognised by those in the third wave of fishers' knowledge research, or would it be re-interpreted by fisheries scientists and managers? In the first of these two chapters, the results allowed a conclusion to be drawn over whether fishers' knowledge could complement and supplement existing fisheries science in Ireland (e.g. stock assessment). In the later chapter 4, more attention was given to whether it could support emergent scientific and management techniques (e.g. EBFM, participatory management).

The introductory part of **chapter 3** details the methods used to successfully conduct interdisciplinary fishers' knowledge research in an Irish context. It was possible to produce qualitative and quantitative outputs comparable to those reviewed in chapter 2.

However, the reaction to the results by the scientists who commissioned the *Irish Fishers' Knowledge Project* (detailed through the remainder of the chapter) is evidence that a reformist approach to integrating fishers' knowledge will not work if focus is only directed towards complimenting the existing research of traditional biological scientists. A number of areas were listed where the fishers' knowledge contributed by our interviewees could be used to assist with the activity of stock assessment. These included: better spatial identification of stocks, hypotheses of how inter-species interactions may be affecting individual fish populations, fishers' own quantitative assessments of CPUE, and their narratives of the historical trends in discarding within the region. Yet, the scientists stated that only a minority of the findings were of value to them. These were generally the ones where they had little of their own comparative data (e.g. CPUE in shellfish fisheries, locations of unknown nephrops stocklets). Predominantly, they found the data to be either too subjective or too imprecise for integration into their fisheries assessments and indicated that they would continue to place primacy in their own rigorously collected scientific data.

The Irish scientists' generally unfavourable reaction to the results presented in chapter 3 acts to largely point towards a negative answer to Q³. If such a small proportion of findings are deemed acceptable by these important actors in the integration project, then a reformist integration is not plausible. At best it will remain a 'boutique' concept that scientists call upon sporadically.

Despite this apparent barrier, recent publications by the same Irish scientists [Lordan, *et al.*, 2011; Rihan, *et al.*, 2011] and the nations' fisheries managers [MI, 2006] show that there continues to be a commitment to engaging with fishers and their knowledge. With this in mind, Dunlop's [2000] gradualist approach to integration should be

remembered. The elements of fishers' knowledge which were identified as useful by scientists should be researched further so that the best can be made of this potential alliance, but further opportunities must also be sought to integrate fishers' knowledge (and with new actors) if it is to become mainstream. One question that could be asked is should fishers' knowledge become more precise? For example, instead of asking fishers to draw on maps freehand, should the probably more accurate GPS plots from their boat's computers be used instead? A following question then would be, can fishers learn new skills that allow them to report their knowledge more rigorously (without interfering dramatically with the unique nature of that knowledge)? The reactions of fisheries unions to some of the findings presented here (which mirrored those of scientists) imply that they may not be institutions where the best alliances can be found.

The results in **chapter 4** showed that a reformist integration of fishers' knowledge is much more desirable in Ireland if firstly, the ability of fishers to describe ecosystems at varying scales is considered and secondly, if their fishing strategies are identified and then marketed as part of their knowledge.

It was demonstrated how fishers' ecological narratives (given over long temporal scales) could add to scientists' understanding of biodiversity through identification of a shifted environmental baseline in the Galway and Aran region. Additionally, their maps could delimit at fine scales areas of particular ecological importance to local fisheries (e.g. spawning grounds). Such information would not just become an information pillar for fisheries scientists and practitioners of EBFM, but also for European policy-makers, national civil servants, and NGO employees trying to protect habitats with high biodiversity.

Of equal, if not more significance, was how the results showed the way individual fishers simultaneously reference their ecological, socio-economic, cultural, and operational experiences to develop current and future strategies for their operations. Understanding these strategies afforded the chance to see that a substantial portion of skippers wanted to switch to less-intensive strategies, which would likely be less

environmentally damaging. Stopping them switching were restrictive top-down fisheries policy and the struggle to achieve onshore prices for their catch which could financially support less industrial operations.

In addition, the existence of considerable hidden social capital was revealed, with interviewees harbouring many ideas (based on their knowledge) of how the fishery could be sustainably managed.

Two major implications arise from the results in chapter 4. Firstly, in going a long way to answering Q² and Q³ affirmatively, credence is given to the plausibility of an integration of reformist fishers' knowledge via a gradualist approach. Here, a case is set out for how it can be more than just a supporting act to population ecology. It can be a reliable information pillar for the diverse range of actors attempting to broaden the fisheries paradigm through the introduction of EBFM.

Secondly, the integration project is much more likely having taken a step towards providing a positive answer to Q⁴. In identifying a section of the industrial fishing community (not always represented by their unions) who want to decrease their fishing effort and take part in fisheries management, it contributes to solving the greatest conundrum of the epistemic community. It shows how fisheries can be more environmentally sustainable whilst remaining socio-economically and culturally sustainable.

Chapter 5 built on the case study results theoretically, mapping the multi-scaled political and institutional complexity of fisheries science and management. The purpose of this was to identify the broad institutional barriers to fishers' knowledge, and how they might be mitigated. Through a detailed analysis of national and international fisheries policy, and the nature of the epistemic community, it was theorised what sort of integration was possible. The ultimate aim was to further determine whether a radical or reformist approach to fishers' knowledge was feasible, or whether both were, or neither.

It was found that a reformist fishers' knowledge might only be possible if it was allied with those elements within key scientific institutions who are exploring EBFM. This conclusion was made because attempts to integrate fishers' knowledge within population ecology had broadly failed. Moves away from hierarchical fisheries governance had rarely empowered fishers' knowledge because new participatory institutions designed to capture it (e.g. RACs) continued to be incompatible with the information source. Although fishers had sometimes become empowered as actors in these institutional arrangements, the information pillars used to prop them up were still those of quantitative biological science [Jentoft, 2005]. The primarily qualitative style of fishers' knowledge and its temporal and spatial scales (which often contrast with those of population ecology) means it is hard to market in institutions that rely on population ecology. In contrast, the operational scale of EBFM matches the scales of fishers' knowledge, and it is a discipline more open to qualitative inputs.

Significantly for the mechanism of the integration project, it emerged that the fisheries management paradigm would only act to privilege new sources of information if the epistemic community permitted it. Although it was shown that governments and international policy-makers might act to empower fishers' knowledge, it was also shown that they were primarily influenced by scientists (e.g. ICES). The problem with this evaluation, is that sections of the scientific community are either hostile to fishers' knowledge and its integration, or do not see a need to move away from single-species stock assessment. However, the major argument presented in chapter 5, for a partnering of fishers' knowledge with EBFM, offers a route to avoiding this hostility and ensuring integration of fishers' knowledge into mainstream fisheries science. It was also found that if the value of knowing and understanding fishers' strategies and human capital could be marketed to a number of empowered institutions, then it may provide further incentives to integrate fishers' knowledge, because some may see it as a way to help meet goals associated with ecological and sociocultural sustainability as well as stakeholder participation.

It was found that socio-economic crises and moves to adopt EBFM had brought changes to other sections of the scientific community, which also

introduced better opportunities for the integration of fishers' knowledge. The EBFM practitioners, who have recently become part of the established scientific community, are open to the inclusion of qualitative and socio-economic data and additionally are used to working with data collected at smaller ecosystem scales or with a less defined timescale. The synergies between their informational needs and the content of fishers' knowledge would make them an ideal conduit through which to integrate it. Institutional support for EBFM outside of the epistemic community (e.g. within the green movement) could lead to the building of additional alliances for fishers' knowledge, as these actors come to understand its potential utility for this activity.

The headline conclusion of this chapter is a tentative 'yes' to Q², that the "integration project" referred to by Soto is possible [2006]. However, a radical approach that challenges the dominance of existing fisheries science and seeks to shift the paradigm is unlikely to succeed, because of the continued faith that the managers of the epistemic community put in population ecology. Therefore, the only viable path into the scientific mainstream for fishers' knowledge seems to be the reformist one, where fishers' knowledge does not challenge scientific knowledge, but finds ways to work alongside it or compliment it (e.g. by becoming an important information pillar for EBFM). By following Dunlop's [2000] gradualist approach, finding appropriate niches for fishers' knowledge and partnering with institutions where possible, a broadening of the paradigm may be possible.

An important footnote within the chapter's findings was that the integration project is not just about integrating fishers' knowledge, but (reformist) fishers' knowledge researchers themselves [see sections 4.4. and 5.4]. Fishers acting alone would likely not be able to contribute their knowledge in the optimal format to encourage its integration. Fishers' knowledge researchers would almost certainly be needed to uncover the tacit knowledge, fishers' strategies and human capital that could be so valuable to the institutions and actors who might act to mainstream fishers' knowledge.

6.2. Re-visiting the argument: were the research questions answered?

Through an analysis of how each research question was answered, the overall argument can be made for what was found in this thesis.

Q¹ - Is fishers' knowledge more than just a theoretical concept? Does it really exist and can it be discovered?

The answer to each strand of this research question was **an emphatic 'yes'**. I suspected this would be the case before embarking on the research, and indeed would not have committed to the study if I thought this might not be the case. The very existence of the literature on the concept of fishers' knowledge [see chapters 1 and 2] always meant it was likely that I would find the same result in the Galway and Aran region [see chapters 3 and 4]. Still, answering this question affirmatively is a useful exercise for three reasons.

Firstly, as seen in chapter 2, the majority of fishers' knowledge case studies were conducted in the developing world and the First Nations. Examples from developed world fisheries were relatively sparse, especially in Europe. Existence of fishers' knowledge in offshore industrial fisheries is still subject to debate, with some researchers having suggesting that it only exists in artisanal inshore and coastal fisheries where knowledge was passed from generation to generation [Berkes, *et al.*, 1995]. The discovery of fishers' knowledge within all sectors of the Galway and Aran fleet supports theories expressed by other researchers, which state that the drivers of fishers' knowledge are more dynamic [Murray, *et al.*, 2005]. It can also be accumulated in fisheries where the workers are more transient and have in some cases had to accumulate their knowledge independently of family ties.

Secondly, another chance is provided to define what exactly fishers' knowledge is. Whilst chapter 3 and section 4.1 exhibit findings that support the radical perspective of the second wave (that fishers have ecological knowledge which can be used to inform fisheries management), the socio-economic and operational findings presented in sections 4.2 to 4.4 reveal

that the reformist view of third wave fishers' knowledge researchers is perhaps more accurate. Fishers' knowledge is an interdisciplinary knowledge and should not be limited to potential integration into solely biological fisheries science.

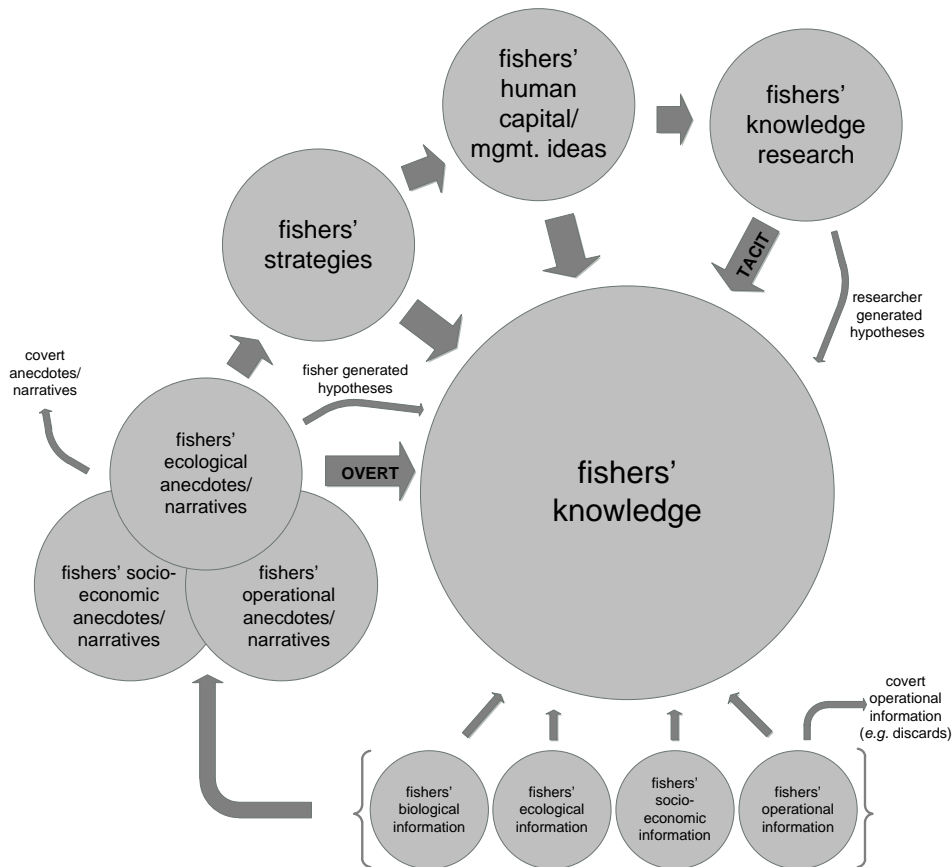


Figure 6.2. The construct of fishers' knowledge (revisited).

Thirdly, I can attempt to define more accurately the different legitimate ways in which fishers' knowledge can be conceived. One is as a quantitative source of biological and socio-economic *information*. Another is as interdisciplinary *narrative*. However, here I formalise an idea developed recently in comparative literature [e.g. Holland, 2008; Abernethy, 2010], that fishers also form *strategies* through referencing their quantitative and qualitative knowledge, which are knowledge in their own right. The fishers' knowledge ultimately described in my thesis is that in figure 6.2. Added to the fishers' knowledge I theorised in figure 2.1 are the concepts of fishers' strategies [see section 4.3], human capital [see section 4.4], fisher and researcher generated hypotheses [see section 3.3], the need for fishers' knowledge research (if all fishers' knowledge is to be discovered) [see

section 5.4], and the covert knowledge that may be impossible to discover [see section 3.3].

Q² - *Can fishers' knowledge be reconciled with fisheries management? Does it have the potential to add value to the discipline and change the current paradigm that is dominated by information produced by population ecologists?*

Findings in three chapters proved that reconciliation of fishers' knowledge with fisheries management had the *potential to add value*, meaning the answer to this question is a **partial 'yes'**. Examples in chapter 2 showed that whilst adoption of fishers' knowledge has not been widespread, it is already adding value by informing management and policy-making in both developing [Johannes, *et al.*, 2000] and more industrial nations [Maurstad, 2002; Edwards, *et al.*, 2009]. The in-depth analysis of Irish fisheries management in chapters 3 and 4 demonstrated where it may be specifically serviceable, firstly through complimenting single-species stock-management, but perhaps more significantly by informing new modes of ecosystem, socio-economic and participatory governance. For these latter activities, fishers' knowledge contained novel findings that could become essential to their practitioners due to the significant implications they have for fisheries management policy.

It cannot be definitively stated, but where the answer to the question is **probably 'no'** is in examining the theory that it could *change* the current paradigm. The political analysis in chapter 5 shows that shifting the Kuhnian paradigm is highly unlikely in the case of fisheries management. Population ecologists are a respected part of an epistemic community and will only be unseated if their political allies find that another information source would provide them with dramatically more certain assessments of fish stocks. The mixed results I present in chapter 3 are evidence that this is unlikely. The only other way to *change* the paradigm would be to persuade scientists themselves that their methods are inferior. The hostility of some scientists to the integration of fishers' knowledge [documented in chapters 1 and 5], and the lukewarm reactions of Marine Institute scientists to the results presented in chapter 3 reveal that this is even less likely. The more probable reconciliation is one where fishers' knowledge adds value

step-by-step; gradually *broadening* the paradigm through supporting (wherever it can) any institutional needs for information. This as an approach deemed possible in the conclusion to chapter 5, and supported by the identification of specific real-world examples of where it could meet these needs in chapters 3 and 4.

Q³ - *Can fishers' knowledge be more than a source of information to be accessed and used solely by academics primarily practicing social sciences? Can fishers' knowledge be collected practically and presented in a format that is understood by biological scientists as well as other interested parties? Do methods exist (or can they be formulated) to translate qualitative knowledge into a quantifiable output?*

In some cases the answer is '**yes**'. One example of where that is the case is through the use of mapping. Combined with chapter 2's successful examples of integrating fishers' knowledge through mapping [Edwards, *et al.*, 2009; McClintock, *et al.*, 2009], the positive reaction of Marine Institute scientists and delegates at ICES [MariFish, 2010] to some of the spatial results illustrated in figures in sections 3.3 and 4.1 is attestation that they find it familiar enough to identify where it may compliment their work. Future fishers' knowledge research should therefore look to integrate GPS and GIS tools, as these are technologies that already have the respect of the scientific community. Another example was that the ability to quantify qualitative perceptions was seen to have potential for Irish fisheries management. A prime case of this was being able to state how many of the interviewees wished to trade down from a single to twin-rig gear setup in the FU17 nephrops fishery.

Yet, **in other respects** the answer is '**no**'. Some qualitative information cannot be quantified, but still appears to have value in its own right. Reducing individuals' fishing strategies [discovered in chapter 4] to simple statistics, such as "What percentage would trade down?" would cause the crucial detail of the circumstances under which each fisher would trade down to be lost. Furthermore, interviewees' descriptions of discarding in chapter 3 could not accurately be supported by quantitative data, but a collated qualitative narrative gave important descriptions (not documented in scientific reports) of dramatic historical changes to discarding practices in the Galway and Aran fishery. Although the conclusions of chapters 3 and 4

show scientists are starting to recognise the existence of such information, it is also noted that they currently have no methods for integrating it. The management advice produced by ICES therefore remains dominated by quantitative single-species stock assessment. The institutional analysis in chapter 5 identifies few audiences for qualitative information, due to either intellectual disdain, the lack of training to process it, or the constraint of the time to fully comprehend it. The one party perhaps more open to it were those practicing EBFM (e.g. at ICES) who had less quantitative data to work with [Wilson, 2009].

What should also be said in hindsight is that **the third question misses the point on two levels.**

First, it should maybe have asked not whether findings of fishers' knowledge could be understood by scientists and other actors, but whether they would be respected. The qualitative narratives of fishers recounted in chapter 3 were at best seen as "interesting" background information by Marine Institute scientists [Anon. MI scientist, 2011a] and the quantitative fishers' information was reported to be too subjective and imprecise. Neither could therefore be used in key fisheries science activities like stock assessment. Scientists preferred to rely on their own techniques, which they saw as more accurate and trustworthy (e.g. UWTV surveys, VMS tracking). However much effort is made to produce fisher's knowledge that is 'science friendly', it may never meet the standards set by population ecologists.

Second, it is important not to forget Holm's [2003] criticism of fishers' knowledge research which is extractive and does not let participants impart their true knowledge. Rather than just asking if fishers' knowledge can be translated to meet the needs of other institutions, it should also be asked whether fishers' knowledge can be understood by scientists and managers when in its unedited form. Intense focus on the results of chapter 3 and section 4.1 may thus be unwise. Fishers rarely use their biological and ecological knowledge in isolation. As was found in chapter 4, they most commonly reference multiple facets of their experience to build strategies and pass judgement on how the fishery should operate. Until fisheries

institutions start to recognise and integrate these sources of information, we will not be making the best use of fishers' knowledge. Whilst fishers' knowledge will not replace stock assessment based on scientific surveys of catch data or VMS and electronic logbook records, it can be used to answer 'why?' and 'why not?' questions.

Q⁴ - *Is the use of fishers' knowledge in fisheries management not just useful, but vital? Without fishers' knowledge will the widely acknowledged deterioration of global fisheries (and marine ecosystems) continue? Without fishers' knowledge will it be impossible to enforce any marine legislation aimed at conservation due to it being impossible to know what will be compatible with fishing industry interests?*

It is too early to definitively state whether the answer to this question is 'yes', but it can be said to be probable. The consideration of the question does allow the opportunity to state the degrees of significance of the overall argument made here.

Fishers are certainly now central to fisheries management and are at the management table (e.g. through union representation), but what has been missing is their content (*i.e.* they have not been able to deploy their knowledge).

Important to remember, is that fish stocks are still declining and that the fisheries science is still seeking remedies to the crisis identified in chapter 1 [Gascuel, *et al.*, 2011]. Whilst the findings in chapter 3 and section 4.1 show that fishers' knowledge may be useful for population ecologists and practitioners of EBFM, it would be overstating the utility of fishers' knowledge to say it can solve all the biological uncertainty within current fisheries science. Essentially, it is not a 'silver bullet'. Population ecology will remain vital to the fisheries science paradigm for the foreseeable future. Fishers' knowledge will at best achieve the status of a complimentary science, which the epistemic community reference when they cannot solve a problem themselves. A qualification should be added here. If fishers' knowledge can become an essential component of EBFM, then it could become viewed as indispensable if EBFM itself achieves that status (which is a definite possibility) [see chapter 5].

Where it could become vital in its own right, is if managers take note of the findings in sections 4.2 to 4.4 and use them to arrest fishery declines. In these sections it was shown that if fishers' strategies and their ideas for management were integrated, then two major drivers of fisheries decline could be at least slowed. Firstly, fishing effort could be reduced if institutional support was given that allowed fishers to adopt less intensive strategies. Secondly, conflict with the fishers could be reduced if science and management became more participatory. In a more convivial environment, scientific assessments would garner greater respect from the fishing industry, who would in turn be less likely to contest policy designed on the back of them, even if it restricted some of their operations [Daw and Gray, 2005]. It cannot be said with foresight whether this eventuality is possible, but the conclusions made here provide a strong case for at least testing the effects of integrating fishers' knowledge.

Restating the argument

The core argument I make is that: **a reformist version of fishers' knowledge would be both desirable and achievable if it were associated with EBFM, and also if institutional capacity was developed to harness fishers' strategies and social capital.**

It is necessary to note whether there are any major qualifications that may derail my argument. Also, it is important to identify any objections that could be made by fellow fishers' knowledge researchers which might invalidate it. Here, I propose respectively how these concerns can be addressed and rebutted.

A lack of consideration of scale is one qualification. The spatial scale at which most scientific assessments are made and management is undertaken (e.g. ICES zones) is above the micro-scale at which fishers' ecological knowledge is richest [Griffin, 2009], and also at which they plan their strategies [see chapter 4]. Additionally, fishers' knowledge does not conform to the rigid, mostly annual timescales of fisheries science. Their ecological knowledge is both in-the-moment and historical and their strategies are a way of looking into the future. In summary, the potential institutional partners for fishers' knowledge are not operating at the scales

where fishers' knowledge performs best and are therefore less likely to be convinced of its value.

The **disempowerment of individual fishers** is another qualification. The feedback from our interviewees [see sections 3.4, 4.4 and 4.5] concurred with findings in chapter 5: that moves to participatory governance have not actually given fishers the chance to impart their knowledge. They complained that their opportunities to contribute knowledge were rare, and that their union representatives could not always make representations to policy-makers on their behalf. The results in chapters 3 and 4 show that fishers' strategies, and much of their most significant ecological knowledge is heterogeneous and only known at the level of the individual. Therefore, if individual fishers cannot contribute their knowledge then again some of the most compelling reasons to integrate it are not being recognised by those who can actually empower it.

My argument therefore, is a qualified one. I believe that if the fisheries paradigm does not first broaden to empower institutions and actors who consider a wider range of scales when gathering information (e.g. those that practice EBFM), and also who practice true bottom-up participatory management, then there is little chance of the paradigm broadening to integrate fishers' knowledge. Those pushing the integration project must be aware of this. Even some institutions set up with the partial goal of gathering stakeholder knowledge (e.g. Europe's RACs) use the larger scales of scientific knowledge and only empower the small number of individuals heading up the unions of (usually) the most industrial fishers [Griffin, 2009].

To address the issues of scale and representation, fishers' knowledge researchers should look to find, and exploit, openings that match the scales of the information they research. These are now appearing with the introduction of real-time data collection and management [Johnson, 2008] and the introduction of localised EBFM [Pikitch, *et al.*, 2004]. They should also find, or advocate for, forums where fishers can contribute their knowledge as individuals, preferably on a one-to-one basis. Efforts have been made to achieve this in Canada [Rice, 2005], but these must be

expanded on, perhaps through introducing internet forums or other communication tools that allow fishers to communicate directly with scientists and managers [JNCC, 2010; Zarauz, *et al.*, 2010]²⁰⁴. Within Europe, attention should be directed towards reform of RACs so as to make them better institutions for dealing with fishers' knowledge, or else new institutions should be set up which can perform this role instead.

Objections to my argument will likely be made by both reformist and radical fishers' knowledge researchers.

Reformist proponents of fishers' knowledge might say that I am risking the future of fishers' knowledge research by resting such a large portion of the integration project on the success of other research fields (e.g. EBFM), which themselves are not guaranteed to be part of the fisheries management mainstream. However, it should be noted that I am not proposing dramatic changes to the methods of fishers' knowledge research conducted by the applied social scientists of the third wave [see section 2.3]. I am simply arguing that the results can be disseminated differently, so that more institutional alliances can be built for the information. I take inspiration from the those who have already found the ecological, socio-economic, and operational aspects of fishers' knowledge to be so rich [Murray, *et al.*, 2006; Edwards, *et al.*, 2009], as well as those like Stanley and Rice [2003] who propose broader consideration for it. Where Stanley and Rice [2003] asked, "Why not add their scientific skills to the mix while you're at it?", I ask, "Why not also throw in fishers' strategies and management ideas?" I am not attaching fishers' knowledge to niche concepts that have no chance of becoming mainstream. EBFM is close to achieving this elevated status [see section 5.6]. Even if the research fields I propose attaching fishers' knowledge to do ultimately fail, reformists can continue with efforts to find better ways for it to compliment population ecology.

²⁰⁴ In the UK, an online map has been set up at <http://www.mczmapping.org/> where stakeholders (including fishers) can log on to individually upload spatial aspects of their knowledge [JNCC, 2010]. In the Basque Country region of Spain, the electronic logbooks onboard fishing vessels have been modified so that each fisher can record their fishing tactics (*i.e.* strategy) and so that they can freely contribute their anecdotal contributions.

Some **radical proponents of fishers' knowledge** would certainly criticise my argument for not portraying circumstances in which fishers' knowledge might be used as the only information pillar for fisheries management (which may be by fishers themselves). Beyond the political and practical difficulties with this critique identified in chapter 5, the results in chapter 3 showed that whilst fishers' knowledge could certainly add to fisheries science in places, and that their estimates of CPUE were in line with scientific estimates, there were also occasions where fishers comprehended little about issues important to the current and future health of the fishery (e.g. the sex ratios of nephrops) [see section 3.3]. It is perfectly possible that if managers replaced the assessments of population ecology with only fishers' knowledge, then the same failures that triggered the crisis in population ecology would occur.

Through overselling fishers' knowledge, radicals fail to manage fishers' expectations. In advocating a management system where fishers' knowledge is all that is needed to assess fisheries and make management decisions, they are setting fishers' knowledge up to fail, and opening up fishers themselves to criticism. Where fishers' knowledge cannot explain a fishery decline, which as seen in chapter 3 will certainly be the case on occasion, radicals propose no alternative. They will have created a policy vacuum, where fisheries are likely to continue to collapse. When such collapses occur, fishers and their knowledge would likely be criticised for their inability to understand and arrest them. Not only would the failure of fishers' knowledge provide ammunition for detractors of fishers' knowledge, but it would probably foster resentment amongst fishers towards fishers' knowledge researchers for exposing them so openly to criticism.

Radicals could counter this, citing my arguments for the utility of fishers' strategies and management ideas as evidence that fishers could (as Ostrom [1998] says) come together for the common good. They might suggest that fishers could employ precautionary strategies that prevented overexploitation of the fisheries. Yet, this would ignore Ostrom's [2000b] further work and the results in chapter 4 which show that where the situations of fishers are heterogeneous, then they can act differently. A key problem I discovered, whilst uncovering fishers' hidden social capital, is that

they are strategically divided. For instance, some of the fishers-for-volume profiled in chapter 4 could never fish at precautionary levels under their current socio-economic pressures. This complicates fisheries management, and shows that it could not always be conducted by fishers alone. In fact, fishers themselves may undermine this radical argument. The Galway and Aran fishers had tried before to collectively agree on management regulations and failed [see section 4.4]. They were now asking for assistance from various institutions (e.g. BIM) to help introduce policy via co-management.

Other radical exponents are not necessarily intent on fishers' managing fisheries themselves, but are upset at the power bias towards population ecologists and nation state networks. In particular they are distrustful of the state because of the way it uses science to serve its political agenda. Whilst they would not advocate the end of science, they might criticise my argument because they believe it perpetuates the scientific discourse and leaves that of fishers still at the margins. They would be right to point to the reaction of Marine Institute scientists in chapter 3 and their preference to use modern VMS tracking and UWTV surveys (rather than fishers' knowledge) as evidence of this. To an extent I would agree that my results are in danger of being co-opted in this manner, but I would counter this criticism by first pointing to the call from ICES scientists for a greater range of indicators to inform their work [Degnbol, 2005; Degnbol, *et al.*, 2006]. The reformist approach I propose is not one that challenges established science *per se*. It can take (and is happy taking) this role as one of a suite of indicators which can be referenced in attempts to solve scientific uncertainty. Secondly, the results I present and the proposals I make in chapters 4 and 5 demonstrate that I am not simply happy to see fishers' knowledge in this partially subjugated role. By partnering it with approaches such as EBFM, I am proposing to attach it to emerging discourses which are changing the power dynamics of the epistemic community. Fishers and their knowledge would become more powerful through these associations.

A final challenge may come from radicals who believe that inshore artisanal fishers should be privileged ahead of more industrial fishers, because they believe them to have the most knowledge and often operate most

sustainably. They might argue that my approach does not give this sector of the fleet the representation they have so often struggled for as the group least able to play the scientific game (e.g. not having the same representation on RACs as the offshore industrial fleet). I would firstly reply that this sector should not necessarily be privileged for being more knowledgeable and sustainable. For instance, we found that (possibly unsustainable) fishing-for-volume was a strategy also present in the inshore potting fleet. Knowledge and strategies varied within all sectors of the fleet and therefore I believe it is problematic to say which should get greater representation. Secondly, I would state that it is crucial to include the industrial offshore fleet in fishers' knowledge research. The findings in section 4.3 show that understanding their knowledge (and therefore strategies) may be the best way to reduce fishing effort and make fisheries more sustainable. This is a chance that cannot be missed.

6.3. Originality and contribution of arguments to the academic literature

It is important to show how this study differs from the research that it is closest to in the fishers' knowledge field. In doing this it can be seen whether I am replicating and confirming existing work, or introducing new ideas for how fishers' knowledge should be studied and integrated, or both.

As stated in section 3.2, I drew directly on the work of those who first pioneered fishers' knowledge research in industrial fisheries, especially those working in Canada and then in northern regions of Europe [**e.g. Neis, 1992; Neis, et al., 1999a; Pálsson, 2000; Maurstad, 2002; Murray, et al., 2006**]. To a large extent I was able to replicate their work, my case study findings confirming fishers' diverse knowledge at multiple scales. However, whilst adding another case study (from a country where there are few previous examples) was a useful exercise, it was important to take the opportunity to add conceptually to their work. I did this by taking a lead from Canadian researchers, in the hope that I could take a stepping-stone towards answering questions this group had about how fishers' knowledge could find its way into policy [Neis and Murray, 2009b].

In the conclusion to her recent thesis, Cristina Soto highlighted an area where there was a specific need for further research:

“A detailed examination of stakeholders’ goals, both fishers’ and scientists’, and whether and how the application of Fishers’ Knowledge was able to meet them, was beyond the scope of this research project. This remains an important piece of work to be done in future field work.” **[Soto, 2006, p. 230]**

Here, I have contributed to what she calls (and I have continued to call²⁰⁵) the “integration project”: the development of a framework to ensure a long-term integration of fishers’ knowledge into fisheries science and management. Like her, I identify the greatest barrier to integration to be the nature of the epistemic community. The difference with my approach to making this finding is that I take her theoretical approach and implement it in a real-world setting. Working within the institutional networks of Irish fisheries management, I was myself able to actually push against the potential barriers to integration (*e.g.* the scientists of the Marine Institute), in doing so finding out how fishers’ knowledge could be used to break these down through meeting stakeholder goals (as Soto suggests in the previous quote). Ultimately, her conclusion matches mine. A paradigmatic broadening, which opens fisheries science to more than just population ecologists, is necessary if fishers’ knowledge is to be integrated. She also called for further research to discover the form which institutions would need to have to integrate fishers’ knowledge. My identification of the elements of fishers’ knowledge which are most desirable to existing institutions could inform such a study.

My thesis must also be read alongside that of Tim Daw, who agrees with the conclusion made here; that some of the most important findings from fishers’ knowledge research are not those of biological states or measurements of CPUE, but instead of those which represent a fisher’s worldview **[Daw, 2008]**. Similar to my chapter 4 findings, he identified fishers’ perceptions, changing strategies and views on management as part of this outlook. I additionally subscribe to Daw’s statement that one of the

²⁰⁵ I find the term “integration project” to be a very useful and appropriate one, thus it is one I have adopted in my own research.

most important outcomes of an integration of fishers' knowledge would be the improved working relationships between industry and scientists:

Collection and translation of [fishers' knowledge] into quantitative forms which can be subsumed into stock assessment models [...] cannot address key conceptual differences between stock assessment science and fishers; nor allow science to learn from the novel insights held by fishers; nor allow fishers to understand the work and insights of scientists. [Daw, 2008, p. 241]

Where I diverge from his findings is in my assessment of how top-down fishers' knowledge research can afford to be. I agree with Daw's [2008] belief that fishers' knowledge research can never be entirely extractive. However, he also states that predominantly extractive approaches, which retain at least some participatory element, could be acceptable where there are large samples of fishers. He suggests that this may be a technique we have to settle for in industrial fisheries with large fleets that are difficult to survey in their entirety [Daw, 2008, p. 236]. Essential in my opinion is that the research must be primarily bottom-up. The gradualist integration for fishers' knowledge, which I suggest as potentially the only approach, will only succeed if it can push for inclusion at multiple entrance points in the institutional network. To do this it needs to include the ecological narratives that will impress EBFM advocates and it especially needs to include fishers' strategies and management ideas, because this is the knowledge which has the most potential for satisfying scientists' long-term goal of reducing fishing effort. Narratives and strategies can only be collected through predominantly bottom-up research²⁰⁶.

Some of the authors in this section (e.g. Tim Daw; Grant Murray; Barbara Neis) have introduced ideas close to what are here termed "fishers' strategies"²⁰⁷. In this thesis I have perhaps pushed this concept towards the forefront more than they have. Because I have found fishers' strategies to be one of the elements of fishers' knowledge that institutions would most

²⁰⁶ Perhaps in the cases of large survey samples, bottom-up integration research can be achieved via the new communication tools being used in the UK [JNCC, 2010] and Spain [Zarauz, *et al.*, 2010] and mentioned in an earlier footnote in this section.

²⁰⁷ When describing the importance of recognising fishers' perceptions, Daw [2008] uses the example of how fishers change strategy in response to fuel price. Murray *et al.*'s [2006] example of 'Jack' and his operational decisions, as well as arguments for modelling actor-behaviour as part of fishers' knowledge research [Murray, *et al.*, 2008b] are examples of this.

benefit from integrating if they could recognise it, I believe they deserve greater consideration during research and a more prominent position in project outputs. I think the work of Kirsten Abernethy and Daniel Holland must therefore be considered as an extension to the third wave of fishers' knowledge research. Whilst their research appears to have developed independently of the fishers' knowledge research reviewed in chapter 2, it agrees closely with the findings I present in section 4.3. Both found that fishers' constructed strategies from ecological, socio-economic and operational knowledge, and that if these strategies are understood, then it is possible to predict how fishers would react to changes in management policy and fisheries regulations [Holland, 2008; Abernethy, 2010]. I believe all fishers' knowledge research would benefit from further consideration of their work.

By citing the research in this section as work that I have tried to add to, I have identified myself as part of what can be described as the reformist fishers' knowledge community. The interdisciplinary approach of applied social scientists is the only one that has the scope to capture all the aspects of fishers' knowledge identified in chapters 3 and 4. The narrower approaches of ethnographers and natural scientists (in the respective second and fourth waves of fishers' knowledge research) limit the concept to something that is purely qualitative or conversely, purely quantitative and primarily ecological. Bottom-up research performed in this thesis and by other applied social-scientists shows that this is simply not representative of fishers' knowledge. As somebody who believes that fishers' knowledge has to be presented in a manner which fishers themselves would recognise, I see myself firmly in the third wave.

6.4. Wider significance of research: theorising the future of fishers' knowledge research

A number of implications for the future of fishers' knowledge research can be recognised following the contribution of this thesis.

The first implication is for those making an emotive challenge to the dominance of population ecology. Whilst the importance of the second wave of fishers' knowledge research in precipitating the third should not be

underestimated, it should be stated that a radical integration of fishers' knowledge is likely not viable. The management of industrial fisheries using fishers' knowledge as the sole information pillar is an unrealistic target, because powerful and entrenched epistemic communities will not allow a paradigm shift that supplants scientific knowledge²⁰⁸. By way of contrast, a reformist approach which gradually builds institutional alliances is the only one with a good chance of success.

The second implication applies to reformist proponents of fishers' knowledge. I have been distinctive in this thesis in highlighting the potential alliances for fishers' knowledge research with EBFM. This raises questions over how they should carry out and present their research. Should they themselves be considering labelling themselves ecosystem scientists? The answer is likely no, as this would dramatically narrow their remit and close off other opportunities for a gradualist integration of fishers' knowledge (e.g. through discovery of fishers' strategies). However, they should certainly be considering where exactly within the large EBFM discipline they would be able to forge the strongest alliances. For this purpose they need to assess precisely how fishers' knowledge could best act as an information pillar to EBFM. This is an area which requires future research.

Thirdly, in every chapter I have highlighted the issue of attention to scale, as it is often little considered by fishers' knowledge researchers, but can be the difference between fishers' knowledge finding and not finding the actors that are its potential allies. From an institutional perspective, if interfaces for collecting fishers' knowledge are set up at too large a scale they will fail, because they will not be able to process the micro-scale ecological and strategic data that I have described as so important for the integration project. From a methodological perspective it will be important to be aware of the scales used by both the institutions that can empower fishers' knowledge, and of the knowledge itself. The introduction of real-time

²⁰⁸ A radical might argue that their aim is not to market fishers' knowledge to these communities, but to use it as defensive concept as part of a longer term attritional strategy to seek the collapse of the paradigm (and a subsequent shift which would allow the inclusion of fishers' knowledge as they envision it). However, this is too high-a-risk strategy, because there is no guarantee that a collapsed population ecology paradigm would be replaced with a more benign regime. Indeed, the void may well be filled by the economists identified in section 1.5, who would have even less use for qualitative anecdotes and narratives.

management by the institutions of the epistemic community [Johnson, 2008] will be a particular challenge, as the traditional methodology of in-situ interviews (followed by fairly slow dissemination of results) will not be compatible with hi-tech systems. Fishers' knowledge is accumulated in real-time and therefore it can meet this challenge, but methods will need to be developed to achieve this²⁰⁹. Additionally, the primacy I give to fishers' strategies extends the temporal scale of fishers' knowledge into the future. This can be a big selling point, but researchers will need to move some of the focus from interviewing the eldest and most experienced fishers to the younger fishers (who have the most time left in the fishery) if it is to be sold effectively.

Finally, as I have emphasised that a gradualist integration of fishers' knowledge (which will involve the co-operation of a broad range of institutions) is perhaps the only feasible approach, then it must be remembered that the outputs of fishers' knowledge will be required to meet diverse needs. An interdisciplinary mixed methods approach therefore seems prudent, as it will produce the most diverse results. Innovative research techniques that can demonstrate how fishers' knowledge is different (whilst remaining useful) are to be encouraged. Spatial mapping techniques that appeal to biologists and ecologists alike [des Clers, *et al.*, 2008] are part of the future of fishers' knowledge research, as are those which integrate GIS [Macnab, 2002; McClintock, *et al.*, 2009] and cognitive mapping of fishers' strategies [Prigent, *et al.*, 2008].

If it is to be a sustainable academic field, fishers' knowledge research cannot remain the boutique concept that unfortunately it still is within fisheries management in most industrial nations. As was seen in chapter 2, occasions where it has been implemented as part of state-run research programmes are few and far between. Entry to the mainstream paradigm of fisheries science and management must continue to be sought by those pushing the integration project. As a peripheral concept, where it is only

²⁰⁹ Electronic-log books are already being used to get fishers' to contribute quantitative information in real-time [Johnson and van Densen, 2007]. The adaptations made to the electronic log-books on board industrial fishing vessels in Spain's Basque Country are one such tool that could gather fishers' knowledge in real-time [Zarauz, *et al.*, 2010].

called upon to solve the occasional uncertainty with scientific stock assessments, it will not add the value that it clearly can, and will not gain the recognition that it deserves. Whilst not as expensive as some research programmes, fishers' knowledge research still involves considerable cost and requires significant investments of personnel. Ignorant of its true worth, international and state bodies may instead seek to direct funding and effort into rejuvenating population ecology and kick-starting research into discovery of other information sources which they judge to have more promise. Yet, the results presented here show that fishers' knowledge can perform better than population ecology in important areas. Fishers' ecological knowledge performs at more numerous scales than established science. Fishers' strategies tell managers far more than métier data ever could. The ideas fishers have for management showcase a human capital that scientists have rarely found. These are the unique parts of fishers' knowledge that show fishers, like scientists, to be experts in their own right. Concentration on the integration of such concepts can ensure an ongoing demand for fishers' knowledge within fisheries institutions.

6.5. Thesis limitations and recommendations for follow-on research

During the course of this research one of the most consistent queries of those I described it to was to do with the choice of interviews as a research methodology, particularly as to why I chose them ahead of participant observation and why I had chosen not to live in the community I was researching. It has long been claimed that participant observation is the "most complete" sociological method, and that it is the best way to uncover nuanced local knowledge that is hard to understand without long-term exposure, as well as the most productive in revealing the full nature of an individual's beliefs, which could be being obscured deliberately or through their feeling uncomfortable during an interview [Becker and Geer, 1957]. Indeed, Abernethy's [2010] decision to live with the community she was researching likely contributed to her so ably discovering fishers' strategies in UK fisheries [see section 4.3], and participant observation by those studying fisheries discards and bycatch [e.g. Mangi, *et al.*, 2007; Turek, *et al.*, 2009] led them to discover more covert fishers' knowledge than it was

possible to do with the interviews of the *Irish Fishers' Knowledge Project* [see section 3.3].

If there had been no constraints, then an attempt would have been made here to conduct both interviews and participant observation, but as noted in section 3.2 this was not possible or even desirable. As a result of the need to use a methodology that employees of Ireland's Marine Institute may need to replicate in the future, participant observation was ruled out as too time consuming for these already busy individuals. It was also concluded that such ethnographic methodologies could harm the integration project for fishers' knowledge, because actors best placed to integrate it into the fisheries management mainstream may be ideologically opposed to highly qualitative ethnographic techniques. These considerations may not have been necessary in previous fishers' knowledge research that successfully used participation observation, but are crucial when considering the wider mechanisms of knowledge integration detailed in chapter 5. Additionally, it should be noted that many of the results described in chapters 3 and 4 were only elicited when fishers became reflective, an occurrence which is much more likely in an interview [McCormack, 2004]. Therefore, an interview approach may actually generate a more complete knowledge than participant observation anyway.

Further research should focus on trying to create reflective spaces that combine interviewing and participation observation, so that the most complete fishers' knowledge can be produced. It should also be sensitive to the operating requirements of actors like the Irish Marine Institute and those discussed in chapter 5 in order to maximise the chance of its integration. One possible approach would be to observe fishers' behaviour using VMS and real-time catch data and then to telephone interview them, asking them *why* they conducted the observed fishing. It could result in the understanding of fishers' strategies in near real-time.

A second limitation is a result of the necessarily restricted research remit. Although the Irish case study presented an excellent chance to assess institutional appetite for integrating fishers' knowledge, the depth and breadth of this assessment was limited. For instance, within Ireland our

interviews and attendance at meetings allowed us to interact with scientists at the Marine Institute, fishers themselves, environmental NGOs and fisheries unions, but not with civil servants at the DAFF or EU, nor with elected politicians. Conclusions drawn on their potential attitude towards fishers' knowledge were deducted from published literature. Additionally, there was only the opportunity to interview fishers about how they thought their knowledge should be perceived and used, where perhaps it would have been advantageous to also interview individuals from all the institutions analysed in chapter 5 (specifically those mentioned in sections 3.4 and 4.5 which had roles in Irish fisheries management). The discussion in chapter 5 is subsequently compromised by its inability to definitively affirm how serious various institutions are about seeking new forms of knowledge to support fisheries management, or even about whether they want to continue to engage with fisheries science and management at all.

Fisheries management has certainly become politically contentious, with either stock collapses or the mitigating quota cuts designed to prevent such collapses seen as undesirable to different sections of the fishing industry and public (depending on their outlook). The greatest risk to fishers' knowledge research may therefore be one not yet considered in this thesis; one of governmental retreat from fisheries management for political reasons. A rise in the popularity of the neoliberal market-based fisheries management described in section 1.5, evident in the increased use of ITQs [Chu, 2009], is an example of this development. The simplicity of a system which requires little government intervention, as well as little investment of time or money, is probably highly attractive to politicians looking to avoid the controversies of fisheries management, such as those that have blighted Europe's CFP [Daw and Gray, 2005]. Given chapter 3's mixed conclusions on the utility of fishers' knowledge in stock assessment (the only science needed to set the quota for ITQs) a turn to market-based fisheries might mean the potential institutional alliances for fishers' knowledge identified in chapter 5 (e.g. with institutions favouring EBFM) may not exist. The only possible 'integration' may be the one envisioned by radical fishers' knowledge researchers, but that would still be highly unlikely with the existing epistemic community still in place.

However, reformist fishers' knowledge researchers will not be alone in contesting any wholesale switch to market-based management. There would be considerable institutional and public opposition to switching to systems like ITQs, which sometimes reward corporations rather than individual fishers and that do not always guarantee the sustainable exploitation of fish stocks or the protection of biodiverse ecosystems [Eythórsson, 1996; Chu, 2009; Gibbs, 2009]. Future fishers' knowledge research can likely be successful then if it can prove that fishers' knowledge can make fisheries management less fractious, less uncertain and more successful. To do this it must move beyond the discovery of fishers' knowledge and the theoretical concept of an integration project to find real-world spaces where it can be demonstrated that elements of fishers' knowledge (e.g. their strategies) can inform management that improves both socioeconomic and ecological sustainability. Firstly, scientists, civil servants, NGO employees and fishery union officials should be interviewed, so that evaluations can be made about how fishers' knowledge could best fit into their future operations. Secondly, pilot projects need to be set up where fishers' knowledge researchers do not just report findings to such actors, but work alongside them in order facilitate its integration. Ultimately, the widespread practical demonstration of the worth of fishers' knowledge will be necessary to convince the epistemic community of the need to integrate it. In the Irish case, a pilot project that required the engagement (facilitated by fishers' knowledge researchers) of the Marine Institute, BIM, the NPWS, the DAFF, NGOs, and the FIF with fishers and their knowledge in at least one regional fishery would be a desirable step.

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Appendix A: Interview guide sheets

(Survey has been edited here for brevity, but no words have been changed)

FISHER SURVEYS

Cast study: _____
Fisher Number: _____
Interviewer: _____
Date: _____

Introduction: Marine sociologist/marine researcher from National University of Ireland, Galway, studying Irish fisheries, particularly interested in knowledge of fishers regarding the fishery. Would like to ask some general questions about your experiences of fishing.

SECTION 1: DEMOGRAPHIC INFORMATION

1. Sex?

a. Male	b. Female
---------	-----------

2. Age?

a. <20 years	b. 20-39 years	c. 40-59 years	d. 60+ years
			How old?

3. Years in fishery?

a. <5 years	b. 5-10 years	c. 11-15 years	d. 16-20 years	e. >20 years
				How long?

4. What age did you start fishing?

a. <20 years	b. 20-39 years	c. 40-59 years	d. 60+ years
			How old?

5. What is your involvement in the fishery?

a. Active/Full-time	b. Retired	c. Semi-active/Part-time?
	For how long/when?	Status description:

6. Have you had any gaps in your fishing career?

a. No	b. Yes	
	When/how long?	Why

7. What role do you have in the fishing industry?

a. Boat Owner	b. Boat Skipper	c. Crewmember	d. Other
		Rank?	Specify?

8. Which sectors have you fished in?

a. Inshore (pots)	b. Inshore (trawler)	c. Offshore (trawler)	d. Commercial (e.g. factory ship)	e. Other
				Specify?

9. Are any of your family involved/have been involved in the fishing industry? If not, what do they do?

a. No	b. Spouse	c. Parents	d. Children	f. Other (specify)
	Description:	Description:	Description:	Description:

10. How many generations of your family have been involved in fishing?

a. None	b. 1	c. 2	d. 3	e. >3
---------	------	------	------	-------

11. Would you recommend future generations of your family join the fishing industry?

a. No	b. Yes	Why?
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12. What level of education and training do you have (tick all that apply and brief description)?

a. School	b. College	c. Fishing training courses
		Detail:

13. Can you answer these questions regarding your fisheries experience?

a. Which general areas have you fished in your career?	
b. Who did you fish with when you started?	
c. Who taught you to fish?	
d. Have you/your family always been based here? Born here? If not from where have you come? Do you live here currently?	

SECTION 2: VESSEL HISTORY

14. Can you provide the following information regarding vessels you have crewed on?

	Vessel 1	Vessel 2	Vessel 3	Vessel 4	Vessel 5
Name?					
Years Fished: When to when?					
Ownership?					
Builders/Designer?					
Tonnage?					
Length/Width/Depth?					
Material?					
Engine Type and HP? Gas/Diesel?					
Fish finding equipment?					
Navigation equipment?					
Communications equipment?					
Hauling equipment?					
Species fished? (Nephrops, Cod, Haddock, Plaice, Whiting, other)					

Gear used (for each species)?					
Licenses and permits held?					
Crew size and composition?					
Share system? Details of:					
Other boats owned/in fleet? Brief description:					
Why did you change boat?					
Other/Notes:					

SECTION 3: FISHING HISTORIES

15. For each vessel described in the previous section, can you describe your fishing history for each species fished from that vessel? (USE SPECIES CARDS FOR EACH SPECIES)

VESSEL 1 Name:	
SPECIES (draw line after each species)	
VESSEL 2 Name:	
SPECIES (draw line after each species)	
VESSEL 3 Name:	
SPECIES (draw line after each species)	
VESSEL 4 Name:	
SPECIES (draw line after each species)	
VESSEL 5 Name:	
SPECIES (draw line after each species)	

SECTION 4: QUESTIONS RELATING TO CHANGE AND THE FUTURE

16. Can you answer the following questions in general terms describing changes that have happened over your career and how you think things may change in the FUTURE? What are their preferences?

When you have changed gear and boat design why did you do this? What was the consequence of that change? Do you think it will change again in the future? What sort of boat and rig (if any) would you prefer to fish?
As you have changed the location and/or depth at which you fished over time, when and why have you made these changes? Do you think this will change in the future? Where do you prefer to fish?
Where you have changed species targeted over time, why have you made that shift? Why did you make it then? Do you think species focus will change in the future? What species (if any) would you prefer to fish?
What effect have rule and regulation changes had on your work and on the fishery in general? Do you think there will be more rule changes in the future? What changes to rules and regulations would you like to see?
What role have gear conflicts and other fishers intercepting fish, etc. had on your fishing practice? Do you anticipate further conflicts? What is your preferred resolution to these conflicts and who should resolve it?
What do you think the consequences for the fish and their habitats have been of different types of fisheries and gears, etc.? Do you think these fisheries and habitats will survive ecologically in the future? Do you think there is an ecological problem at all, and if so, does it concern you?
Were the changes in your fisheries over your career similar to, or different from others in the area? <i>i.e.</i> in the fleet fishing that species. Do you think you will align to them or diverge from them in the future? What would you rather do?
Overall what do you think the future for fishing is in this area and the rest of the country? Will you continue to fish? Do you want to continue? Do you want your children to?

SECTION 5: PERSONAL OBSERVATIONS AND OPINIONS

17. What are your personal opinions and observations regarding the following?

Do you have any personal observations on changes or trends in the stocks you have fished over the course of your career (*i.e.* fished out, declining, increasing, environmental problems, etc.)?

--

What, in your view, are the things that put fish stocks at risk in this area? Does it vary from fishery to fishery?

--

What, in your view, are the things that put fishermen at risk in this area? Does it vary from fishery to fishery?

--

Have any of the following impacted you or those you know? Reduction in quota, fishery closures, gear restrictions, boat restrictions, etc.

--

Do you have any recommendations you would like to make regarding changes in fisheries science? Fisheries management? Fishing vessel safety?, etc. that you think would promote the health of fish stocks? The long term incomes, employment and health of fish harvesters?

--

Terminology: In this box write down any local terminology that you encounter during the interview and a definition.

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THANK YOU FOR YOUR HELP WITH THIS SURVEY

Appendix B: ICES management zones and functional units

Image is taken from the Marine Institute's *Stock Book* [MI, 2010, p. 459]. They have given their permission for the use of the image in this thesis.

